PROPOSAL FOR A NEW STANDARDISED BASELINE FOR CHARCOAL PROJECTS IN THE CLEAN DEVELOPMENT MECHANISM

To be considered by the Executive Board of the Clean Development Mechanism

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Commissioned by GreenResources – based on key findings from the report "Towards a more standardized approach to baselines and additionality under the CDM" and "Piloting greater use of standardised approaches in the Clean Development Mechanism ", commissioned by the UK Department for International Development

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The contents of the report reflect the views of the authors and not necessarily the views of the UK government.

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0. Approval of this standardized baseline

Submitting country:		
Party	DNA	Letter of approval
Republic of Uganda		
Further parties approving to the use of this proposed standardized baseline for the development of CDM projects within their country:		
Party	DNA	Letter of approval

Documents for the submission	Comment
"Proposed standardized baseline submission form"	Not available at the time of the submission.
Additional documentation supporting the submission (e.g. relevant data, documentation, statistics, studies, etc.) where applicable.	Upon request if not specifically available from the references provided.
An assessment report on the quality of the data collection, processing and compilation to establish the proposed standardized baseline in accordance with relevant procedures or guidelines adopted by the Board. The assessment report may be prepared by a designated operational entity (DOE) contracted by (….)	In accordance with the procedure, the submitting party with less than 10 registered project activities as of 31 December 2010, wishes to omit the assessment report.

Scope of applicability	
1) Projects which install and operate new low GHG charcoal production kilns - Use of the "consolidated GHG database for the informal charcoal sector" for the calculation of baseline emission factors. - Simplified identification of baselines. - Ex-ante additionality for projects which project activities which are the installation and operation of new low GHG charcoal production kiln	
2) Projects which disseminate more efficient charcoal-based cookstoves - Use of the "consolidated GHG database for the informal charcoal sector" for the calculation of baseline emission factors of charcoal.	

1. Key values and approaches proposed under this standardized baseline

Under this standardized baseline, the following key default value are proposed in order to “facilitate the calculation of emission reduction and removals and/or the determination of additionality for clean development mechanism project activities, while providing assistance for assuring environmental integrity:

Key default values proposed:			
Parameter	Description	Default value	Unit
K_{CH4}	Emission factor for methane emissions as found in the *consolidated GHG database for the informal charcoal sector*	6.5128	tCH_4/t charcoal
K_{CO2}	Emission factor for CO_2 emissions as found in the *consolidated GHG database for the informal charcoal sector*	0.0382	tCO_2e/t charcoal
$CF_{NCV,i,y}$	Correction factor for the project to baseline net calorific value of charcoal product *i* in year *y*		
	Charcoal from mixed plantations, coconut shells and bamboo.	1	-
	Any type of biomass mix which includes dried agricultural wastes	0.66	-
CC_i	Carbon content in wood	0.45[1]	tC/t wood
Specific applicability conditions			
Methodologies and project activities using elements of this standardized approach shall make use of the latest default value of K_{CH4} and K_{CO2}. An opt-out[2] of the proposed values for K_{CH4} and K_{CO2} is strictly prohibited and fully prevents the use of any default assumption on baseline and additionality under this standardized baseline.			

Conservatively estimated balance of emission reductions
Unaccounted for emission reductions: ~30% (expressed as % reduced emissions)

[1] Conservative assumption based on 47% wood carbon content in miombo woodlands and 44% in Savannah woodlands (Chidumayo, 1994)

[2] An opt-out is defined as the use of different values for KCH_4 and/or KCO_2 – or equivalent parameters even under a different name – for the purpose of cherry-picking more favourable values to CER generation which have been identified on a more local level.

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2. Purpose of this proposal

This proposal has the following objectives

(1) Provide a short background on the importance of the “charcoal problem”
(2) Explain why a simplification of projects is required
(3) Establish the compliance of this proposal with applicability conditions
(4) Establish a standardized baseline to facilitate the calculation of emission reductions: the “*consolidated GHG database for the informal charcoal sector*”
(5) Establish ex-ante the additionality of the following

3. Introduction

3.1 Background on the charcoal sector

Improvements in the conversion of biomass to charcoal show a tremendous potential for reductions in the associated GHG emissions. This potential consists in both avoided consumption of non-sustainable biomass and mitigation of CH_4 emissions during the production process. The potential is especially strong in Africa where most Least Developed Countries (LDCs). In Africa alone, over 29 Mt of charcoal were consumed in 2009 year (Steierer, 2011), compared to just 20 Mt in 2000. The strong and growing demand for charcoal fuel is an important cause of deforestation.

Due to a lack of affordability for other fuel types, a switch to fossil fuels is presently highly unlikely under business as usual. Due to the affordability and convenience domestic consumers of fuels in low income countries are increasingly switching to charcoal, especially in urban areas. The production of charcoal in low income countries is however overwhelmingly dominated by the “informal sector” in which small scale producers use traditional technologies to produce charcoal. Wood is almost always sourced from natural forests and very often harvested illegally, despite forest management systems implemented in some countries.

An improved charcoal production chain could substantially decrease the wood consumed per tonne of charcoal and reduce the associated CH_4 emissions. The mitigation potential could be around 100 Mt CO_2e per year in Sub-Saharan Africa alone (De Gouvello, 2009). In fact, there are not many sectors where simple measures can deliver so high benefits. Sanders et al., 2011 mentions on page 10 that “the conversion of wood into charcoal is probably the step in the charcoal value chain with the highest potential for reducing GHG emissions.”

The identified ancillary benefits from more efficient charcoal production and reduced deforestation are huge and well understood.

3.2 Main sources of emissions for the production of charcoal

Charcoal is one of the main fuels in Least Developed Countries especially in Sub-Saharan Africa. The production and consumption of charcoal lead to high associated GHG emissions. These GHG emissions are the result of three factors:

- An unsustainable supply of biomass in which forests are being depleted for the production of this fuel.
- The use of inefficient technologies to convert wood into charcoal with yields as low as 10% observed in certain countries (10 kg of wood required to produce 1 kg of recovered charcoal).
- The use of specific technologies/processes in which the conversion of wood into charcoal leads to a high level of methane emissions.

The sources of emissions to be considered in the baseline are as follows:

Table 1: Emissions sources included in or excluded from the project boundary

Source		Gas	Included?	Justification / Explanation
Baseline	Electricity consumption	CO_2	No	The baseline only consists in pit kilns and earth kilns which are generally built on the site of the wood harvest. Such kilns never have an associated electricity consumption.
		CH_4	No	
		N_2O	No	
	Auxiliary fuels	CO_2	No	Assumed negligible. The objective reached with charcoal is the production of a convenient fuel which unlike commercial liquid fuel is affordable to households. The quantity of expensive auxiliary fuels is assumed to be either non-existing or negligible.
		CH_4	No	
		N_2O	No	
	Carbonization activity	CO_2	Yes	Included both for direct CO_2 emissions and CO_2 from the oxidation of the emitted CO.
		CH_4	Yes	Included – this is a major source of emissions.
		N_2O	No	Excluded for simplification. Overall, project kilns if at all, will result in lower emissions N_2O emissions due to improved processes with sometimes a full combustion of pyrolysis gases. The following average values of N_2O emissions per tonne of charcoal have been found in the literature: Smith et al. (1999): 0.0458 g N_2O / kg charcoal Pennise et al. (2001): 0.15 g N_2O /kg charcoal In turn the average emission factor found from the literature is 0.10 g N_2O / kg charcoal, or an equivalent of 0.03 tonne CO_2e / tonne of charcoal. As a comparison, in the present status of the *consolidated GHG database for the informal charcoal sector,* around 3.80 tCO_2e are emitted from the informal charcoal sector if 50% of the biomass is from non-renewable sources and 7.1 tCO_2e are emitted if 100% of the biomass used is from non-renewable sources.

In turn, in areas with strong deficits in the supply of biomass, charcoal is often by far the most GHG intensive fuel as illustrated below:

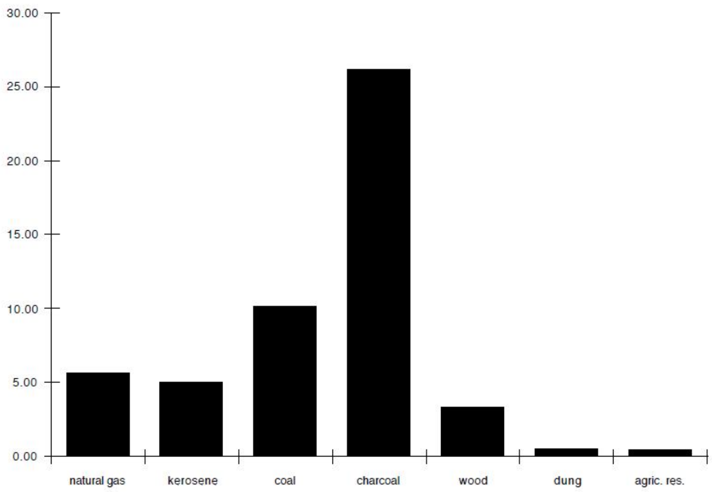


Figure 1: net carbon dioxide equivalent emissions per cooking task for various biomass and fuels (from Kammen and Lew, 2005)

3.3 Opportunities to reduce GHG emissions from the production of charcoal

The potential for reducing GHG emissions by promoting the application of improved kiln technology is tremendous, not only due to higher charcoaling efficiencies, but also due to the application of GHG reducing technologies (e.g. destruction of the methane stream) and the possibility of electricity co-generation as stated in Sander, 2011 page 22.

These opportunities can be divided in two types:
(i) Opportunities related to technology and practices for charcoal making and
(ii) Opportunities related to a decrease in non-renewable share of biomass used.

(i) Opportunities related to technology for charcoal making:

- Low CH_4 emitting technologies.
- Efficient conversion of biomass to charcoal which leads to biomass savings. For example yields up to 40% can be achieved instead of the 10 to 20% in the baseline (Adam, 2008).

(ii) Opportunities related to a decrease in non-renewable share of biomass used:

- Production of charcoal from carbon neutral biomass sources:
    - Production of charcoal from dedicated plantations (wood, bamboo, etc.).
    - Production of charcoal briquettes obtained from the carbonization and agglomeration of biomass wastes.

3.4 The need for a standardized approach

Several sources of literature have identified the charcoal sector as having a large potential for emission reductions. As mentioned by Robert Bailis on page 277 (Bailis, 2005a), “if investment in carbon emissions mitigation were directed to the charcoal sector it would facilitate the introduction of this technology”. This analysis is shared by several other publications among which (Hayashi, 2010), (Sander, 2011) and (UNDP, 2009).
Specific barriers have prevented the implementation of CDM projects which reduce emissions associated with the production of charcoal in Least Developed Countries. These are among others the high transaction costs, complex requirements of project specific data, as well as difficulties to demonstrate additionality under the existing procedures.
Standardised approaches could overcome the limitations observed in the existing methodologies, such as AM0041 and AMS-III.K, by providing standardised factors for the determination of the baseline. For project developers, the use of standardised factors will substantially reduce the complexity in the determination of baseline emissions. In order to maintain the environmental integrity of the approach, standardised baseline factors need to be sufficiently stringent and accurate.

3.5 Specific barriers to charcoal projects in the CDM

The potential for emission reductions in the charcoal sector consist in providing charcoal with a lower GHG intensity where charcoal would normally have been produced by the “informal charcoal sector”. This “informal charcoal sector” is highly disaggregated and consists in numerous small-scale producers.

3.5.1 Determination of the baseline emission factor

The determination of baseline emission factors for charcoal produced by the informal charcoal sector is too complex and costly.

Complexity of the procedure:
The baseline determination and calculation procedures provided in the methodologies AM0041 and AMS-III.K are highly complex and cannot realistically be applied in the frame of most projects needed.

Cost of the procedure:
Producers in the informal charcoal sector use the same traditional technologies. These technologies are almost always unimproved kilns such as the earth mound kiln, the earth pit kiln or variations of these two technologies. A quick review of the literature shows significant discrepancies in the level of performance measured for these baseline technologies. This means that a robust baseline value can only be obtained by performing a large number of tests to determine the yield of these kilns as well as their CH_4 emission factor. In turn the associated costs for a large and accurate baseline determination campaign cannot be borne by relatively small projects. Information on the wood to charcoal yield or CH_4 emission factor from baseline kilns are nevertheless available from tests performed in several countries.

Need for performance test in the absence of standardized baselines:
In the absence of standardized baselines which relies on tests which have been performed in countries with extremely similar circumstances to establish a robust baseline, available ex-ante and applicable for a broad range of countries, the following problems are encountered:
(i) For many countries, no performance tests are available ex-ante. This means that costly baseline performance tests would need to be undertaken in order to establish a baseline.
(ii) For countries in which tests are available, the values obtained still exhibit meaningful discrepancies. A robust numerical basis to quantify with enough certainty baseline emission would probably require additional performance tests in order to reduce the level of uncertainty.
(iii) Without standardized baselines, performance tests would need to be undertaken on a project specific basis in order to determine the applicable baseline.

(iv) Baselines tests established on a country basis are suboptimal solution as similar technologies and practices which determine the baseline are found in several countries.

3.5.2 Identification of the most plausible baseline

With the exception of rare cases, the bulk of charcoal in LDCs is produced using the same technologies and consumed by households and in some cases by small and medium enterprises. Under current CDM procedures however, each project would have to perform a complex procedure to determine the most plausible baseline. This would lead to unreasonable transaction costs while in fact, a similar baseline driven by the same circumstances has been observed in LDCs and LICs.

3.5.3 Additionality demonstration

The demonstration of additionality generally used in the CDM is both complex and costly. It would need to be repeated for every project while in fact it has been observed that under specific circumstances no meaningless improvements which decrease the GHG intensity have taken place in the charcoal production chain.

3.5.1 Inadequacy of the procedures for measures in a disaggregated sector

The identified cost associated with (i) the identification of the most plausible baseline, (ii) the quantification of the baseline emission factors and (iii) the demonstration of additionality are high. Projects activities required for an effective reduction of GHG emissions associated with the production of the charcoal in LDCs and LICs on the other hand are often small and dispersed, due to the present nature of the sector. The present costs and efforts which such projects have to face at the moment are prohibitive. This is what has prevented so far the CDM from incentivizing the more efficient production of charcoal.

3.6 Objective of this proposal

The objective of the present proposal is precisely to overcome the cost and complexity incurred by the project-specific data collection and additionality demonstration.

To achieve this, the following elements of standardisation are proposed:

(i) A simplified procedure to determine additionality in determined circumstances (Step 2 of the guideline for the establishment of sector-specific standardized baselines);

(ii) A simple procedure to identify the baseline for the measures (Step 3 of the guideline for the establishment of sector-specific standardized baselines);
(iii) A robust and widely applicable numerical basis for the baseline yield and methane emission factor of charcoal produced by the informal charcoal sector. The key values for the baseline yield will be derived from the "*consolidated GHG database for the informal charcoal sector*" (Step 4 of the guideline for the establishment of sector-specific standardized baselines);
(iv) In addition to that, the present document will provide for the list of "host countries, sectors and measures" to which the standardized baseline is applicable (Step 1 of the guideline for the establishment of sector-specific standardized baselines);

The proposed standardised approach would significantly reduce the data collection burden on project developers. The environmental effectiveness of the standardised approach is expected to be high due to the narrow scope for which automatic additionality is proposed, as well as the strong evidence supporting their additionality under these specific circumstances. In addition to that, the proposed baseline is believed to be numerically robust as it relies on a large set of independent measurements and leads to a demonstrated underestimation of the emission reductions. In turn the proposed approach is conservative enough to avoid over-crediting of CERs.

4. Applicability conditions of the "Procedure for submission and consideration of standardized baselines".

The table below analyses the compliance with the applicability conditions found in the document EB63 Annex 28 – Procedure for submission and consideration of standardized baselines – Version 1.0:

Table 2: Summary of applicability conditions

Applicability condition found	Compliance
This framework is applicable to sectors where project activities are implemented for stationary sources.	The proposed standardised baseline is for charcoal which in the baseline would have been produced from the informal sector in "traditional kilns". This production activity takes place in stationary kilns which are used for a single carbonization cycle and abandoned afterwards. Possible project activities in this sector are always for "stationary sources". For projects which reduce the GHG intensity in the production of charcoal, project kilns are the stationary source. For projects which improve the efficiency at which charcoal is combusted in cooking stoves, the stoves are the stationary source.
The project activities do not include those related to afforestation and reforestation	The project activities do not include those related to afforestation or reforestation. The project activity will not consist in trees being planted. The project activity might however utilize available by-products of trees which have been planted in the frame of emission reduction projects.
One or several measures for GHG emission reduction may be undertaken within a sector	The proposed standardized baseline allows among others the combination of the following measures for the production of charcoal with a lower GHG intensity: (i) switch to renewable biomass or biomass wastes; (ii) increased conversion efficiency in the production of charcoal; (iii) decreased emissions from pyrolysis gases; (iv) a combination of any of the three measures.
Additionality is not to be demonstrated for each individual project activity ex-post (after its formulation) but rather for types of measures and ex-ante.	This proposal suggests a list of emission reduction activities that are considered automatically additional under certain conditions (e.g. location, technology / measure, size). It details the applicability conditions is finds to be

	adequate to assume additionality and provides documented evidence supporting these assumptions.
This document contains the process for the submission of a proposed standardized baseline by DNAs and for consideration by the Board in accordance with paragraph 45 of decision 3/CMP.6. It only applies to proposed standardized baselines developed using an approved methodology or tool, or the "*Guidelines for the establishment of sector specific standardized baselines*".	The present proposed standardized baseline follows the "*guidelines for the establishment of sector specific standardized baseline*".

5. Applicable definitions in this proposal

Under this proposal, the following definitions apply:

- **Charcoal and Renewable charcoal.** Charcoal is solid biofuel obtained from biomass by means of a chemical process known as “pyrolysis” or simply as “carbonization process”, which consists of the thermal decomposition of biomass in the absence of oxygen. Renewable charcoal is charcoal produced using renewable biomass resources as per the definition of renewable biomass approved in Annex 18 of the twenty-third meeting of the Board criteria.

- **Charcoal products.** Charcoal products are solid biofuel products obtained from **biomass** by means of a chemical process known as “pyrolysis” or simply as “carbonization process”, either directly in the form of charcoal blocks or from the agglomeration of small carbonized particles as a product known as “**charcoal briquettes**”.

- **Charcoal briquettes.** Charcoal briquettes are solid fuels from smaller biomass or charcoal particles whose shape and consistency is obtained from an agglomeration process.

- **Biomass.** Biomass is non-fossilized and biodegradable organic material originating from plants, animals and microorganisms. This shall also include products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes. Biomass also includes gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material.

- **Forest plantation after its last rotation.** Lands that were previously stocked with human-induced forest plantations (e.g., pinus, palm trees, bamboo, eucalyptus, etc.) at the end of their rotation cycle (i.e., which were harvested after their last rotation).

- **Dedicated plantation.** A plantation implemented in the context of this project activity in order to supply the production of charcoal products with renewable biomass. A dedicated plantation must be newly established as part of the project activity. In case a dedicated plantation is an A/R CDM project, then A/R CDM modalities and procedures of approved A/R methodology apply.

- **Biomass residues.** Biomass residues are defined as **biomass** that is a by-product, residue or waste stream from agriculture, forestry and related industries. This shall not include mixed municipal waste or other wastes that contain fossilized and/or non-biodegradable material (however, small fractions of inert inorganic material like soil or sands may be included).

- **Informal charcoal sector.** The informal charcoal sector is a sector which produces charcoal from wood. It is characterized by the use of traditional kilns such as earth mound kilns, pit kilns or equivalent open-end technologies which require no investment besides labour. The sector may include illegal activities such as the illegal cutting, harvest of wood and the subsequent production and trade of charcoal made from this wood.

- **Charcoal production facility.** Under this methodology, a charcoal production facility is a facility comprising one or more carbonization unit and which produces one or more types or charcoal products (charcoal, green charcoal, briquettes).

- **Gravimetric yield.** Weight of charcoal produced divided by wood used for charcoal production on dry basis.

- **Sedentary kiln.** Sedentary kilns are kilns which once built are not dismantled and abandoned after the carbonization process but instead re-used.

- **Traditional kilns.** Traditional kilns for the production of charcoal have the following characteristics: (i) they are not sedentary as the kiln is typically built on the site of wood harvesting and abandoned after one carbonization process; (ii) mud is the prime material of the kiln shale and no bricks or metal sheets are used; (iii) no metallic chimney is used. These technologies are characterized by:- a non-sedentary kiln (the kiln is abandoned after the pyrolysis process)- ().-These technologies include in particular the earth pit kiln, the earth mound kiln as well as the variations of these kilns which are sometimes found under different names.

6. Supporting evidence for steps 1 to 3

6.1 Procedure for the ex-ante identification of the most plausible baseline and demonstration of additionality

In order to perform ex-ante step 1 to step 4 of the ""guidelines for the establishment of sector specific standardized baselines", a step-wise demonstration is used on a basis of a large body of evidence found in the literature. It should be noted that the supporting quotes provided represent only a fraction of the large literature available about the charcoal sector in low income countries and middle income countries.

The demonstration can be summarized as follows:

- A very large amount of charcoal is consumed in developing countries, mostly in urban areas (chapter 6.2).
- The charcoal business clearly results from poverty combined with an economic opportunity for the production of charcoal (chapter 6.3).
- Neither the greenhouse gases intensity of charcoal, nor the production of charcoal are expected to show improvements.
    - There is little to no incentive for saving wood when producing charcoal (chapter 6.4).
    - A switch to commercial fuels is unlikely (chapter 6.5)
    - It can be assumed with a high degree of confidence that policies and programmes are not successful at solving the problem (chapter 6.66.5)
    - There is no incentive to reduce the CH_4 emission intensity 6.7.
- The baseline overwhelmingly consists in the production of charcoal in traditional kilns (unimproved earth kilns)
    - Earth kilns are identified as the overwhelming baseline kilns for most LDCs/LICs (chapter 6.8)
        - There are only few exceptions to the unimproved earth kiln being the baseline (chapter 6.11)
    - There are no noticeable improvements of this technology over time (chapter 6.8).
    - There are substantial barriers which prevent the shift to more efficient kilns (chapter 6.10).
- An unsustainable wood harvesting for the production of charcoal leads to deforestation (chapter 6.12).

In addition to that, it is demonstrated that reducing emissions from the consumption of non-renewable biomass and CH_4 emissions associated with the production of charcoal leads to additional emission reductions which are not accounted for (chapter 6.13). This is conservative.

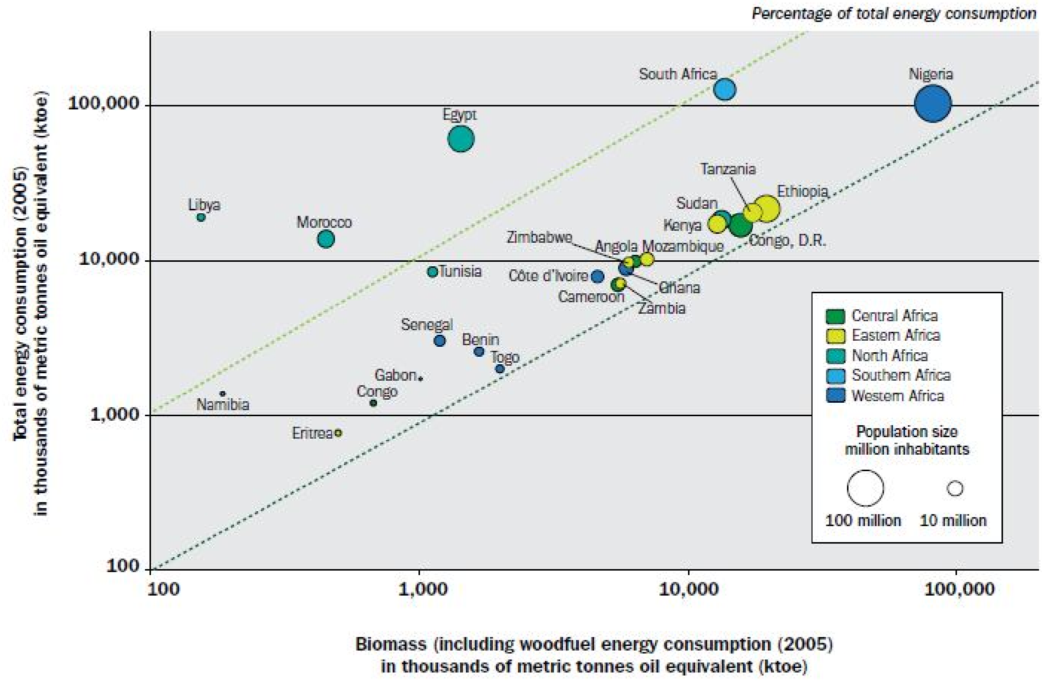
6.2 The consumption of charcoal and traditional fuels

Biomass, especially wood provides most of the energy need in LDCs and LICs

The consumption of traditional biomass fuels, mostly wood, is strong in developing countries. It can be well established that wood is the main fuel in almost all LDCs and LICs. This is the case, not only in Sub-Saharan Africa but also other LDCs and LICs around the world such as Nepal, Cambodia, etc. (Sanders et al.).

A high share of biomass in the energy mix is correlated with a low level of income in the country

From the figure below, it is possible to safely assume that the share of biomass in the total energy consumption is consistently higher for countries with a low level of income. In fact, the figure shows that most LDCs and LICs are close to the line which (dark dashed green line) which represents a theoretical 100% share of biomass in their energy supply. It can also be observed that countries with a higher level of income consume a higher share of non-biomass fuels.



Source: World Resources Institute. EarthTrends (http://earthtrends.wri.org) Searchable Database Results.[4]
Note: Data not available for Central African Republic and Equatorial Guinea.

Figure 2: Total energy consumption, biomass energy consumption and population in Africa

Most wood harvested in LDCs and LICs is for woodfuel and charcoal
As noted by Seidel, 2008, in Africa, 90% of the wood taken from forests is woodfuel.

A shift to charcoal is observed in urban household
A significant share of urban households has shifted from unprocessed biomass such as fuelwood to more charcoal which is a more convenient fuel, as illustrated on the fuel ladder in the figure below:

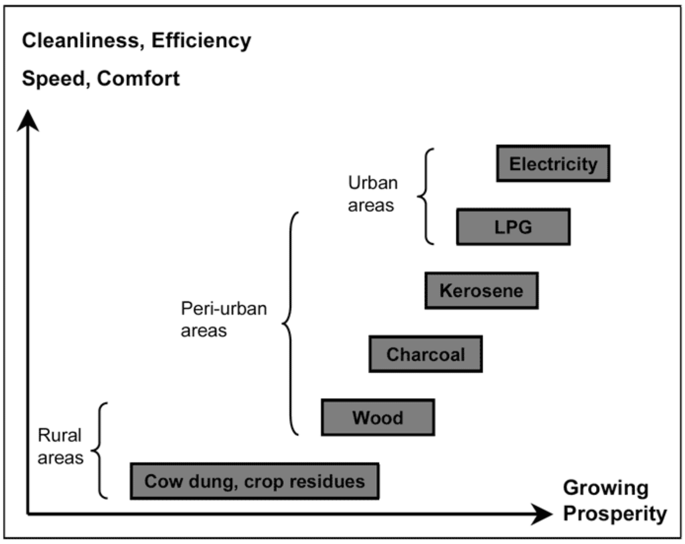
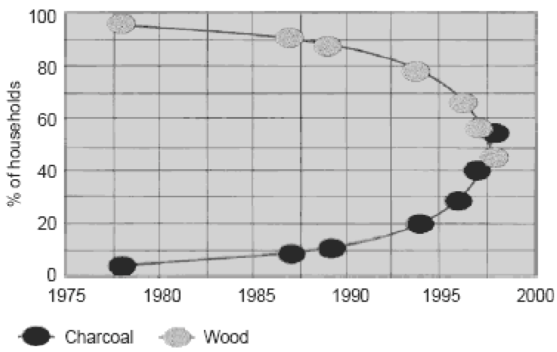


Figure 3: The energy ladder (source: Lawali, 2010)

Growing urbanisation along with changes in habits explains this shift to fuels which require less handling and gathering (Girard 2002). In many parts of Sub-Saharan Africa, Charcoal has become the main domestic fuel, especially in urban areas (Kammen and Lew 2005). In addition, the switch from wood fuel to charcoal in urban areas is well documented as illustrated below:



Source: World Bank, 2000.

Figure 4: Switch from wood fuel to charcoal in Bamako, Mali, as retrieved from Girard, 2002

In addition, the switch to charcoal will continue at a rate between 4% and 10% per year as found in the literature. At the same time, the further switch to more convenient fuels on the energy ladder is expected to be hampered by high oil prices

Charcoal is already the domestic fuel of most urban household

Charcoal is a widely used fuel in Sub-Saharan Africa, where most LDCs are located. It is also largely used in other LDCs and LICs. Changes in the fuel mix have been observed in Sub-Saharan Africa (Seidel 2008).

While wood remains the key fuel in most rural areas, charcoal is often the primary fuel for cooking in urban areas. As noted by E.Smeets and al., in 2009 "While information on charcoal use in the region is sparse, available estimates indicate that the fuel provides energy for a majority of urban households." This pattern of charcoal being the predominant fuel in urban areas is common to LDCs and LICs. The table illustrates the situation of different countries. Charcoal is consistently the fuel of choice of a large majority of urban households in LICs and LDCs:

Table 3: Examples of charcoal use in urban centers

Country	Share of charcoal as fuel in urban areas	Year	Source
Kenya	80%	2002	(Republic of Kenya, 2002), as quoted in Mugo and Ony, 2006
Tanzania	80%	2003	Ngerageza, 2003 – as quoted in Mugo and Ong, 2006
Ethiopia	97% (urban areas consume 70% of the charcoal in the country	2009	E.Smeets and al., 2009
Zambia	85%	2000	(Chidumayo et. al., 2002).

An increased charcoal consumption increases the pressure on wood resources

As mentioned by Knoepfle, (Knoepfle, 2004) "the inefficiencies inherent to charcoal production and use, rapid urbanization (….) place a heavy strain on local wood resources. Although charcoal can be combusted in a more efficient manner than wood, its production is inefficient. While 1 kg of charcoal has an energy content equivalent to 2 kg of wood, the production of 1 kg of charcoal commonly requires 6 kg of wood (Triffelner 2009). This means in turn that the increased use of charcoal has led directly to a large increase in wood consumption (Kammen and Lew 2005) as roughly three times more wood is required per unit of biomass energy consumed.

The demand for charcoal is steadily increasing and expected to continue to do so.

The demand for charcoal is in LDCs and LICs is set to increase as (i) the population increases, (ii) the share of population living in urban centres increases and (iii) a growing share of urban populations switch to charcoal as their main domestic fuel. For example the production of charcoal in Africa increased from about 20 Mt in 2000 to 29 Mt in 2009, equivalent to an annual increase of 6%. In fact, the demand for charcoal and associated production of charcoal are expect to grow without interruption, often beyond 2030, as can be seen from the figure below. This is especially the case for Africa (red line on the figure) where most LDCs are located. This demand cannot be swept away.

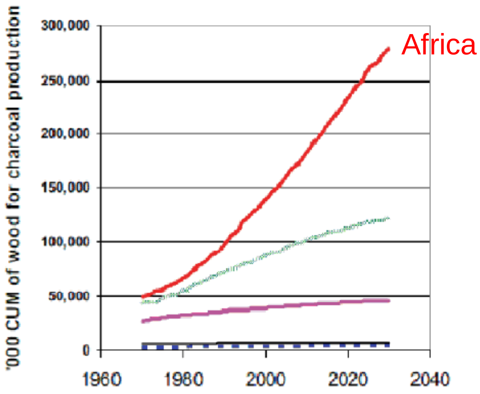


Figure 5: Global charcoal consumption

Table 4: The consumption of charcoal and traditional fuels – evidence

Country	Quote	Page	Source
Mali	The urban shift from fuelwood to charcoal is illustrated by the case of Bamako, Mali, where in 1990 over 85 percent of families used wood as their everyday household fuel. The figure is under 50 percent today, and in 1997 charcoal (which had previously been kept for such special uses as tea-making and barbecuing) replaced wood as the primary fuel in Bamako (see Figure).	1	Girard, 2002
Africa	In Africa over 90 % of the wood taken from forests is woodfuel	2	Seidel, 2008
-	Wood-based biomass in Africa, Asia and Latin America accounts for 89%, 81%, and 66%, respectively, of total wood consumption. In Bangladesh, Cambodia, Nepal and Pakistan, the share goes up to 98% (IEA 2006 and 2010).	1	Sander et al., 2011
SSA	In the 47 SSA countries, most rural and urban residents rely on wood-based biomass to satisfy their energy needs, especially for cooking.	1	Sander et al., 2011
SSA	Given the fundamental role of wood-based biomass in satisfying SSA households' basic energy needs for cooking, the paper will focus on fuelwood and charcoal. The former is primarily used in rural areas, and the latter is the primary energy source for cooking in urban areas.	4	Sander et al., 2011
Uganda	…a rising consumption of about 50% in the last decade	50	Knoepfle, 2004
Uganda	…between 1996 and 1997 even a 7% increase in charcoal production	3	Knoepfle, 2004
Kenya	The huge demand of the commodity cannot be swept away. On the contrary the business is lucrative because of the high demand and existence of a distribution network.	13	Mugo and Poulstrup, 2003
Ghana	With increasing household income and urbanization, it is expected that a larger number of households will switch to using charcoal instead of firewood.	2	VanTilburg, 2011
Malawi	the four largest urban centres do account for roughly 90% of the charcoal used in Malawi	vii	Kambewa, 2007
-	Over 90 % of the 1.2 billion living in poverty worldwide rely on forests to some extent for subsistence needs.	3	Craster Herd, 2007
Mozambique SSA	In Mozambique, as in the rest of SSA, the consumption of wood fuels is increasing due to growing urban populations' dependency on charcoal.		Craster Herd, 2007

Cambodia	In Cambodia, wood provides for more than 80% of people's energy needs. People have traditionally relied on wood and charcoal for cooking.	27	GERES - as found in Müller, 2010
Cambodia	A large percentage of the urban population in Cambodia uses charcoal for their daily cooking energy needs. The choice for charcoal is led both by personal preference (it produces less smoke and is easier to use compared to cooking with wood fuel), and the fact that charcoal is relatively inexpensive and readily available. The consumption of charcoal in Phnom Penh alone represents an estimated 100,000 tonnes.	27	GERES - as found in Müller, 2010
Cambodia	Demand forecasts show that in the next decades fuel wood demand will slowly decrease, but charcoal's market share will increase until at least 2030, especially in urban areas, according to projected trends based on the recent 2007 Social Economic Survey (NIS) and draft Second National Communication to the UNFCCC	27	GERES - as found in Müller, 2010
Cambodia	40% of households use charcoal as main source of energy in Phnom Penh. The annual demand is estimated at around 90.000 tonnes (Charcoal Flow Study, GERES for IGES CCCO, 2006); Demand is increasing in the capital and exponentially in other urban centres of the country and rural middle class households (GERES for GVEP 2005 and UNDP REP-PoR 2005	28	GERES - as found in Müller, 2010
Mali	The majority of families in Mali rely on traditional fuels, such as charcoal, and will continue to depend on them for many decades to come. Together, charcoal and firewood still account for 97% of the final energy for the residential sector.	17	GERES - as found in Müller, 2010
Mali	Although firewood is the largest energy carrier, the use of charcoal is becoming predominant and expected to increase relative to wood. For example, in a 1990 survey, Bamako reported that 90% of the population cooked on wood; by 1996, wood use had been almost entirely displaced by charcoal	17	GERES - as found in Müller, 2010
Tanzania	Charcoal production in Mkuranga district is undoubtedly triggered by the growing demand in urban areas in particular the Dar es Salaam City, where population is high and growing rapidly amid lack of adequate alternatives. For instance, the Dar es Salaam population in the 1998 population census was 1,360,850 people, while in the 2002 census the figure was 2,497,940, with 596,264 households, a variance of 54.5%. With 70 – 71 per cent of households depending on charcoal as first choice for domestic energy, therefore, availability of affordable and better alternatives of energy in Dar es Salaam will slow the rate of tree cutting for charcoal production in Mkuranga district. The demand of charcoal for Dar es Salaam residence is unquestionably so high that it is a threat to forests and woodlands from the supply districts.		Minja, 2006
SSA	Increased urbanization is also accelerating the demand for wood fuel—especially charcoal—which is the fuel of choice for most SSA urban residents.	8	Sanders et al., 2011
SSA	Projections suggest that the consumption of wood-based biomass by SSA households will increase in relative terms over the next 30 years as demographic growth continues to outstrip access to other modern fuels (IEA, 2009).	8	Sanders et al., 2011
Haiti	The majority of the population is poor and uses charcoal as their source of fuel, especially for cooking. Although it is far from the best solution, they do not have the money for electricity or gas, which are much more expensive.		Jatrophahaiti, 2009

	One study estimates that a 1 percent increase in urbanization leads to a 14 percent increase in charcoal consumption.		Hosier, 2003 as quoted in WorldBank, 2009

6.3 Poverty is the driver and there is an economic opportunity to produce charcoal

Traditional fuels (consisting mostly of wood and charcoal) are widely used in Sub-Saharan Africa, where most low income countries are located as can be seen in the figure below:

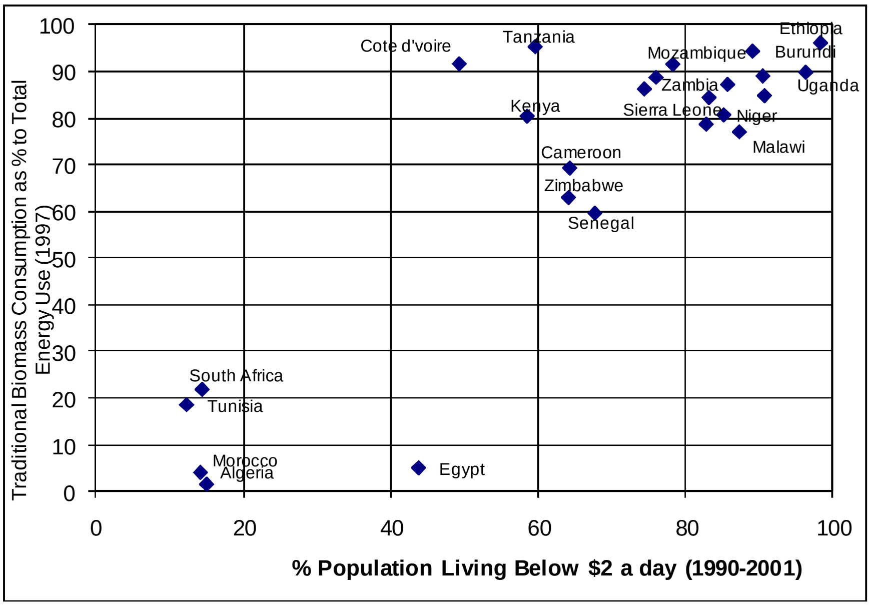


Figure 6: Share of traditional fuels (wood and charcoal) as a function of income levels

Their consumption is strongly correlated with a poverty defined as less than $2 a day per capita (as can be seen on the figure above). Overall, charcoal and poverty are extremely well correlated. This correlation is well understood from the literature. The production of charcoal from the informal sector results from local poverty combined with an economic opportunity to generate an income. Charcoal is the basis for the subsistence of many.

It is safe to assume that there is a correlation between poverty in a geographic area (either local poverty, LIC status or LDC status of the country) and the production of charcoal from the informal sector consisting in small scale producers.

It should also be mentioned that charcoal production can be undertaken ad-hoc to generate cash without the need for any investment. This prevents the use of improved technologies which require an upfront investment.

Table 5: The link between charcoal and poverty - evidence

Country	Quote	Page	Source
Kenya	We do not produce charcoal as some sort of business, but simply do it for survival		Mutimba, 2005

Mozambique	Therefore, in the rural areas charcoal represent the main form of family income (65%)		Pereira, 2001
Zambia	Per capita income from charcoal production was about twice the income from agriculture in 1990 about five times in 2000 respectively		Ellgard, 2002
Uganda	It provides a livelihood to a large number of people who produce it, distribute it and sell it.	7	Knoepfle, 2004
Uganda	It is only cattle farming and charcoal production where these rural people can get cash money according to this official.	50	Knoepfle, 2004
Uganda	The core statement is true that there are only few possibilities to get cash money and charcoal seems to be the one you can realize in the fastest and easiest way.	51	Knoepfle, 2004
Uganda	The poor situation and lacking employment alternatives in rural areas set the opportunity costs for labor to nearly zero. However scenario analyses show how sensitive the net-revenue out of charcoal reacts relating to increasing opportunity costs for labor.83 If you only increase the opportunity costs of labor from 1 US$ per day to 2 US$/day the net-profit for the producers is already negative. The break-even point relating the labor costs is around 1.50 US$ per day.	54	Knoepfle, 2004
Kenya	The lack of alternatives forms of livelihood has forced many charcoal burners to take up the enterprise on a subsistence basis	12	Mugo and Poulstrup, 2003
Kenya	The huge demand of the commodity cannot be swept away. On the contrarty the business is lucrative because of the high demand and existence of a distribution network	13	Mugo and Poulstrup, 2003
Somalia	Due to poverty young men as well as older men – desperate to survive and feed their families – are forced to engage in this business.	39	Dini, 2006
Malawi	Many small-scale producers operate at subsistence level and charcoal production provides an opportunity to generate income.	viii	Kambewa, 2007
	Charcoal production is a primary or secondary activity, for many millions of rural labourers in developing countries, and is one of the rural activities that brings in cash.	95	Rosillo Calle, 2007
	Several studies on charcoal have shown that the production of wood fuels follows Scherr, (2000) downward spiral of livelihoods, suggesting that deforestation is the result of unsustainable resource use driven by poverty.	10	Craster Herd, 2007
	...a large section of rural households are involved in the activity, facilitated by the low entry barriers.	21	Craster Herd, 2007
Africa	When based on the World Banks poverty definition of US$ 1 per day it can be seen that more than 95 % of the population fell below this standard. Charcoal production in the CR is therefore a subsistence activity to diversify income streams, an approach that typically lies at the heart of livelihood strategies in rural Africa (Barrett, Reardon & Webb, 2001).	52	Craster Herd, 2007
Mozambique	this, 95 % of the producers fell below the US$ 1 poverty line, indicating that current production strategies are not capable of pulling people out of poverty.	63	Craster Herd, 2007
Zambia	According to the respondents, charcoal production is the second largest economic activity and the most important source of income. Proceeds from charcoal production are used to buy agricultural inputs such as fertilizer and also to supplement to the household income when the agricultural activities are on recess.	40	Yamba – in Müller, 2011

Zambia	Among the socio-economic and environmental factors influencing the charcoal industry have been the general economic decline; collapse of agricultural production and marketing; loss of wage employment; general increase in tariffs of alternative household energy sources (electricity and kerosene); the massive depreciation of the local currency and the increase in the world price of petroleum products;	42	Yamba – in Müller, 2011
Cambodia	Charcoal production is a traditional activity for the poorest; it is illegal but necessary for their subsistence.	28	GERES – in Müller, 2011
Tanzania	The poor state of environment in Mkuranga district which is manifested by uncontrolled tree cutting for charcoal production is attributed to poor socio□economic base. This state of affairs has largely been contributed by poor agricultural production and marketing,and lack of alternative sources of income.	66	Minja, 2006
Uganda	These patterns underscore the importance of charcoal income for households with limited agricultural capacity, but suggest that charcoal producers are relatively better off than non-producers. Contrary to popular belief, it appears that charcoal production is not the domain of the poorest of the poor, at least in this sample. As Figure 1 indicates, among charcoal producers both the absolute amount of charcoal income and the charcoal income share increase with income.		Khundi et al., 2010
SSA	Charcoal production is one of the major income sources for rural people in study areas in Tanzania and Mozambique. In Zambia it is it is virtually the only source of income after the collapse of the agricultural market. Charcoal prices did not increase in real terms during the last two decades. In Mozambique prices were higher during the war, but have normalized since the end of the war.	17	Seidel, 2008
SSA	In the past projects addressing the problem of sustainable charcoals production failed	17	Seidel, 2008
Kenya	However, we now recognize that the root cause of charcoal production is poverty.	9	Mutimba and Barasa, 2005

6.4 There is little to no incentive to save wood

Overall, the available literature illustrates well the situation in which the charcoal market in LDCs and LICs is dominated by the informal sector. Producers from the informal sector do not have an incentive to save wood as it is sourced for free either legally, or illegally. In the few cases where taxation exists, taxes are applied on the basis of the charcoal produced, not on the basis of the wood consumed for its production. As will be demonstrated in further chapters, except in very few exceptions, attempts to regulate the charcoal sector have overwhelmingly failed.
As there is no incentive to save wood, investments in improved charcoal kilns do not have any return for the informal charcoal sector.

Table 6: The lack of incentive to save wood - evidence

Country	Quote	Page	Source
	Unregulated, free or very cheap sourcing of trees and shrubs for charcoal production causes steady deforestation and environmental degradation.	8	Gathui et al., 2011

	Chambers and Leach (1987) found that where local markets for fuelwood exists, trees were assets which could be cut and sold at short notice to meet urgent household financial needs.	8	Mugo and Gathui, 2010
Cambodia	Today, all of the fuel wood in Cambodia comes from unsustainable and illegal logging of local forests, which has become a major issue due to the rapid pace of population growth and development.	27	GERES, 2011
SSA	Dissemination of these kilns proved to be difficult because they are economically only attractive when wood has to be bought.	15	Seidel, 2008
-	Wood that is illegally or unsustainably harvested to produce charcoal is generally free, and the producer only incurs labor costs,which means the product can be sold at a price that undercuts charcoal produced from sustainable sources. This example further underlines the need to address the charcoal sector in a holistic manner and look beyond a single intervention along the production–trade–consumption chain.	18	WorldBank, 2009
-	Trees are often harvested from open areas at no cost to the producer.	6	WorldBank, 2009
	only marginal amounts of cash flow to the charcoal burners—and virtually none to communities whose forest areas are being depleted.	23	Sanders et al., 2011
	based on ESMAP calculations using Rwanda data, suggests that wood price should influence charcoalers' choice of kiln technology. If charcoal producers are economically “rational”, then a price of US$ 0.75/stere represents a breakeven or indifference point between the traditional Earth Mound and Casamance kiln. If charcoal wood costs more than this price, incomes will be higher using the Casamance method, and vice versa.	14	Feinstein and van der Plas, 1991
	Today, only about 20% of the charcoal produced in the district is taxed according to district forest officer.	ii	Minja, 2006
	A large proportion of charcoal production in developing countries is carried out as a semi-illegal, part-time activity – the wood used is often procured illegally. Consequently, few charcoal-makers are willing to invest in improved charcoal kilns because of the risk of punitive official measures and taxes. Consequently, dissemination of improved charcoal techniques to the informal sector has proved difficult.	30	FAO, 2010
	Despite growing scarcity of wood, charcoal generally remains under-priced by more than 20-50% relative to its economic cost in most African countries (Sepp 2008). This is mainly caused by insecure land-tenure, which leaves many forest areas open to free and unregulated access and use. In consequence, market prices of wood-based fuels reflect only the opportunity cost of labour and capital required for production and transport. Undervaluation translates into wasteful forest management and tree growing.	121	UNDP, 2009
	Investment costs for improved kilns (metal chimneys, etc.) do not pay off as long as wood remains a free resource.	121	UNDP, 2009

6.5 A switch to commercial fossil fuels is unlikely

The shift to petroleum products such as kerosene and LPG has been extremely limited and an overwhelming majority of the energy supply in Africa still comes from wood. This is mostly due to the limited affordability of petroleum based fuels for low-income households. Instead, charcoal has become one of the preferred fuels due to both its convenience and affordability (Girard 2002). Studies have confirmed this success of charcoal as the cheapest fuel per unit of energy[3] in Africa. It has even been observed that with increasing cost for petroleum products, households have shifted back to charcoal.

Efforts by states to trigger the shift to petroleum products have also overwhelmingly failed. This is due to the following reasons: (i) the initial investment required for households to switch to petroleum products; (ii) the difficulty to change habits; (iii) the high cost of the subsidies to countries with limited financial resources; (iv) the continued competition from charcoal.

In turn, no switch to commercial fuels is expected to take place in LDCs and LICs mostly due to income levels which do not allow for such a switch to take place.

Table 7: Barriers to the switch to commercial fossil fuels - evidence

Country	Quote	Page	Source
	The low level of household income is probably the only factor holding back the shift to fossil fuels, LPG and petroleum.	1	Girard, 2002
	Despite some successful examples like these, many African governments, concerned about the potential threat of charcoal to forest resources, have launched programmes in the past two decades to encourage substitution of charcoal with other fuels (particularly LPG and kerosene) through subsidies and provision of equipment to households. Despite the effective distribution of equipment (in Dakar, Senegal, over 60 percent of families were equipped to use LPG), these programmes have not succeeded, in part because African cities do not always readily take on urban habits (Matly, 2000).	2	Girard, 2002
Uganda	...make it impracticable to switch to encourage the switch to gas, kerosene and electricity	66	Bongers and Tennigkeit, 2010
Tanzania	Looking at the present economic forces, the majority of urban population in Tanzania will continue to depend on fuelwood for unforeseeable future (Moyo et al., 1993; URT 1998; Luoga et al. 2000).	1	Malimbwi et al., unknown
Tanzania	Yet still, the majority of woodfuel consumers cannot afford the high investment costs associated with alternative commercial energy sources	2	Malimbwi et al., unknown
Africa	Significant increases in access to cleaner commercial energy are unlikely	1	Kituyi, 2006
Africa	The majority of African households will continue depending on traditional fuels to meet their daily energy needs for many decades to come	1	Kituyi, 2006

[3] The cost per household for shifting from charcoal to kerosene has been estimated to be an increase from $50 initially to $200 fuel cost per year (Triffelner 2008).

	...while some households convert back to charcoal or firewood, others try to reduce their kerosene consumption whenever the price rises (Nakaweesi, 2008 chapter 13.1.3)	19	Boerstler, 2010
	Substitute fuels such as kerosene must be highly subsidized to become competitive, as is the case in a number of countries (e.g. Senegal, Chad).	21	Miranda et al, 2010
Zambia	Among the socio-economic and environmental factors influencing the charcoal industry have been the general economic decline; collapse of agricultural production and marketing; loss of wage employment; general increase in tariffs of alternative household energy sources (electricity and kerosene); the massive depreciation of the local currency and the increase in the world price of petroleum products;	42	Yamba, as found in Müller, 2011
Cambodia	The choice for charcoal is led both by personal preference (it produces less smoke and is easier to use compared to cooking with wood fuel), and the fact that charcoal is relatively inexpensive and readily available.	27	GERES, as found in Müller, 2011
Uganda	Charcoal consumption in urban centres has continued to increase rapidly due to the increases in energy (population growth) and higher cost for alternative energy sources, especially electricity and gas.	531	Nturanabo, 2010
Tanzania	Surveys have shown that in many towns and even in some metropolitan areas, wood fuels are widely used by both low- and high-income groups.	48	World Bank, 2009
Tanzania	According to the survey, the perceived low cost of charcoal is one of the main reasons for its use. Second, widespread availability, is also important for more than half of the respondents.	5	World Bank, 2009
-	The advantage of charcoal is that the household can phase its purchases, such as every two days, while the expenses for LPG have to be made in one payment up front.	6	World Bank, 2009
SSA	Although most SSA countries experienced strong price hikes for commercial wood-based biomass over the past years, prices of other energy sources also increased, which meant there was little incentive to switch away from wood-based biomass	9	Sanders et al., 2011
	Fuel switching, targeted at better-off segments of the society, must be an integral part of policy measures to achieve sustainable wood-based biomass energy sectors in SSA. While this practice will not be economically feasible for most urban dwellers due to the initial investment costs in new cooking equipment and other economic constraints	x	Sanders et al., 2011
	Because most charcoal is harvested without anyone paying for the raw material (wood), and licenses and levies are largely evaded, the cost of charcoal to the consumer does not reflect its real value. Thus, the lower costs undermine efforts by producers or traders to comply with the laws by paying for licenses and levies, or investing in efficiency savings through improved conversion technology, long-term sustainable forest management, or creating plantations/woodlots.	20	Sanders et al., 2011

6.6 Policies and programmes are unlikely to solve the problem

From the reviewed literature, it appears clearly that policies and programmes aimed at solving the charcoal problem have overwhelmingly failed, either due to their design or due to a poor enforcement. For example, a ban of charcoal has consistently led to a continuation of the activity on an illegal basis. Similarly, none of the licensing or fee systems has provided the expected results due to a very low enforcement. With the rare exception of Sudan, the lack of enforcement of mandatory applicable laws and regulations for all LDCs and LICs surveyed.

Table 8: Inability of policies and programmes to solve the charcoal problem - evidence

Country	Quote	Page	Source
-	But except in a few cases, policy and programme interventions failed to effectively deal with the problem of charcoal-based deforestation and its associated environmental concerns.	35	Chidumayo, 2011
Uganda	The charcoal producers work almost exclusively independently are small-scale and are largely unlicensed (and thus illegal)	7	Knoepfle, 2004
SSA	Even in SSA countries where regulations for a legalized charcoal production are in place, they are often poorly enforced or circumvented by powerful interest groups which control one or more parts of the commodity chain (Ezzati et al., 2004)	73	Boerstler, 2010
Malawi	Efforts to protect the forests are failing, as shown by continued charcoal production. In all areas visited, traditional leaders are aware of unlicensed charcoal production in their areas but either participate in or ignore this economic activity.	viii	Kambewa, 2007
Malawi	Current efforts to discourage charcoal making are expensive and ineffective	x	Kambewa, 2007
Mozambique	Although regulations exist for the exploitation of wood fuels, weak state capacity has lead to uncontrolled charcoal production and deforestation on a localised scale.	22	Craster Herd, 2007
-	The lack of fees collected due to illegal production not only hinders the efforts of forest guards to enforce these laws due to financial constraints, but also prevents the collection of important data concerning the harvesting and consumption patterns of charcoal (SEI, 2001).	24	Craster Herd, 2007
Mozambique	The study identified that 15 % of the producers surveyed were producing charcoal illegally without licenses. However, on closer examination it was clear that even those with licences were operating in a dubious fashion with regards to the licensing law.	54	Craster Herd, 2007
Mozambique	The poor returns of the activity performed in a legal manner explain the motives for operating in an illegal manner.	55	Craster Herd, 2007
Mozambique	The extent of this strategy can be seen where 25 people were operating under a single license.	55	Craster Heerd, 2007
Zambia	It was found that charcoal is largely been produced in areas outside the forest reserves on customary land and farm plots and hence no fees were paid to the Forestry Department.	41	Yamba, as found in Müller, 2011
Zambia	Currently there is no organized system for i) allocating land for charcoal production and ii) forest management in previous charcoal production areas to ensure good forest regeneration.(Chidumayo, 2001)	41	Yamba, as found in Müller, 2011
Zambia	Despite the size of the sector, charcoal production remains informal and unregulated.	40	Yamba, as found in Müller, 2011
Zambia	The illegality of the activity has not ended it in the absence of acceptable alternatives and has kept charcoal producers vulnerable to informal tax charges and hazards suffered along the long distances that have to be travelled to get wood and transport charcoal.	29	GERES, as found in Müller, 2011
Mali	Around 1/3rd of the territory is threatened by illegal harvest.	15	GERES, as found in

			Müller, 2011
Mali	All commercial exploitation of forest resources, including charcoal production are now subject to taxation. The law, however, is not being enforced, as the relevant authorities lack sufficient resources to administer the sector. Indeed, official production stands at 54,000 tonnes of charcoal and 31,000 tonnes of wood fuel compared to an estimated demand of 6 million tonnes of wood fuel.	18	GERES, as found in Müller, 2011
-	Lack of coordination has been reported in Mozambique (Pereira, 2001), Tanzania (Malimbwi, 2001) and Ethiopia (Trossero, 2003). According to Tumuhimbise (2003), the Uganda charcoal industry is disorganized. The exception is Northern Sudan, where the Forest National Corporation (Ibrahim, 2003) implements charcoal production programmes and regulates the trade.		Mugo and Ong, 2006
-	Recent energy policies do not adequately address the problem. The energy policy for Zambia was approved in 1995 and Uganda's in 2002. Those for Kenya and Tanzania were passed in 2004. In Ethiopia and Eritrea, the documents are in draft form. Significantly, the four policies that have been officially adopted emphasize modern energy and pay little attention to charcoal		Mugo and Ong, 2006
Tanzania	In the mid 2006, the Government of Tanzania, through its Annual Budget Speech announced measures to improve environment. They include the exemption from value added tax (VAT) on kerosene and LPG, also on LPG cylinders. *(note: the policy has not been implemented)*		Minja, 2006
Malawi	Politically, a ban of traditional hardwood charcoal by the Malawian government could not be enforced and traditional charcoal remained popular among urban dwellers.		Seidel, 2008
Kenya, Mauritania	Banning the production and/or marketing of charcoal, as has sometimes been done (for example in Mauritania and Kenya), has proved counterproductive: bans do not in fact reduce production, but simply drive producers underground, thereby precluding proper control of production procedures (FAO, 1993).		Girard, 2002
Tanzania	The charcoal trade is characterized by very weak governance, law enforcement, and other regulatory capacity charcoal trade is dominated by a small number of powerful and politically connected entrepreneurs who are able to use their influence to further avoid and evade payments of fees and obtaining of licenses		World Bank, 2009
Tanzania	As indicated earlier in this chapter, it is estimated that around 80 percent of the charcoal trade takes place outside the formal system. Instead of obtaining the necessary licenses or paying required fees, the majority of producers and traders chose to evade payment, and, where necessary, pay bribes when challenged by either the police or government checkpoints. The reasons for evasion are many, but some common causes are listed below. • High costs incurred in travelling to the district forestry office and waiting for the license to be issued. • Those involved in the trade are unable to pay license fees (and the accompanying bribe needed to facilitate licensing). • They also are attracted by the willingness of law enforcement staff to accept bribes at a fraction of what it would cost to obtain a license.	14-15	World Bank, 2009
Tanzania	However, due to the massive demand for charcoal, the trade continued, albeit illegally, and corruption at checkpoints increased. The greater transaction costs associated with the	16	World Bank, 2009

	(illegal) production and trade in charcoal were simply passed on to the consumer, and immediately following the ban, the price of charcoal nearly doubled.		
Chad	However, the project's success alarmed certain interest groups, whose influence subsequently eroded policy commitment and national ownership. The government reversed its policy, enacted a blanket charcoal ban, and used force to nullify community tenure rights. The basis for operating differential taxation was thus lost, causing the newly introduced system to collapse.	16	Sander et al., 2011
Senegal	the traders surpassed charcoal production quotas due to ineffective monitoring systems.	15	Sander et al., 2011
-	Due to its informal nature, the wood-based biomass energy sector is systematically neglected in formal economic analyses;	9	Sander et al., 2011
SSA	Anecdotal evidence for many SSA countries shows that few traders routinely obtain the papers required and that bribes are offered whenever controls are executed. This may be caused by: (a) high transaction costs connected with traveling to the nearest forest service representative and waiting for a license to be issued; (b) a lack of resources to obtain the license; and (c) potential bribes to the license issuing public service representative who issue the licenses. Difficulties in obtaining licenses seem to lead to illegal production and marketing of charcoal.	24	Sander et al., 2011
SSA	Laws and regulations are not enforced largely because the sector operates within a complex and multi-layered regulatory context.	24	Sander et al., 2011
-	To date, with the exception of South Africa and a couple of other richer nations such as Namibia and Botswana, no programme in the region has been able to claim success in reducing charcoal use (Girard, 2002).	4231	Mwampamba, 2007
Eastern and Southern Africa	Tree growing approaches remain ineffective, as planting and maintenance costs must be taken into account when competing with open access resources. Significant subsidies (e.g. Madagascar: €200-300/hectare) are necessary to provide sufficient incentive. This also holds true for any investments in natural forest management (Sepp, 2008).	121-122	UNDP, 2009
Kenya	Until now, a blanket ban on charcoal production has not worked. Charcoal production still takes place in spite of the ban, and this current 'illegal' status has driven production underground, contributing towards corruption, makeshift and inefficient production methods, marginalization of producers and little or no resources being put into replanting and agro forestry.	11	Mutimba and Barasa, 2005
Senegal	Habituellement, le charbon de bois est produit avec les techniques traditionnelles dans les zones non aménagées, même si l'article R55 du Code Forestier du Sénégal précise que « utilisation de la meule Casamance et de toute autre technologie réputée plus efficiente, est obligatoire ».	4	Mundhenk, 2010

6.7 No incentive to reduce CH_4 emissions

Now law applying CH_4 emissions from the production of charcoal by the informal sector have been found. In addition to that, there is no incentive to reduce such emissions. The valuable stream of pyrolysis gas cannot be recovered by producers from the informal charcoal sector.

6.8 Baseline is the earth kiln

From a broad range of evidence, it can safely be assumed that in the informal sector the traditional kilns (unimproved earth kilns) are the baseline technology used to produce charcoal. Only a very few numbers of other kilns have been found. Their share in the total production is anecdotic. For example, in Kenya – the country for which the best data exist - the charcoal market represents a yearly volume of 1.6 Mt per year (Mutimba and Barasa, 2005). Only one company has been found to produce charcoal at an industrial scale in the country: Kakuzi which produces in improved kilns at an enhanced yield between 28% and 35%. The scale of production is however relatively small and the overall production only represent a small fraction of the global volume of charcoal in Kenya[4]. This situation is similar to Cambodia where only one industrial producer of charcoal has been identified. No industrial producer of charcoal has been identified in Zambia. Overall, with the exception of Sudan, there is a high level of certainty that unimproved earth kilns represent the overwhelming majority of kilns in southern and eastern Africa, with the exception of Sudan. Where quantified evidence was available such as is the case in Kenya, Tanzania or Burundi around 99% of the production was found to be from unimproved earth kilns. In 2001, SEI stated in a report by Frey and Neubauer that "moment almost 100% of the charcoal demand is produced by traditional earth kilns in Southern African countries". Based on the evidence, we can assume with a high level of confidence that over 90% of charcoal is likely to be produced in unimproved earth kilns in the following countries:

- Burundi
- Cambodia
- Kenya
- Madagascar
- Malawi
- Mali
- Mozambique
- Tanzania
- Uganda
- Zambia

In addition to that, it is also likely that over 90% of the charcoal production in Chad, Benin and Ghana and northen Somalia is from unimproved traditional kilns.

Table 9: Baseline kilns in selected LDCs and LICs - evidence

Country	Quote (or information)	Page	Source
Zambia	Basically all the charcoal in Zambia is produced using the earth clamp method, details of which are provided in Chapter Two of this Manual.		Hibajene and Kalumiana, 2003
-	The most widespread system used in the developing world is a kiln made of earth.	13	Baldwin, 1987

[4] According to a report, Kakuzi operated a 24,000 acre forests (WWF-Forest Landscape Restoration, Kenya country report) – equivalent to around 9700 ha. Considering a biomass Mean Annual Increment (MAI) for Savannah Woodlands and a charcoal yield of 35%, Kakuzi could have at best produced 10,200 tonnes of charcoal per year.

-	The bulk of the charcoal in the tropical ecosystem is made in earth kilns	6	Chidumayo, 2011
Uganda	Traditional earth kilns dominate the production of charcoal in Uganda. These include the Kinyankole ("the bus") and the Kasisira ("the banda") earth kilns.	3	Knoepfle, 2004
Africa	Earth pit kilns are the traditional way of making charcoal in many parts of the world and may represent the simplest technology for charcoal production.	6	Seidel, 2008
Africa	Earth Mound Kiln: This is also a common kiln used for charcoal production.	7	Seidel, 2008
Kenya	Over 90% of charcoal producers are using inefficient, traditional earth kilns with recovery rates of as low as 10%.		Mutimba, 2005
Kenya	Only one private company has invested in an improved charcoal production: Kakuzi (28-35% efficiency kilns); All other efforts have been supported.	24	Mugo and Gathui, 2010
Kenya	The traditional earth mound kiln without chimney is the most commonly used in Kenya (...) is common due to its low capital requirement and can be sited near the wood.	39	Mugo and Poulstrup, 2003
Kenya	Apart from Kakuzi Ltd, the traditional earth kiln is the technology currently used in Kenya.	39	Mugo and Poulstrup, 2003
Kenya	Unfortunately all the producers visited use the traditional earth kiln.	40	Mugo and Poulstrup, 2003
Tanzania	The oldest and still the most widely used method for charcoal production is the earth kiln. Two varieties exist, the earth pit kiln and the earth mound kiln.	97	Malimbwi and Zahabu, 2008
Misc.	The Earth-Mound Kiln (EMK) is the most common method of making charcoal in sub-Saharan Africa	99	Malimbwi and Zahabu, 2008
Kenya SSA	The earth kiln is the most common method of making charcoal in Kenya, as well as in the rest of sub-Saharan Africa.	276	Bailis, 2005a
Burundi	Au Burundi, par example, près de 99% du charbon de bois est produit par le méthode traditionelle (Adam, 1990)	-	Schenkel et al., 1997
Ghana	currently, charcoal is produced mostly by earth mound kilns in Ghana (NCRC, 2008), This production method has efficiencies of 10-20%	2	VanTilburg, 2011
Tanzania	Traditional (basic) earth mound kiln: This is the most common traditional earth kiln in Tanzania. It is a very popular kiln used by charcoal producers and it is usually rectangular in shape.	15	Beukering et al., 2007
Malawi	All 19 active kilns observed in the charcoal production sites were traditional earth kilns, which are used throughout Malawi.	26	Kambewa, 2007
Malawi	In the sites visited, all charcoal production is done using traditional earth kilns, a technology that is known to be wasteful and inefficient.	ix	Kambewa, 2007
Malawi	There may be as many as 40,000 kilns operating each year: this means that on any given day, there will be approximately 109 kilns active in Malawi. *NB: This is proof that most kilns are non-sedentary traditional kilns abandoned after the carbonization cycle*	vii	Kambewa, 2007
-	The bulk of charcoal is produced in earth kilns and is usually transported over long distances.	97	Rosillo Calle, 2007
-	Earth kilns, they are generally the most appropriate technology	97	Rosillo Calle, 2007

	for the woodland, savannahs and rangeland areas where most of the charcoal is produced. Here the producer moves from site to site.		
Mozambique	... and the traditional earth mound kiln (Figure 5b), which is the predominant type used in the CR.	25	Craster Herd, 2007
Zambia	According to experts interviewed, the share of technologies, earth mound kilns predominantly used in charcoal production in Zambia is 100%. There are no large scale charcoal producers present in the country. The current status is that efforts to improve the charcoal production chain have only been done at research level.	40	Yamba, as found in Müller, 2011
Zambia	All the charcoal in the Chongwe study area is made in earth kilns built by covering a stack of logs with soil clumps dug around the kiln site	41	Yamba, as found in Müller, 2011
Zambia	reduced availability of wood for charcoal production in the immediate areas of Lusaka resulting in increased distances to sources of charcoal and transport costs	42	Yamba, asfound in Müller, 2011
Zambia	The information collected on the ground and from the literature indicates that indeed 100% of production is from earth mound kilns. The use values derived from a database featuring only traditional kilns is adequate	46	Yamba, asfound in Müller, 2011
Cambodia	The traditional kiln technology prevalent throughout the country, the vast majority of which is made up of earth mound kilns, is archaic and extremely inefficient. It is estimated that over 99% are earth mound kilns. No large scale or modern technologies are currently being used. A handful of pilot improved kilns (T-LUD, Yoshimura) are run by GERES Cambodia. There is only one large scale producer known in the country (see below –Initiatives sector).	28	Yamba, asfound in Müller, 2011
Mali	Pit kilns from compacted clay (over 90% of total production)	15	GERES, as found in Müller, 2011
Congo, DR	All kilns observed from the available literature are earth kilns – due to the illegal nature of the activity. Investment needs to be kept low as the production might get disrupted by the intervention of forest rangers.		Own observations
Tanzania	Usually charcoal is produced in earth mould kilns made by covering a pile of logs with earth, igniting the kiln and allowing carbonization under limited air supply. About 95% of the respondents used rectangular kilns and the rest used either rectangular alone or the combination of both rectangular and circular.	65	Minja, 2006
SSA	Currently, nearly all charcoal is made in traditional earth-mound kilns.	9	Kammen, unknown (2005 or later)
Tanzania	Nearly 99% of charcoal used in Tanzania is from natural forests and woodlands (Mnzava, 1994) and production of charcoal is done through inefficient earth kilns (Emrich and Mwihava 1989); Kaale, 1984; Kilahama, 1983; Songela, 2003) and also woodcutting for charcoal making is not controlled.		Kilahama, unknown (2004 or later)
Benin	Le procédé le plus couramment utilisé est la meule de terre, la moins coûteuse et élaborée à partir de produits locaux. Les tas de bois vert à carboniser sont disposés sur le sol et recouverts de feuilles et de pailles. Au centre un cône de combustion est réalisé à partir de petits bois secs empilés. Le tout est recouvert de terre. Des évents sont aménagés pour contrôler la carbonisation qui se déroule en trois phases : déshydratation, carbonisation, refroidissement. La surveillance est constante afin	4	Juhe-Beaulaton, 2000

	d'empêcher l'air de pénétrer.		
Madagascar	Charcoal is produced in traditional kilns with efficiency between 8 and 14 %.	14	Seidel, 2008
Senegal	However, the technique (Casamance) has had only a minor effect on Senegalese charcoal production efficiencys since the kiln has not been widely adopted by charcoalers on a national basis.	23	Feinstein and van der Plas, 1991
Africa	This type of kiln dominates charcoal production in Africa. The biomass is gathered and cut to size, and placed on a ground kiln.	107	UNDP, 2009
Kenya	Percentage of producers using inefficient, traditional earth kilns 99%.	13	Mutimba and Barasa, 2005
Mozambique	All charcoal produced in Maputo province is manufactured in traditional earth mound kilns. The production is mostly labor intensive with manual tools (axes, hoes and shovels).		SEI, 2002 (Final report Mozambique)
Kenya	"Almost 100% of Kenya's charcoal, and indeed for the entire East African region is produced using earth kilns, characterized by poor operation practices e.g. poor loading, use of green wood, poor control, and premature harvesting of charcoal before full carbonization.	1	(Senelwa et al. 2006).
Kenya	Worse still, over 99% of the charcoal produced in the country is processed in traditional earth kilns	77	Practical Action Consulting, 2009
Kenya	current adoption level of efficient kilns is about 1%		Mugo, 2011
Southern Africa	At the moment almost 100% of the charcoal demand is produced by traditional earth kilns in Southern African countries.	16	Frey, 2001
Somaliland (North Somalia)	With regard to the charcoal production technology, two types of kilns were observed across the study area. The pit/trench kiln is practiced in mountain areas where the surface mound kiln is not in use due to unavailability of enough soil to cover it, whereas in valleys, surface mound kiln is used	21	MoPDE, 2001
Mozambique	All the charcoal consumed in Mozambique is produced by the traditional earth kiln method.		Mangue, 2000

6.9 No noticeable improvement in traditional technologies detected

No autonomous improvement in the technology used by producers from the informal sector is to be expected. The technology used has been the same for centuries. Already in 1929-1930, similar yields were achieved with the same traditional technologies.

Table 10: Lack of improvements with traditional charcoal technology - evidence

Country	Quote	Page	Source
India	Kiln type: traditional mound – India Dry weight yield: 15.5-26.2% Anonymous (1929-30) "Experimental and Commercial Activities: Charcoal" Annual Forest Administration Report, Bombay Presidency, p. 51	12	Kammen and Lew, 2005

-	major preoccupation in charcoal production is the slow pace of technological development. Indeed, this technology has remained, in the main, unchanged for centuries.		Rosillo Calle, 2007

6.10 Barriers to other kiln

A shift to other kilns with an improved wood to charcoal yield and/or decreased CH_4 emissions is unlikely to take place due to numerous barriers for which evidence is provided in the table below. These barriers are among others:

- Investment barrier: the prohibitive upfront investment cost for cash-constrained producers.
    - Even for the most simple technologies, the investment cost is high compared to the income level of charcoal makers (e.g. an Adam retort kiln costs the equivalent of one year of income, the chimney for Casamance kiln costs the equivalent of 3 to 5 months of income).
    - Charcoal is an activity to earn money with close to no investment.
    - Small scale producers from the informal sector rarely have capital to invest.
    - Under present circumstances, small producers do not have access to capital to invest.
- Lack of profitability of the investment (both real and perceived):
    - There is virtually no perceived return as wood is implicitly sourced for free.
    - Any investment would compete against producers which continue to source their wood for free.
    - The cost of labour is extremely low due to widespread poverty.
- skills and knowledge needed for the operation of new kilns
    - In addition to the cost of new kilns, an initial investment in training is required.
- lack of awareness about improved technologies
    - A specific investment would be needed to raise awareness about the improved kilns
- low acceptance of new technologies
- the increased difficulty for operating advanced kilns
    - increased need for supervision
    - even in the case of the simple Casamance kiln, producers have to transport the heavy chimney, yet do not have access to motorized transportation
    - added work to process the wood to a specific size (e.g. billet of 50cm in the case of the Casamance kiln)
    - in the case of sedentary kilns: added work for the transportation of wood from the harvest site to the kiln site (instead of the kiln being constructed for a single pyrolysis campaign on the harvest site).

- This is especially demanding in cases of Savannah where the low density of trees already long distances to be travelled, even with non-sedentary kilns.
- This is also a strong obstacle in hilly or mountainous areas.

As a result of the barriers detailed above, most efforts to introduce enhanced kiln technologies have failed. More advanced technologies such as the introduction of charcoal production from previously unused biomass residues is even less common as might often require construction of a dedicated briquetting unit. Efforts to improve the charcoal production chain have been found to have net cost for project proponent, despite their overall positive value if ancillary effects are taken into account. Unfortunately, host countries (LDCs/LICs) suffer from a weak enforcement of programmes and regulations combined with limited resources to implement their policies.

Table 11: Barriers to more advanced kilns - evidence

Country	Quote	Page	Source
SSA	Casamance kiln: Disadvantages of this kiln type are that it requires some capital investment for the chimney and it is more difficult to construct.	7	Seidel, 2008
SSA	Although improved kilns were in the 1960s introduced in Uganda they are virtually still unknown in the country today In Kenya more than 90 % of charcoal producers use inefficient traditional kilns. There are several reasons for this: • Brick and concrete kilns are stationary, whereas charcoal is frequently produced in a manner which requires mobile kilns or kilns constructed on site for the duration of production. • Investment costs for many improved kilns are too high especially for metal kilns which are transportable • Special skills are required to construct and to operate improved kilns	9	Seidel, 2008
-	implementing activities exactly as presented in the scheme may be constrained by various barriers, which must be eliminated if the goal is to be met. These include, inter alia, finances, awareness, technical capacities, and governance	6	Kituyi, 2006
Madagascar	It would be unrealistic to promote the use of improved carbonization techniques such as Casamance mound kilns, earth pits or metal kilns in Madagascar as these require investment at levels beyond the reach of most charcoal burners.		Caramcodec, 2007
India	As a result, whichever technology may be used, the production cost of locally produced char briquettes is always more than that of locally produced wood charcoal.	10	Karve, Priyadarshini, 2011
-	More efficient portable or masonry kilns are available, but the higher cost restricts their use by small producers	44	FAO, 2010
	Positive cost of improve charcoal production (around $70/tCO2e)	102	Global Climate Adaptation Partnership (2010)
Tanzania	The improved cassamance earth mound kiln from Senegal has efficiency of 25 – 30 %. The CEK technology was introduced to Kilimanjaro and Coast regions of Tanzania in	15	Beukering et al., 2007

	1980s. However, the technology was not accepted/adapted due to high investment cost and tedious work involved in its construction and operation process.		
Tanzania	The efforts to encourage and popularize the use of portable steel kilns in Tanzania have been unsuccessful, due to high capital investment cost.	15	Beukering et al., 2007
	Investment costs for improved kilns (metal chimneys etc.) do not pay off as long as wood remains a free resource. Despite training and support, people who produce charcoal eventually abandon the improved technology. This is the main reason why the efficient Casamance kiln has been disseminated for 20 years throughout Africa without success.	21	Miranda et al, 2010
-	Tree growing approaches remain ineffective when competing with open access resources. Costs for planting and maintenance in this case are prohibitively high, and significant subsidies (e.g. Madagascar: US$300/ha) are necessary to provide enough incentive. This generally holds true for any investments in natural forest management where investment costs are at least US$10 per ha.	21	Miranda et al, 2010
-	In addition, further support is required for the introduction of improved charcoal kiln technologies	27	Miranda et al, 2010
-	A major preoccupation in charcoal production is the slow pace of technological development. Indeed, this technology has remained, in the main, unchanged for centuries.	96	Rosillo Calle, 2007
-	One of the reasons is that charcoal is mostly an activity of the poor who are struggling to survive, let alone invest in technological improvements.	96	Rosillo Calle, 2007
Mali	The large size of the black market for charcoal production has implications for the success of a project which might require additional cost for the production of charcoal. The low likelihood of enforcement of laws on charcoal production will require project activities to produce charcoal at or below the current price of charcoal.	unpublished	GERES, as found in Müller, 2011
Kenya	Charcoal from forest plantations can, however, is produced on a much larger scale, making it feasible to use more advanced and efficient equipment like retorts in order to recover the by-products. Investment costs are high and if there is no ready market for the by-products, the option may not be attractive to the large-scale charcoal producer.	10	Mugo and Ong, 2006
-	Attempts have been made to improve kiln efficiencies in many countries. In Tanzania, some of the proposed technologies and techniques include: portable steel kilns, improved traditional earth kilns, and 13 half-orange brick kilns. These methods have been under investigation for over 30 years. Studies by the Tanzania Forest Research Institute also enabled development of improved earth mound charcoal kiln reinforced with burned bricks but uptake of the results has not been successful due to high cost involved (Sawe and Meena, 1994) (….). Portable steel kilns achieve considerably higher conversion efficiencies but have not been adopted because of the higher initial cost, manpower and skill required for viable management. A problem with marketing of softwood charcoal (low calorific value), the production of which is technically most feasible using improved kilns, is also a limiting factor in the adoption of these technologies.	165	Chidumayo and Gumbo, 2010

Africa	Improved kilns could contribute substantially to production efficiency. However in spite of their efficiency, the use of improved kilns has failed due to lack of capital for kiln construction. The need to process the billet into specific sizes and transport them to kiln sites is an added cost that is limiting adoption.	171	Chidumayo and Gumbo, 2010
Senegal	Often new techniques are adopted for brief periods and then discarded: evidence of this is found by the remains of metal kilns and metal pit covers scattered in the Senegalese forest		Feinstein and van der Plas, 1991
SSA and much of the third world	Secondly, the location of the wood feedstock is highly scattered. The main sources of supply (in rough order of importance) are communal/traditional woodlands and state forest followed by private farmlands and small-scale woodlots. Large plantations and other dense, intensively cultivated wood aggregations are conspicuous by their absence, a part from trials in a few countries. The overwhelming majority of charcoaler are by consequence highly mobile as are their kilns. This eliminates the introduction of brick kilns, as an important example, and other efficient but stationary technologies. Lastly, the techniques employed are time-tested and traditional usually earth mound and earthen pit kilns. Befitting relative factor availability, the technology is labor intensive and very low capital.	3	Feinstein and van der Plas, 1991
-	Many programs over the past century have been implemented to increase efficiency of charcoal kilns. Appendix A lists a number of these projects. Foley notes that few of these have had any significant or permanent effect on charcoal production in the developing world [1986].	6	Kammen and Lew, 2005
Tanzania	Many projects have tried to overcome the challenge of low efficiency levels by promoting more efficient kilns for charcoal production, but adoption rates have been disappointing. The reasons for this are mainly found in the informal—and often illegal—nature of charcoal production, as frequently described throughout this paper. Without secure and long-term access to wood resources, investments by producers for more efficient conversion methods are likely to be limited. Additional challenges that have been encountered when promoting improved conversion technology include: • the cost of improved kilns, which may be prohibitive for small-scale producers with limited purchasing power and very little access to credit; • given that most charcoal is produced in the drylands where forest cover is low, charcoal production tends to be highly mobile. Improved kilns tend to be stationary, which places additional costs on producers due to the need to carry wood from the point of harvest to the kiln. This can be an arduous and time-consuming task over rough ground	22	World Bank, 2009
Tanzania	In addition, government royalties and fees are often lower than the true opportunity cost of the resource. These factors lead to an underpricing of the resource and reduce incentives for investments in sustainable charcoal production or trade, either by the government or private entrepreneurs.	6	World Bank, 2009
SSA	At present, however, the unregulated production of charcoal does not create an environment that promotes investments in better methods and technologies; hence,	10	Sanders et al., 2011

	charcoal is still produced with very traditional processes.		
Ghana	An anthropologically complex issue was encountered in Ghana related to the Casamance kilns need for nighttime surveillance. The nomadic Sissala charcoalers expressed strong reluctance to monhor the kilas in the forest after dark, possibly because harmful spirits - -embodied in the trees and come out by night	9	Feinstein and Van der Plas, 1991
SSA	A core challenge when enhancing the kiln technology is that it would require a change in the socio-organization structure of charcoal production. At present, traditional and improved kilns are constructed in the forest where the wood is harvested; when improved kilns are used, producers need a small chimney that can be easily transported by bicycle or on foot. However, semi-industrial kilns are more permanent structures that require the wood be transported to the kiln. Given already the challenges individual charcoal producers face for making minimal technology improvements such as chimneys, semi-industrial technology can only be established through larger scale private investments or when joint investments by former individual charcoal producers can be facilitated, for example by forming producer associations or cooperatives	21-22	Sanders et al., 2011
SSA	A key element for promoting improved kiln technology requires providing financial resources to potential investors. Due to the increased costs of improved kiln technology, seed funding in form of “one-time” input subsidies may be a policy option	22	Sanders et al., 2011
SSA and much of the third world	the mobility of the chimney itself has been a source of concern to charcoalers, who generally do not have the advantage of motorized transport from production site to site.	9	Feinstein and Van der Plas, 1991
SSA and much of the third world	In practice, a number of constraints have limited the spread of the Casamance method. In the first place, traditional charcoalers need to see dear advantages over their usual methods. These advantages could be expressed, among others, by higher revenues, larger charcoal output, less labour required, or a combination of several of such factors. Obviously there also needs to be a government. commitment and finance for large scale outreach programs to train charcoalers in the new methods.	8	Feinstein and Van der Plas, 1991
SSA and much of the third world	Evidence that local charcoal makers had previously tried several" improved methods" was found in the remains of metal kilns and metal pit covers which were scattered throughout the forest. As the project leaders, a Peace Corps Volunteer and his Senegalese forester counterpart would later write, These gave a good indication of the way not to go.	23	Feinstein and Van der Plas, 1991
SSA and much of the third world	First, the kiln is more complex than the traditonal method, requiring installation of a metal chimney which must be replaced regularly due to corrosion and poses problems in transportation from one site to another.	23	Feinstein and Van der Plas, 1991
Tanzania	In the 1990s the Government through the Ministry of Energy and Minerals (MEM) in collaboration with the MNRT and other key stakeholders/partners attempted to improve and advance appropriate technologies but with little success and impact. Dissemination of charcoal making technology such as the half-orange brick kilns (Argentina type) and the Casamance, in the Coast, Iringa	8	Kilahama, unknown (2007 or later)

	and Tanga Regions did not make any notable changes in terms of adoptability (widely used) and therefore impacting positively to woodlands conservation.		
-	Low income by the majority of charcoal producers in Ikwiriri and Mbunju - Mvuleni could hinder use of more advanced charcoal production methods, such as use of brick kilns and portable steel kilns that require high initial capital investments (Kiwele et.al. 1999, Witold & Gerhard 1990).		Kaale et al., 2000
Eastern and southern Africa	Lack of finance to purchase modern kilns: the costs of modern kilns are high. Low-income charcoal-makers should have access to a revolving fund or loans from banks to overcome their shortage of finance.	120	UNDP, 2009
Eastern and southern Africa	Investment costs for improved kilns (metal chimneys, etc.) do not pay off as long as wood remains a free resource. Despite training support, charcoal burners eventually abandon the improved technology. This is the principal reason why the improved and efficient Casamance kiln has been disseminated for 20 years throughout Africa without much success.	121	UNDP, 2009
-	It has proved even more difficult to gain acceptance for improved kilns. By now it can be safely stated that any type of fixed cover kilns can not be successfully introduced in the present charcoal production system. This is mainly due to lack of capital, power tools for cutting and haulage systems in the production areas.		SEI, 2002
SSA	Improved charcoal production technologies have been introduced in order to increase production efficiency and reduce the emissions of potentially harmful pollutants. However, the use of these technologies remains very low because of limited awareness, weak technical capacity, and high risks to investment. If investment in carbon emissions mitigation were directed to the charcoal sector it would facilitate the introduction of this technology	277	Bailis, 2005a
-	The low capital cost of the system (pit kilns) commends its use where wood is abundant and labour costs are low.	-	FAO, 1987

6.11 Exceptions and other kilns

It has been established that unimproved kilns can safely be assumed as the baseline in LICs and LDCs. Nevertheless, a few notable exceptions should be taken into account. For example, evidence suggests a meaningful use of improved kilns in Senegal and to some extent western Africa. The report prepared by Mundhenk et al. for Peracod suggests however a widespread use of traditional technologies in Senegal, despite the mandated to use Casamance kilns. No other LIC or LDC was found to mandate or ban any specific technology. More precise surveys would be needed to assess with a better level of confidence the share of different technologies in use for most western African countries.
In addition to that, Soudan has been identified as the sole country in which an effective framework to regulate the charcoal sector has worked, as found in Mugo and Ong, 2006.

Table 12: Exception to generally applicable circumstances

Country	Quote	Page	Source
Senegal	while the relatively more efficient Casamance charcoal kilns have significantly spread in Senegal.	6	Kituyi, 2006
Somalia	Un autre type de meule améliorée est utilisée en Somalie (Robinson, 1988) ...recouvrement simple d´une grande partie de la charge de bois par des feuilles de metal		Schenkel et al., 1997
Sudan	Information: Charcoal Producers Association in Sudan, for example, are recognized by the government and can expel members who fail to pay taxes or engage in corruption. In return, the government reinvests taxes and royalties in establishing plantations		Mugo and Ong, 2006.
West Africa	Promotion of improved kilns – this has been successful in Ghana, Senegal, and other countries in West Africa	60	Minja, 2006

6.12 Deforestation

The increased use of charcoal has raised major environmental concerns. Sources of literature confirm charcoal as a source of deforestation. Along with agriculture, the production of charcoal is thought to be among the leading causes of deforestation in Africa (Greenresources 2010)[5]. In Tanzania for example, out of the 420,000 ha of forest lost each year, around 100,000 ha of annual deforestation have been attributed to the production of charcoal (Mongabay 2005). A portion of such evidence is presented in Table ***13***.
Charcoal is produced from wood, a renewable source of biomass. In many areas, the collection of wood however exceeds the natural regrowth. In turn, forest coverage and the associated carbon stocks are decreasing as a result of this biomass deficit.
In areas with biomass surplus, the consumption of charcoal is not a problem. The contribution of charcoal to deforestation is more obvious in places with scarce wood supply and strong demand for charcoal (Girard 2002). This is the case for example with forests surrounding centres of charcoal consumption such as cities. In fact, the consumption of charcoal is much localized as it is mostly consumed by urban households. Accordingly, charcoal is produced around urban centres which account for the bulk of the charcoal consumption. The production of charcoal is very inefficient and more wood is consumed to provide the same heat than in the case of a direct use of woodfuel. In turn, charcoal exacerbated the demand for wood around urban centres. As a result, a pattern of localized deforestation around the centres of charcoal consumption is observed in LDCs and LICs.

Table 13: Link between charcoal and deforestation

Country	Quote	Page	Source
	Nevertheless, in places where high fuelwood and charcoal consumption and weak supply sources put strong pressure on existing trees resources (because of high population density, low	2	Girard, 2002

[5] In Africa, the leading driver for clear cutting of forests is still for livestock and agricultural purposes (Kammen and Lew 2005). In some cases charcoal is produced as a by-product of these forest clearing.

	income and/or severe climate conditions), deforestation and devegetation problems are still of great concern.		
Tanzania	In our study area, the main contributor to degradation is unregulated and illegal charcoal production	118	Bongers and Tennigkeit, 2010
Uganda	Charcoal use and inefficient methods of charcoal production are leading to deforestation in the areas surrounding urban settlement	66	Bongers and Tennigkeit, 2010
Tanzania	Most degradation follow slash and burn activities where trees are cut down for fuelwood and charcoal	109	Bongers and Tennigkeit, 2010
Tanzania	This study demonstrated that charcoal production and cultivation have an impact on large-scale deforestation that has occurred in the area between 1991 and 1998. Tree species suitable for charcoal production have been depleted at the roadside and the average distance to charcoal production sites has increased. Tree cover is worse today than ten years ago due to charcoal production.	1	Malimbwi et al., unknown
Tanzania	These results clearly indicate that charcoal production has been a major source of woodland degradation and deforestation. This was also confirmed by 75% of the respondents in Mbwewe, Bana and Kitulangalo areas during the socioeconomic survey (Table 13).	12	Malimbwi et al., unknown
Tanzania	Although cultivation has been a major source of woodland change and deforestation in Southern Africa, its contribution in the study area has been negligible compared to charcoal production between 1991 and 1998.	12	Malimbwi et al., unknown
Benin	Cette forte consommation du bois-énergie entraîne la dégradation progressive des ressources forestières. Ces dernières ne sont pas suffisamment renouvelées malgré les différents projets de reboisement qui sont développés dans le pays.		Badarou and Kouletio, 2009
-	Deforestation and forest degradation caused by charcoal production negatively affects the quality and quantity of these ecosystems	34	Chidumayo, 2011
-	In almost all countries where charcoal is produced, there have been reports highlighting concern about deforestation and forest degradation linked to charcoal production	11	Chidumayo, 2011
Africa	One major problem related to charcoal production is deforestation. Although Chidumayo denies that charcoal is a cause of deforestation, most scientists agree that charcoal production contributes to an overuse of forests.	13	Seidel, 2008
Kenya	fuelwood, charcoal production and agriculture contribute to woodland degradation and deforestation.	12	Mugo and Gathui, 2010
Madagascar	As elsewhere in the country, the natural forests in Boeny Region (in the west of Madagascar) are tending to shrink due to rising demand for wood for fuel coupled with a lack of a managed wood energy supply compatible with regeneration of natural formations.		Caramcodec, 2007
Madagascar	Charcoal production is not the only cause of deforestation in Madagascar, though.		Caramcodec, 2007
Uganda	The use of woody biomass is the leading cause of deforestation		Knoepfle, 2004
Uganda	The inefficiencies inherent to charcoal production and use, rapid urbanization, and the preference of urban dwellers for charcoal, place a heavy strain on local wood resources.		Knoepfle, 2004

	For those studies that made a distinction between rural versus urban consumption of fuelwood and between firewood versus charcoal forms of fuel, the threat to forests has always been clear: while firewood use rarely poses a threat, the implications of charcoal are quite different	4232	Mwampamba, 2007
Africa	By failing to highlight this important distinction, the solo-impact of charcoal may have been grossly underestimated in the past and partially responsible for the lacklustre approach by governments in the region to pursue their 1980s woodfuel energy programs.	4233	Mwampamba, 2007
Tanzania	Assuming that demand for charcoal is always met, forest needed is equivalent to forest lost. This is not unrealistic given that ‘‘about 70% of the deforestation in the country is related to woodfuel provision’’	4226	Mwampamba, 2007
Tanzania	The findings suggest that it is not necessarily alarmist to imagine a Tanzania with sparse to non-existent public forests, brought about solely by the high dependency on charcoal as the cooking energy of urban homes.	4231	Mwampamba, 2007
Kenya	Entire trees are fell for the production of charcoal whereas firewood is mostly commonly collected in the form of branches	14	Boerstler, 2010
	...an escalating decline of the forest cover linked to the production of charcoal...	164	Boerstler, 2010
Somalia	destroy trees in Somalia, forcing women and young girls to walk long hours to collect firewood	39	Dini, 2006
Somalia	As a result of massive charcoal production, trees are now rare. In fact, there are towns and villages where no trees are left standing – a testimony to charcoal and firewood dependency and consumption.	39	Dini, 2006
Benin	La demande urbaine de bois de feu et de charbon de bois est, de ce fait, un facteur important du déboisement de ces zones.		Bagan, 2008
Benin	Cette forte consommation du bois-énergie entraîne la dégradation progressive des ressources forestières.		Badarou and Kouletio, 2009
Tanzania	Perceived caused of deforestation (Figure 2.6: charcoal is perceived as the leading cause)	14	Beukering et al., 2007
Mozambique	Charcoal production (....) showed some correlation with LANDSAT imagery on deforestation in these areas.	2	Craster Herd, 2007
SSA	The growing demand for charcoal in these countries (Sub-Saharan Africa) has resulted in localised deforestation in vulnerable areas, particularly surrounding urban centres in SSA (SEI, 2002).	10	Craster Herd, 2007
Zambia	evidence was available of localised shortages in vulnerable forests, especially those surrounding urban centres (SEI, 2002).	17	Craster Herd, 2007
	However, as cover declines to a level where distances between trees becomes prohibitive to making kilns due to increasing labour costs relative to charcoal profits, producers move to areas with improved stocking characteristics in search of higher profits (SEI, 2001; FAO, 2000; Chidumayo, 1997).	53	Craster Herd, 2007
	In Mozambique, as in the rest of SSA, the consumption of wood fuels is increasing due to growing urban populations' dependency on charcoal. There are significant socioenvironmental consequences related to the production of charcoal to meet this demand, which include forest degradation, loss.	63	Craster Herd, 2007
Africa	Unfortunately the charcoal production in nearly all African countries is unsustainable	14	Boerstler, 2010

Kenya	57% was from unsustainable supplies.	5	Mugo and Gathui, 2010
Madagascar	This wood consumption puts considerable pressure on forestry formations which are threatened with overexploitation, especially around the big towns which create huge demand for domestic energy and therefore for wood-derived fuels.		Caramcodec, 2007
Uganda	The inefficiencies inherent to charcoal production and use, rapid urbanization, and the preference of urban dwellers for charcoal, place a heavy strain on local wood resources.	2	Knoepfle, 2004
Ghana	Although woodfuel products are in itself renewable and thus CO2 neutral, woodfuel combustion can lead to net emissions when there is no reforestation, and due non-CO2 GHG emissions from the combustion process and charcoal production. In Ghana, 90% of the fuelwood is obtained directly from natural forests and the annual deforestation rate is 3%	1	VanTilburg, 2011
Cambodia	In the absence of acceptable alternatives and effective control, charcoal is often made from wood collected from primary forests, degraded forests and shrub lands. This is resulting in environmental pressure, and contributing to turning deciduous forests into deserted landscapes.	27	GERES, 2011
Cambodia	Traditional charcoal production has been demonstrated to be a factor in deforestation in Kampong Speu, Kampong Chhnang, and other provinces	28	GERES, 2011
Cambodia	In the case of Cambodia, the fuel wood /charcoal production frontier is in the forest, and retreating with the forests, and is directly causing deforestation.	28	GERES, 2011
Uganda	…the rampant deforestation which results from inefficient use of woodfuel for charcoal production	531	Nturanabo, 2011
Zambia	Deforestation attributed to woodfuel alone is estimated to be 56,000 ha (Table 5.6), about 28% of the total annual deforestation rate estimated by the Environmental Council of Zambia (ECZ).	31	Hibjane and Kalumiana, 2003
-	Although agricultural expansion is a major cause of woodland change and deforestation in many parts of eastern and southern Africa (Dewees, 1994), in the study of Dar es salaam and its catchment, Malimbwi et al (2001) found the role of cultivation negligible compared to charcoal production. Between 1991 and 1998, for instance, only 5% of closed woodland, 8.9% of open woodland and 6.5% of bushland was converted to mixed cultivation. In Ethopia, 150,000 – 200,000 ha of forest cover is lost annually to charcoal (Yigard, 2003).	5	Mugo and Ong, 2006
Zambia	The increased demand for charcoal entails massive clearing of land for charcoal production		Malambo and Syampungani, 2009
Haiti	On the other hand the deforestation (caused by the massive demand for charcoal)		Jatrophaiti
SSA and much of the third world	The increased demand for charcoal entails massive clearing of land for charcoal production	13	Feinstein and Van der Plas, 1991
Kenya	Estimated biomass deficit: from 39% to 99.5%		Mugo, 2011

6.13 Conservativeness and unaccounted for emission reductions

The present proposal will lead to meaningful unaccounted for emission reductions. This is conservative. The unaccounted for emission reductions are the result of (i) the conservative nature of the proposed standardized baseline as well as (ii) the nature of the project which can be enabled by the present standardized baseline.

Standardized baseline:

- Undervaluation of decreases in carbon stocks:
    - Below-ground biomass: Projects using this standardized baseline lead to reduction of deforestation as fewer trees have to be cut to produce charcoal. This methodology only credits emission reductions from the carbon saved in the wood which would have been used for charcoal production. The total carbon stock of a tree (which is cut for the production of charcoal) exceeds however by at least 20%[6] the carbon stock of the wood which would be used in the charcoal production[7]. In turn, this methodology avoids the total loss of the tree carbon stock[8] (by avoiding the cutting of the tree) yet only credit a certain share of this tree carbon stock. As a consequence, real emission reductions are well in excess of the CERs generated. As a conservative assumption, this unaccounted for source of emission reductions can be estimated at 20%.
    - Not all of the wood removed from carbon stocks (wood cut from living trees) is used for the production of charcoal. Craster Herd, 2007 puts the share of wasted wood at 2 kg for 5.7 kg of wood used in the production, equivalent to 26% losses.

  In turn, it can conservatively be assumed that an additional 30% decrease of carbon stock occurs beyond the wood determined to be from non-renewable sources which is used in the production of charcoal.

Projects:

- Briquettes produced from different types of biomass are less friable than charcoal produced in the baseline. Less fuel will turn into dust which cannot be used by end users (in general, around 5% of charcoal turn into dust). Such projects will therefore supply more useful fuel to end users, on the basis of the same measured output (this output is measured at the production site).
- Projects based on this standardized approach will require the determination of the fraction of non-renewable biomass (Xnrb) in the baseline biomass supply. Due to the complexity of its determination, the factor is in most cases fixed ex-ante. As demonstrated, the pressure on forest resources is however increasing due to an increased used of charcoal. As such, the use of an ex-ante factor is conservative as in most countries the situation in the absence of projects is likely to worsen.

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[6] Table 4.4 „Ratio of below-ground biomass to above-ground biomass" of the IPCC Vol. 4 on "Agriculture, Forestry and other Land Use" puts the ratio of biomass in the root system between 20% and 56% for tropical and subtropical climate systems where most of the eligible countries for this methodology are located.

[7] Typically, only stems above knee high and branches with over 2 cm in diameter are used in the production of charcoal. The associated carbon stock in small branches, leaves, the lowest part of the stem and roots represents more than 20% of the wood harvested for charcoal.

[8] With the exception of deep roots which are expected to partly fossilize.

- The use of an approach based on the determination of the fraction of non-renewable biomass (Xnrb) in the baseline is performed on a determined geographic area. The consumption of wood for the production of charcoal is however very local. As such the factor Xnrb is likely to under evaluate the pressure on wood resources in areas supplying charcoal to the centres of consumption.
- In addition to CO_2 and CO emissions, the emissions of other greenhouse gases (for example GHG not included under the Kyoto Protocol) are expected to be reduced.
- Several project types will include the switch to a sedentary kiln, thus avoiding the more permanent deforestation which happens on every kiln spots for the traditional and non-sedentary kilns.

Table 14: Unaccounted for emission reductions

Country	Quote	Page	Source
	Transportation: It is estimated that about 20 % of charcoal is lost	11	Seidel, 2008
	Charcoal makers typically remove the root mass to a depth of ~0.5m. Taproots of trees in semiarid or drought prone areas can descend 5m or more, but typically the majority of the root mass (55-85%) is found within 0.5m of ground level (Breman and Kessler, 1995).	187	Bailis, 2005a
	Equation 1 does not take into account any wastage from the felling process, thereby underestimating the impact of charcoal production on the forests in the CR. The largest and smallest diameters of trees felled for charcoal were 95 cm and 13 cm respectively (....) equates to 58m3 of wood wasted	46	Craster Herd, 2007
	Currently in the CR tree cutting is practiced at waist height (Figure 21). This not only creates considerable wastage but also invariably renders the stem defective for coppicing	60	Craster Herd, 2007
	Permanent deforestation on kiln site due to extreme heat	24	Chidumayo, 2011
	improved health among women and children owing to reduced exposure to toxic indoor air pollutants	6	Kituyi, unknown
Uganda	Proportion of fines in the bags, which sometimes amounts up to 20% (on the average 5%).	20	Knoepfle, 2004
	The massive destruction of acacia trees will have profound environmental consequences for nomadic families, whose survival is linked to the environment they inhabit.	39	Dini, 2006
	However, there are significant social and environmental impacts associated with the consumption of charcoal including: forest degradation, loss of biodiversity and environmental services, as well as health issues.	2	Craster Herd, 2007
	Root biomass can comprise between 32% of total woody biomass (in Zambia, Chidumayo 1997) and 20% (in Tanzania, Malimbwi et al. 1994). – from: http://www.geos.ed.ac.uk/homes/cryan/miombo		
	The government should therefore encourage industries to invest in converting their biomass waste into charcoal briquettes for extra earnings. This would also reduce the demand for lump charcoal.	12	Mugo and Ong, 2006
Mozambique	Wood used in kiln 5.7 kg woody biomass per kg char produced. Additional harvesting losses / damage 2 kg woody biomass	76	Craster Herd, 2007

	per kg char produced		

7. Step 1: Identification of host countries, sectors, output(s) and measure(s)

7.1 Generic procedure

The present proposal for standardized baselines proposes:
- the establishment of a sector-wide baseline for the charcoal produced from informal charcoal sector: baseline CC1(in step 4);
- the definition of project types P1, P2 and P3 (in step 1);
- the demonstration that the baseline CC1 is applicable for the proposed measures for a group of countries as it represents the most plausible baseline (step 3);
- the demonstration that the proposed measures are additional for a range of countries.

7.2 Key elements of the standardized baseline

Key elements of the standardized baseline are provided in the summary table below. These include among others choices provisions on the following key elements:
- system boundaries;
- outputs;
- sectors;
- key performance indicators;
- aggregation levels;
- stringency.

Table 15: Key applicability elements of the standardized baseline

Item	Sub-item	
Sectors	**Sectors included**	The proposed standardized baseline is applicable to: - the production and consumption chain of charcoal products as a household fuel. - the production chain of charcoal products as a fuel for small and medium industries (SME).
	Sectors specifically excluded	The proposed standardize baseline is not applicable to: - The production and consumption chain of charcoal products as a fuel supplied to large scale industries. - Projects which directly result in users switching from other fuels to charcoal products. (note: the supply of charcoal products to the market with an unidentified pool of buyers shall not be considered as a measure resulting in a switch from other fuels to charcoal as the supplier has no control over the pool of buyers).
System boundary	**-**	<u>Baseline:</u> Charcoal production site. No "associated upstream emissions" occur[i]
		<u>Project:</u> (i) Charcoal production site (ii) Associated upstream emissions a. Electricity consumption to be considered (if any) b. Transportation of biomass to be considered (if any) c. Ancillary fuels: ignored[ii]
Key Performance Indicator	**-**	tCO_2e per equivalent amount of charcoal produced – corrected for the charcoal Net Calorific Value (NCV) *(cf. section on "product aggregation level").*
Aggregation level	**(1) Process:**	<u>Baseline emission factor:</u> (i) <u>Baseline CC1:</u> the charcoal consumed by households and SME is produced by the "informal sector" on the basis of traditional kilns. (ii) <u>Other baselines:</u> the current proposal does not include baselines applicable for cases in which other production technologies (e.g. the Casamance kiln) form a substantial share of the baseline charcoal production. Parties, project proponents, international industry association or admitted observer organizations are invited to propose additional baselines reflecting the use of a different mix of production technologies over time.
		<u>Baseline applicability:</u> The proposed baseline(s) are solely for project activities which reduce the GHG intensity of charcoal supplied to households/communities/small and medium enterprises (SMEs). Large scale activities for the supply of industrial users of charcoal are therefore excluded.
		<u>Project:</u> no process differentiation. All processes transforming biomass into charcoal products with a flexible choice of measures/technologies are allowed.

		Additionality: - Only a selected number of project types/processes are proposed as deemed additional (positive list). - Restrictions on the process scale apply for the ex-ante additionality demonstration.
	(2) Product:	Inputs: all inputs whose use lead to a decrease in forest carbon stock as they are partly or totally non-renewable shall take into account the following elements: (i) the fraction of non-renewable biomass (XNRB) in inputs; (ii) the carbon content in the wood used (expressed on an oven-dry wood basis).
		Outputs: Charcoal products are simple carbon-based fuels and are interchangeable. Different charcoal qualities might differ in their net calorific value (NCV). In order to provide the same amount of energy level of service in the project and the calculated baseline, a correct quantification needs to take into account the difference in the net calorific value. - If the net calorific value (in TJ/tonne of charcoal) is higher in the project activity than in the baseline, a correction for the difference in net calorific value can be applied. It can also be neglected (this is conservative) - If it can be demonstrated that the net calorific value is similar as wood, coconut shells or bamboo are used in the project in conjunction with a more advanced technology than in the baseline CC1, net calorific values can be assumed to be similar[iii] (this is sufficiently accurate and substantially increases the simplicity). - If the net calorific value (in TJ/tonne of charcoal) is lower in the project activity than in the baseline, as can be expected for charcoal briquettes produced from products other than wood, coconut shells or bamboo, a correction for the difference in net calorific value shall be applied. As pointed out by Mugo and Poulstrup, 2003 on page 30, the "heating value of charcoal is determined by its fixed carbon content". Since hydrogen content of charcoal is negligible (Baker et al., 1991), LHV of charcoal was assumed to be the same with HHV. The correction for different carbon content can be done in accordance with one of the following approaches: (i) Direct ratio between NCV (ii) Direct ratio between carbon contents (iii) HHV=0.437*C-0.306 MJ/Kg (Rosillo Calle, 2007) (iv) HHV=0.3536*C+0.1559*VM-0.0078*ASH where C represents carbon, VM the volatile matter and ASH, the ash content expressed in mass percentages on dry basis. (Misginna and Rajabu, unknown) (v) HHV=0.3491*C+1.1783*H+0.1005*S-0.1034*O-0.0151*N-0.0211*A where C,H,O,N,S and A represents carbon,

		hydrogen, oxygen, nitrogen, sulphur and ash content of material, respectively, expressed in mass percentages on dry basis. (This is the correlation proposed by Channiwala and Parikh, 1991.
	(3) Time	Baseline emission factor: No autonomous improvements in the technologies used have been observed in the case of traditional unimproved technologies[iv]. This has two consequences: - The baseline emission factor for CC1 does not need to be updated over time. - Performance test from any point in time can be included in the vintage used to derive values for the baseline emission factor (e.g. a performance test from the 1950´s would still be valid) for CC1. Baseline applicability: please refer to the "updating frequency" section. Projects: Only installation of new equipment is allowed. As kilns in the baseline production have a lifetime limited to a single carbonization campaign, all projects proposed are by definition "greenfield projects". Additionality: n/a
	(4) Space	c.f. section 7.5
Stringency	**Specific levels**	Baseline emission factor: CO_2 emissions: Determined based on the "average" observed on all adequate performance tests for the technology at the 90th percentile of the cumulated production. This represents the continuation of the current practice. CH_4 emissions: Weighted average for the region as there is no "most economically attractive course of action" for CH4 emissions from pyrolysis gases – as there is no economic incentive for charcoal producers to reduce CH4 emissions. These emissions are the result of both the technology and operating conditions. Baseline applicability: n/a Additionality: all measures types M1, M2, M3 and M4
	Unaccounted for emission reductions	Estimated to represent around 30% of the baseline emissions (cf section 6.13 of this proposal).
Updating frequency		Baseline emission factors: No need for updating of the "consolidated GHG database for the informal charcoal sector" as the traditional technologies presented and found in baseline CC1 have not evolved over time[v]. The database might however be updated and improved over time as more information is gathered. Baseline applicability: The baseline applicability is to be reassessed according to the following principles: (i) Countries for which the baselins CC1 has been established as applicable: the applicability of the baseline CC1 is to

		be re-assessed five years after their approval by the board. This means that new evidence shall be provided that over 90% of the total charcoal production is from the informal charcoal sector using traditional technologies. (ii) Countries for which a baseline other than CC1 has been established as applicable: the applicability of baselines other than CC1 is to be re-assessed five years after their approval by the board. In reassessing the baseline applicability, attention has to be paid among others to the two possible following changes which could jeopardize the assumption on the continuation of the baseline over time: • New availability of cheap sources of commercial fuels to the population of the country (e.g. major oil discovery in the country). • Autonomous spread of efficient and advanced charcoal-making technologies: this is demonstrated not to happen[vi] and in turn does not need to be considered. <u>Project:</u> n/a. <u>Additionality:</u> As additionality is correlated with poverty and weak governance over the informal sector, the following updates would apply to the additionality demonstration: (i) Locations/countries in which projects types P1, P2 or P3 are automatically additional due to their LDC, LIC or SUD status: • the LDC status of countries will follow updates by the official UN list of LDCs; • the LIC status of countries will follow updates by the official world bank list (atlas method); • the SUD status of a region/subregion will follow UNFCCC rules.

[i] No associated upstream emissions have been identified for charcoal produced by the informal sector on the basis of traditional technologies. No CO_2 emitting source of energy is used in this baseline.

[ii] As previously demonstrated, charcoal in LDCs and LICs is the fuel of choice as it can be purchased for less than petroleum based fuel. Charcoal producers only earn a fraction of the final charcoal price. As such it is economically not feasible for charcoal makers to use meaningful quantities of petroleum based fuels as ancillary fuels in the charcoal making process.

[iii] As found in Tippawong, 2010

[iv] Demonstrated in chapter 6.9 of the current proposal

[v] Demonstrated in chapter 6.9 of the current proposal

[vi] Demonstrated in chapters 6.4, 6.6, 6.8, 6.9 and 6.10 of this proposal

7.3 Host countries and areas

As eligible countries found to be eligible in step 1 to 4 are not the same, an overview is provided in the table below. Stakeholders are invited to suggest changes and addition to the table on the basis of new available evidence:

Step	Description	Host countries (or group of countries, countries or specific areas within a host country)
1	Identification of host countries, sectors, outputs and measures	n/a
2	Demonstration of automatic additionality of various measures for projects P1, P2 and P3 on the basis of the country/area status	a) LDC b) LIC in which the baseline CC1 has been found to be valid (that is Ya=Yb=90% and CC1>90% of the production of charcoal for households for households and SME) c) special underdeveloped zone of the host country identified by the government before 28 May 2010; d) area[9] with observed poverty defined as an average of less than $2 per capita per day[10]. *Exception: Soudan*
3	Identification of CC1 as the most plausible baseline for project types P1, P2 and P3	a) Countries with ex-ante evidence that CC1>90% of the production of charcoal for households for households and SME: - Burundi (LDC) - Cambodia (LDC) - Kenya (LIC with baseline CC1 identified as valid) - Madagascar (LDC) - Malawi (LDC) - Mali (LDC) - Mozambique (LDC)

[9] The area is defined as the charcoal production area. The limit does not apply to areas of charcoal consumption which are typically urban areas with higher income levels.

[10] The definition of moderate poverty used by the World Bank was of $2 per person per day. In case of a more recent definition, project proponent can use the updated figure.

		- Tanzania (LDC) - Uganda (LDC) - Zambia (LDC) *Explicit exception: Senegal (LDC with doubts on the validity of CC1)* b) New proof that for the considered country or area, Countries with ex-ante evidence that CC1>90% of the production of charcoal for households for households and SME
4	Establishment of a sector-wide baseline for the charcoal produced from informal charcoal sector: baseline CC1	Not restricted. No differentiation is applied as practices and technologies have been found to be similar across the considered categories of countries (mostly LICs and LDCs). Due to conservative assumptions such as a rather low carbon content in wood (45%) to be used in conjunction with all methodologies based on this standardized approach, a same baseline emission factor can be used, despite differences in species of wood used locally. The use of performance tests from a broad range of sites in different geographic location provides an average value which is not influenced by local parameters. This is adequate for a standardized baseline, provided that no opt-out is allowed.

7.4 Measures

7.4.1 Project types

The proponent would like to define the following project types:

P1:	**Project activities which provide chimneys for Casamance kiln and training for the operation of Casamance kilns.**	
Technology:	Casamance kilns	
Sub-measures:	M1: fuel and feedstock switch:	Non-applicable. Wood from forests remains the feedstock[11]
	M2: switch of technology with or without change of energy source:	Mandated
	M3: methane destruction:	Non applicable
	M4 : methane formation avoidance :	Possible[12]
Applicability condition for projects	• The chimneys which allow the upgrade to Casamance kilns are supplied to charcoal makers (either individual or communities) which did previously not own one. • For each of the charcoal makers (either individual or communities) training is provided for the construction/operation of Casamance kilns. • No charcoal manufacturing equipment transferred from existing or former charcoal production facilities are transferred to the project.	

P2:	**Project activities which install and operate new sedentary kilns and supply charcoal and/or charcoal briquettes to the household fuel market.**	
Technology:	Sedentary kilns with improved energy efficiency.	
Sub-measures:	M1: fuel and feedstock switch:	Possible – provided that emission reductions accounted for do not exceed the threshold of 60 $ktCO_2e$ per project or CPA, in compliance with the modalities for small-scale projects.

[11] Although wood from forest remains the feedstock, project participants are invited to propose projects in which the input is switched to sustainably managed forests or newly established plantations.

[12] No specific CH_4 emission factor (expressed per quantity of charcoal) for charcoal produced from Casamance kiln using mixed wood is provided under this proposal. Project proponents are however invited to submit a default value on the basis of documented evidence.

	M2: switch of technology with or without change of energy source:	Mandated – the project kiln has to be sedentary
	M3: methane destruction:	Applicable
	M4: methane formation avoidance :	Possible[13]
Applicability condition for projects	• No charcoal manufacturing equipment transferred from existing or former charcoal production facilities are transferred to the project. • Measures are limited to those that result in emission reductions of less than or equal to 60 ktCO_2 equivalent annually. • The project supplies charcoal to one or more identified areas in which charcoal is consumed as fuel for households, small and medium businesses and cottage industries. The charcoal is not supplied to large scale industries. • The project is able to demonstrate that it does not accelerate the depletion of biomass stocks. This can be demonstrated by: o The retirement of traditional charcoal making activities on the community level – with the inclusion of workers previously employed in the traditional charcoal production o The distribution of efficient cookstoves. o An afforestation which provides on average a mean annual increment in biomass equal to the depletion by the project. o The implementation of a project for the production and use of alternative to wood-based charcoal (e.g. bio-waste based charcoal, introduction of jatropha oil as cooking fuel, etc.) o Any combination of the above	

P3:	**Project activities which install and operate new production and supply charcoal and/or charcoal briquettes to the household fuel market from the following inputs: (i) invasive plants; (ii) biomass residues; (iii) renewable biomass from newly established dedicated plantation; (iv) pruning of trees.**	
Technology:	Sedentary kilns with improved energy efficiency.	
Sub-measures:	M1: fuel and feedstock switch:	Mandated; Emission reductions accounted for shall not exceed the threshold of 60 ktCO2e per

[13] The present proposal does not provide default values for the specific CH_4 emission factor (expressed per quantity of charcoal) of charcoal produced from specific types of sedentary kilns, using mixed wood. Project proponents are invited to submit, such values on basis of documented evidence.

		project or CPA, in compliance with the modalities for small-scale projects.
	M2: switch of technology with or without change of energy source:	Mandated – the project kiln has to be sedentary
	M3: methane destruction:	Applicable
	M4 : methane formation avoidance :	Applicable
Applicability condition for projects	• No charcoal manufacturing equipment transferred from existing or former charcoal production facilities are transferred to the project. • Measures are limited to those that result in emission reductions of less than or equal to 60 ktCO_2 equivalent annually. • The project supplies charcoal to one or more identified areas in which charcoal is consumed as fuel for households, small and medium businesses and cottage industries. The charcoal is not supplied to large scale industries.	

7.4.2 Threshold for the project types:

The proponent would like to suggest the following applicable limits applicable to projects:

P1: Only limited to the 60 ktCO_2e/year threshold for small-scale projects type III, either per stand-alone project or per CPA. Automatic additionality of the project type is not limited to a specific threshold.
Justification: The Casamance kiln is an improvement of the traditional kilns. Its mud-based shale prevents it from being scale-up. Based on an efficiency improved by 30% (Ndiaye, 2004), and a productivity of 20 to 50 tonnes/yr per traditional kiln (FAO, 2000) , it appears clearly that Casamance kiln are well below the threshold of 100 tonnes produced annually per unit. In turn, even if the savings (reduced depletion of non-renewable biomass) were to be calculated on the basis of 100% non-renewable biomass, the emission reductions would not exceed the threshold of 600 tCO_2e/unit. This is consistent with current "guidelines for demonstrating additionality of microscale project activities – version 3.0"

P2: Only limited to the 60 ktCO_2e/year threshold for small-scale projects type III, either per stand-alone project or per CPA. Automatic additionality of the project type is not limited to a specific threshold.
In line with the "Guidelines for demonstrating additionality for micro-scale project activities" (EB63 / Annex 23), "each of the independent carbonization sites in the project activity has a capacity of less than 3,000 tonnes per year.
Justification: The selected value excludes all types of large-scale industrial kilns, yet allows for most low-cost kilns to be installed, as found in Table 6 from Kumar, 2009.

The value selected is well in line with the "guidelines for demonstrating additionality of microscale project activities – version 3.0" under which automatic additionality is granted to of type III projects located in "an LDC/SIDS or special underdeveloped zone of the host country as identified by the government before 28 May 2010" on the condition that they do not exceed the threshold of 20,000 tCO_2e[14].

P3: Only limited to the 60 $ktCO_2e$/year threshold for small-scale projects type III, either per stand-alone project or per CPA. Automatic additionality of the project type is not limited to a specific threshold.
Justification: The fact that project biomass cannot be sourced from the depletion of local forests and that the charcoal can only be supplied to small-scale users prevents perverse incentives. Chapter 6 demonstrates well that autonomous investments in such technologies do not take place. Applicability conditions restrict the supply to the market of domestic users and small and medium enterprises.

[14] Based on Xnrb=0.7, a carbon content in wood of 45%, KCH4=0.034 and KCO2=7 and a project with a yield of 35% and methane emissions reduced by 90%. In this case projects solely improving the process would roughly save 10,000 tCO_2e while projects also switching to carbon neutral biomass would save around 26,500 tCO_2e.

8. Step 2: Additionality criteria for the identified measures

In compliance with the "Guidelines for the establishment of sector specific standardized baselines", the following applies:

13. According to this framework, additionality may be demonstrated ex ante for a variety of measures rather than for each proposed project activity. For project activities that include multiple types of independent measures, the additionality of each measure is demonstrated by checking against the positive list of measures. If the implementation of one measure m1 (e.g. electricity generation using landfill gas) requires the implementation of another measure m2 (e.g. destruction of the methane contained in the landfill gas) then the two measures are inherently linked. In this case, the additionality is demonstrated for the group of linked measures collectively as well as for each measure separately e.g. electricity generation from landfill gas and destruction of methane in the landfill gas. If m1 is not additional, then m2 cannot be additional.

14. In essence, additionality is not required to be demonstrated for each individual project activity ex-post (i.e., after its formulation) but rather for types of measures and ex-ante.

8.1 Measures and technology:

M1: Fuel and feedstock switch

There is a very high certainty that in virtually all LDCs, LICs and areas defined as underdeveloped or faced with widespread poverty, wood from natural forests (a fraction of which can be from non-renewable sources) is the fuel/feedstock used for the production of well over 90% of the charcoal supplied.

The production and supply of charcoal to household users that is produced from other feedstocks (e.g. bamboo, biomass wastes, plantations, etc.) is anecdotic and when existing is in most cases the result of supported efforts. Such supported efforts have been implemented at the scale of pilot projects. The wide review of the literature performed did not indicate any large-scale deployment which would possibly reduce the share of the defined baseline fuel to less than 90%.

In fact, the production of charcoal from the informal sector on the basis of unimproved technology (baseline CC1) is virtually always done on the basis of wood from local forests. In addition to that, the overwhelming majority of charcoal which would be produced cases other than CC1 is also produced from wood sourced in forests. For this reason, the following can be assumed:

$$xWFF = xCC1 \times xWFF_{CC1} + [(1 - xCC1) \times xWFF_{other\ tech}]$$

Equation 1: Calculation of the baseline share of wood from forests

Where:

xWFF = Share of wood from forests as baseline wood or feedstock
xCC1 = Share of technology CC1
$xWFF_{CC1}$ = Share of wood as feedstock for technology CC1
$xWFF_{other\ tech}$= Share of wood as feedstock for technologies other than CC1

As the following are true:
- CC1 is required to be found to be higher than 90% of the baseline under this standardized and baselines;
- CC1 is virtually always solely produced on the basis of wood from forest as fuel/feedstock ($xWFF_{CC1}$≈100%);
- the overwhelming majority of other baselines than CC1 are also based on wood from forests as fuel/feedstock ($xWFF_{other\ tech}$>>75%);

Related to equation 1 we can therefore assume the following:
If xCC1>90%, $xWFF_{CC1}$>95% and $xWFF_{other\ tech}$>90%, xWFF is in any case larger than 90%.

Therefore if CC1 is found to be the applicable baseline (xCC1>90%), fuel switch is additional as soon as wood from forests is displaced by another type of biomass (e.g. biomass from a dedicated plantation, biomass waste, biomass from pruning, invasive species, etc.). The "guidelines for the establishment of sector specific standardized baselines" define that less carbon-intensive fuels are automatically additional as soon as they are above the 80% threshold (for "energy for households"). Fuel switch is additional even in the case of applying a more conservative 90% threshold. This fact is illustrated by Figure 7.

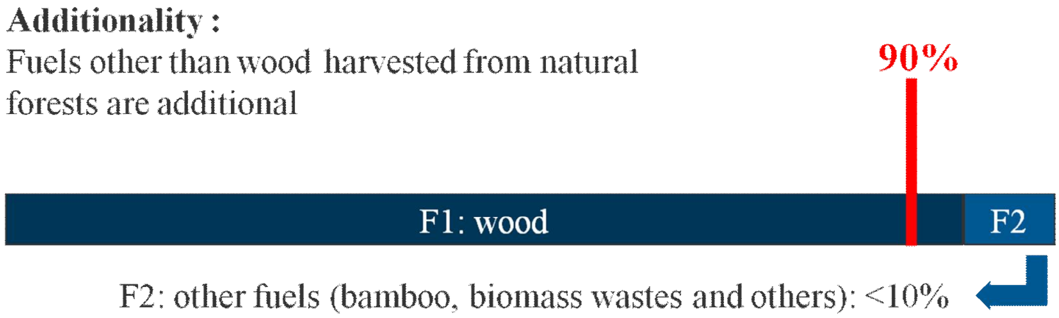

Figure 7: Additionality determination of fuel and feedstock switch

As documented, feedstocks other than wood face the following barriers:
- A higher investment (compared to traditional kilns which do not require an investment) as the the source of biomass either needs an investment to be established (plantation of forest, bamboo or other woody biomass) or to be transformed (free biomass wastes which need an additional agglomeration process).
- A lower return on investment. Indeed even when zero-cost sources of biomass are used, the investment will always compete against producers from the informal

charcoal sector. Such producers have an extremely low labour costs and consume an under-priced or zero-cost resource.
- Lower acceptance by end users.

Table 16: Additionality of feedstock switch

Country	Quote	Page	Source
India	As a result, whichever technology may be used, the production cost of locally produced char briquettes is always more than that of locally produced wood charcoal.	10	Karve, Priyadarshini, 2011
-	Tree growing approaches remain ineffective when competing with open access resources. Costs for planting and maintenance in this case are prohibitively high, and significant subsidies (e.g. Madagascar: US$300/ha) are necessary to provide enough incentive. This generally holds true for any investments in natural forest management where investment costs are at least US$10 per ha.	21	Miranda et al, 2010
Kenya	Charcoal from forest plantations can, however, is produced on a much larger scale, making it feasible to use more advanced and efficient equipment like retorts in order to recover the by-products. Investment costs are high and if there is no ready market for the by-products, the option may not be attractive to the large-scale charcoal producer.	10	Mugo and Ong, 2006
SSA	At present, however, the unregulated production of charcoal does not create an environment that promotes investments in better methods and technologies; hence, charcoal is still produced with very traditional processes.	10	Sanders et al., 2011

<u>Conclusion:</u> The production of charcoal from feedstock which complies with at least one of the following definitions is additional:

Table 17: Applicability conditions preventing leakages associated with biomass feedstocks

L_1	Demonstrate that at the sites where the project activity is supplied from with biomass residues, the biomass residues have not been collected or utilized (e.g. as fuel, fertilizer or feedstock) but have been dumped and left to decay, land-filled or burnt without energy generation (e.g. field burning) prior to the implementation of the project activity. Demonstrate that this practice would continue in the absence of the CDM project activity, e.g. by showing that in the monitored period no market has emerged for the biomass residues considered or by showing that it would still not be feasible to utilize the biomass residues for any purposes (e.g. due to the remote location where the biomass residue is generated)
L_2	Demonstrate that there is an abundant surplus of the in the region of the project activity which is not utilized. For this purpose, demonstrate that the quantity of available biomass residues of type *k* in the region is at least 25% larger than the quantity of biomass residues of type *k* that are utilized (e.g. for energy generation or as feedstock), including the project plant
L_3	Demonstrate that suppliers of the type of biomass residue in the region of the project activity are not able to sell all of their biomass residues. For this

	purpose, project participants shall demonstrate that the ultimate supplier of the biomass residue (who supplies the project) and a representative sample of suppliers of the same type of biomass residue in the region had a surplus of biomass residues (e.g. at the end of the period during which biomass residues are sold), which they could not sell and which are not utilized
L_4	The biomass is from a newly established dedicated plantation

M2: Switch of technology with or without change of energy sources

The cumulative percent of output Oi, produced based on technologies is arranged in descending order of carbon intensity of the technologies:

T1%:“traditional kilns”, using wood from wood from natural forests.
=> Due to the low efficiency and use of fully or party non-renewable biomass source, this is the second most carbon intensive technology
Based on the evidence provided in chapter 6.8, it can be established with a high level of certainty that “traditional kilns” as used by the “informal charcoal sector” is the baseline for well over 80% of the charcoal supplied to households and small scale enterprises (hotels, cottage industry, etc.). This has been found to be applicable to the following countries: Burundi, Cambodia, Kenya, Madagascar, Malawi, Mali, Mozambique, Tanzania, Uganda and Zambia. In countries where very precise and recent figures exist, traditional kilns consistently represent more than 99% of the output over the last 3 years.

T2%: “improved kilns/sedentary kilns”.
=> Due to the higher efficiency and use of fully or party non-renewable biomass source, this is the third most carbon intensive technology

T3%: “production of charcoal briquettes” from biomass other than natural forests.
=> Due to the carbon neutral biomass, this is the least carbon intensive technology.
From a review of the literature, it appears that the share of T3% in the identified locations is only anecdotic (probably 1% or less).

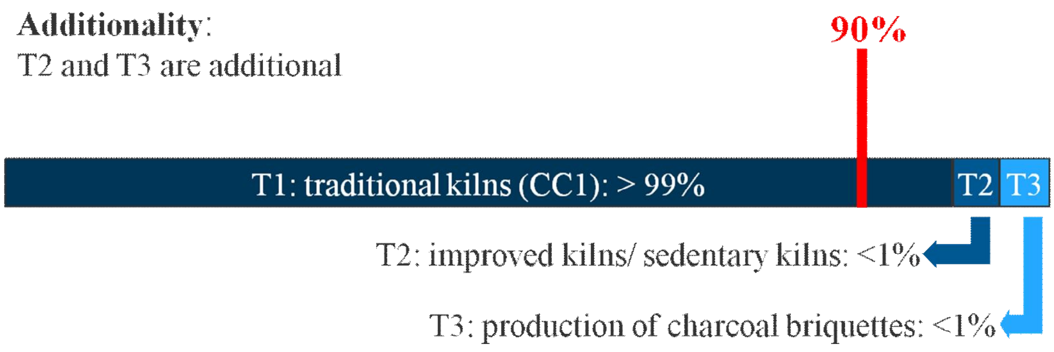

Figure 8: Additionality determination of technology switch

Technologies used in the proposed project types P1, P2 and P3 are additional as they have a lower greenhouse gases intensity than the technology T1% which is the single technology which produces aggregately by far more than 80% of the outputs as illustrated by Figure 8.

In addition to that:
- There is no national or sub-national enforced regulation mandating the use of the technologies specified under project types P1, P2 or P3.
- Attempts at deploying technologies in P1 and P2 have repeatedly failed due to barriers. This is well documented in chapter 6.
- Due to its high cost, no investment in project type P3 has been observed at a scale exceeding 1% in any country.

Conclusion: The switch of technology compared to the baseline as proposed under project types P1, P2 and P3 is additional.

M3: Methane destruction
There is neither a mandated, nor enforced destruction of methane associated with any technology. Without the CDM, there is no economic incentive for the destruction of methane associated with the production of charcoal.

Conclusion: the baseline is the lack of destruction of methane emissions emitted from the pyrolysis process by the “traditional kilns”.

M4: Methane formation avoidance
There is no mandated treatment method to avoid the formation of methane. There is no incentive to reduce emissions of methane compared to the baseline.

Conclusion: methane formation avoidance is additional. The measure is additional for any project type which reduces methane emissions beyond the identified baseline level.

Overall conclusion: Measures M1, M2, M3 and M4 are additional for the project types P1, P2 and P3. In conclusions, all measures allowed under such projects are additional.

8.2 Location:

Poverty, the low ability of countries to enforce regulations and the lack of meaningful autonomous improvements on the sector form the basis for the assumptions with regard to baseline and additionality. These parameters are used for the UN country classification of LDCs, the World Bank’s LIC classification and the definition of host countries SUDs. Therefore, additionality determination based on the project location is an adequate and more straightforward approach to assess additionality than assessing the technology penetration rate. Furthermore, this approach avoids recognizing projects as additional in countries which might have an economic and regulatory capacity that allow them to solve the charcoal problem by themselves. As a result, automatic additionality shall be geographically restricted to project activities of types P1, P2 and P3 in the following locations:

(a) LDCs
(b) LICs in which the baseline CC1 has been found to be valid
(c) Special underdeveloped zone of the host country identified by the government before 28 May 2010;
(d) Area[15] with observed poverty defined as an average of less than $2 per capita per day[16].

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[15] The area is defined as the charcoal production area. The limit does not apply to areas of charcoal consumption which are typically urban areas with higher income levels.
[16] The definition of moderate poverty used by the World Bank was of $2 per person per day. In case of a more recent definition, project proponent can use the updated figure.

9. Step 3: Baseline identification for the measures

9.1 Procedure:

The present proposal for a standardized baseline proposes the identification of the baseline for the following measures applicable to project types P1, P2 and P3:
M1: Fuel and feedstock switch
M2: Switch of technology with or without change of energy sources
M3: Methane destruction
M4: Methane formation avoidance

To identify with a high certainty the baseline, the procedure provided in the "guidelines for the establishment of sector-specific standardized baselines – version 2.0" is used

9.2 Location:

For project types P1, P2, P3 as well as other projects supplying charcoal to the household sector and SME, the baseline can be assumed to by CC1 (the charcoal consumed by households and SME is produced by the "informal sector" on the basis of traditional kilns) if the project is located in one of the following countries:
- Burundi
- Cambodia
- Kenya
- Madagascar
- Malawi
- Mali
- Mozambique
- Tanzania
- Uganda
- Zambia.

9.3 Baseline identification for using the guidelines for the establishment of sector-specific standardized baselines

M1: Fuel and feedstock switch

There is a very high certainty that in virtually all LDCs, LICs and areas defined as underdeveloped or faced with widespread poverty, wood from natural forests (a fraction of which can be from non-renewable sources) is the fuel/feedstock used for the production of well over 90% of the charcoal supplied. The production and supply of charcoal to household users that is produced from other feedstocks (e.g. bamboo, biomass wastes, plantations, etc.) is anecdotic and when existing is in most cases the result of supported efforts. Such supported efforts have been implemented at the scale of pilot. The wide review of the literature performed did not indicate any large-scale deployment which would possibly reduce the share of the defined baseline fuel to less than 90%. Therefore, the baseline fuel is wood from natural forests. This is consistent with the "guidelines for the establishment of sector specific standardized baselines" that define an 80% threshold for "energy in households". Wood from natural forests is the baseline even in the case of applying a more conservative 90% threshold. This fact is illustrated by Figure 9.

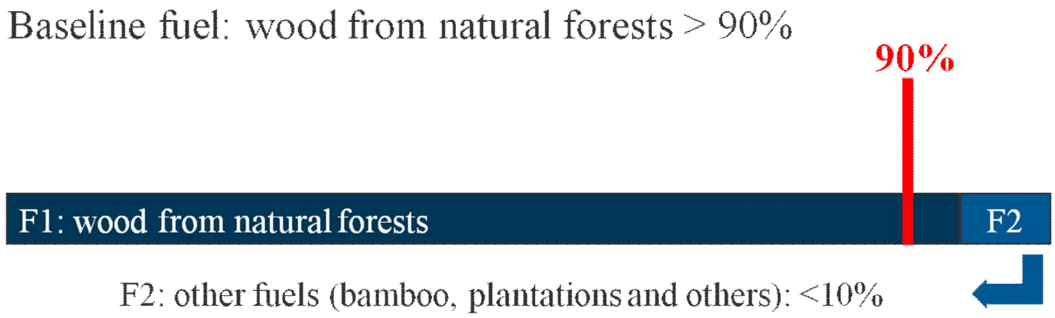

Figure 9: Baseline determination of technology switch

Conclusion: Wood from natural forests is the fuel/feedstock used to produce almost all the charcoal consumed.

M2: Switch of technology with or without change of energy sources (including energy efficiency improvement).

Identification of the technologies used for the production of "charcoal products" supplied to households and small scale enterprises (hotels, cottage industry, etc.).

T1:"traditional kilns", using wood from wood from natural forests.
=> Due to the low efficiency and use of fully or party non-renewable biomass source, this is the second most carbon intensive technology.
Based on the evidence provided in chapter 6.8, it can be established with a high level of certainty that "traditional kilns" as used by the "informal charcoal sector" is the baseline for well over 90% of the charcoal supplied to households and small scale enterprises (hotels, cottage industry, etc.). This has been found to be applicable to the following countries: Burundi, Cambodia, Kenya, Madagascar, Malawi, Mali, Mozambique, Tanzania, Uganda and Zambia.

T2: "improved kilns/sedentary kilns".
=> Due to the higher efficiency and use of fully or party non-renewable biomass source, this is the third most carbon intensive technology.

T3: "production of charcoal briquettes" from biomass other than natural forests.
=> Due to the carbon neutral biomass, this is the least carbon intensive technology.
From a review of the literature, it appears that the share of T3% in the identified locations is only anecdotic (probably 1% or less).

Therefore, the baseline technology is T1 traditional kilns. This is consistent with the "guidelines for the establishment of sector specific standardized baselines" that define an 80% threshold for "energy in households". T1 is the baseline even in the case of applying a more conservative 90% threshold. This fact is illustrated by Figure 10.

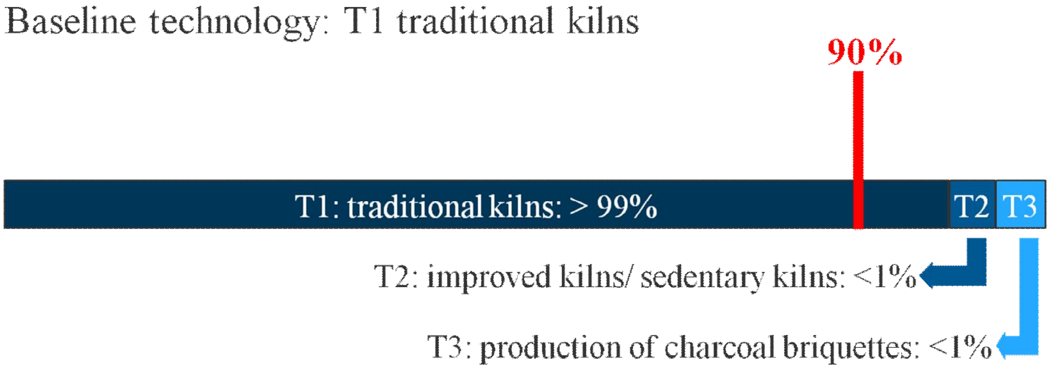

Figure 10: Baseline determination of technology switch

<u>Conclusion:</u> T1 is the baseline;

M3: Methane destruction

There is neither a mandated, nor enforced destruction of methane associated with any technology. No solution has been identified for the destruction of methane from the baseline technology (traditional kilns).

<u>Conclusion:</u> the baseline is the lack of destruction of methane emissions emitted from the pyrolysis process by the "traditional kilns".

M4: Methane formation avoidance

Although methane emissions show some correlation with kiln efficiency, the baseline is the most commonly applied situation: no measure to avoid the formation of methane emissions at "traditional kilns" which form the baseline.

<u>Conclusion:</u> the baseline is the average level of methane emissions per tonne of charcoal produced from "traditional kilns".

9.4 <u>Conclusion</u>

In the identified LDCs and LICs, the following baseline can safely be assumed for projects of type P1, P2 and P3 as well as other projects supplying charcoal to the household sector and SME:

Baseline CC1: the charcoal consumed by households and SME is produced by the "informal sector" on the basis of traditional kilns.

10. Step 4: Baseline emission factor determination

10.1 Objective

Preliminary research indicates that on a country basis, there is a rather poor availability and sometimes quality of data on the conversion efficiency of wood into charcoal and its associated methane emissions. The preliminary research indicates however, that a quite large vintage of performance and emission data is available for the production from charcoal informal charcoal sector on the basis of traditional technologies when all countries in which the informal charcoal sector exists are considered. Most of these countries are African countries.

For example, for Uganda, only five tests have been found to determine the wood to charcoal yield from traditional kilns. No information was available on the specific associated methane emissions.

Instead, a more complete and robust numerical basis is established on the basis of information collected from various studies performed over the last decades for a broad range of countries. The objective of this numerical basis is to be (i) accurate, (ii) rather conservative, (iii) derived in a transparent manner, and (iv) broadly applicable for the defined scope.

10.2 Procedure and rules:

In order to provide the necessary default factor for the calculation of the baseline emissions for the baseline CC1, **this proposal establishes the "consolidated GHG database for the informal charcoal sector"**. To calculate key factors, the following rules apply:

Parameters considered

In order to facilitate the calculation of emission reductions, the "consolidated GHG database for the informal charcoal sector" provides project proponents with default values for the following parameters:

Table 18: Parameters provided as default value

Parameter	Description	Unit
K_{CO2}	Emission factor for methane emissions as found in the *consolidated GHG database for the informal charcoal sector.* This value represents the amount of CO2 emissions associated with the production of one tonne of standard charcoal on the basis of 100% nonrenewable biomass under the baseline CC1.	tCO_2/t charcoal
K_{CH4}	Emission factor for CO2 emissions as found in the *consolidated GHG database for the informal charcoal sector.* This value represents the methane emissions associated with each tonne of standard charcoal under the baseline CC1.	t CH_4/t charcoal
$CF_{NCV,i,,y}$	Correction factor for the project to baseline net calorific value of charcoal product i in year y	-
CCi	Carbon content in wood	

$FC_{BL,Std,y}$	Standard carbon content of the baseline charcoal produced, as found in the *consolidated GHG database for the informal charcoal sector*.	Kg carbon / kg wood

Treatment of carbon products in the charcoal production chain

In order to derive the parameters listed above, the following conservative assumptions are made with regard to the carbon cycle associated with the production of charcoal:

Input		
Type	Comment	Treatment
Wood	This is the total carbon input for the process	Conservatively assumed to be 45% carbon on a dry mass basis. Note: in methodologies, only the share of carbon which is from non-renewable biomass (Xnrb) is considered to lead to CO_2 emissions.
Output		
Type	Comment	Treatment
Charcoal *(collected)*	Main output	Assumed to be fully emitted
Charcoal *(rejects)*	Charcoal which is not or cannot be recovered following the carbonization process under common practice	Considered non-emitted.
Brands	Partly carbonized wood	Considered non-emitted (this is conservative as part of the brands is in the form of mineral carbon which is not emitted)
Ash		Considered non-emitted (this is conservative)
condensable liquids		Considered non-emitted (this is conservative)
CO_2	CO_2 emissions	Emitted
CO	CO emissions;	Emitted; in line with version 3 of AM0009, a 100% oxidation into CO_2 is assumed
CH_4	Methane emissions	Basis for the determination of KCH_4. As these emissions are treated separately, the associated carbon is considered not to be emitted as CO2 in order to avoid double-counting.
TNMHC	Total Non-Methane HydroCarbons	Emitted; the carbon from TNMHC emissions is considered to be emitted as CO_2 while IPCC 1996 provides an emission factor of 11. This is conservative.
TSP	Total Suspended Particles	Considered non-emitted (this is conservative).

The carbon content in the wood used for the production of charcoal is the total carbon input of this transformation process. Three cases are distinguished for the carbon:

(i) the carbon is directly mitted as CH_4;
(ii) the carbon is transformed into outputs which are not emitted
(iii) the carbon is transformed into emitted products which are conservatively assumed to be emitted as CO_2.

The CO_2 emissions associated with the production of charcoal are calculated from the carbon which is (i) not either left not emitted or (ii) is emitted as CH_4.

Updating:

No need for updating of the "consolidated GHG database for the informal charcoal sector" as the traditional technologies presented have not evolved over time.
The database might however be updated and improved over time as more information is gathered. The inclusion of additional performance test would increase the accuracy of the database.

The procedure for updating is summarized in the table below:

Table 19: Summary of the updating procedure

Updating procedure						
Type	Xa%	Xb%	Ya%	Yb%	Data vintage	Frequency update
Baseline identification: Total charcoal production supplying households and SME in the considered area/country	90%	90%	90% or LDC status LIC status SUD zone <2$/cap./day	90%	Validity to be decided by the executive board.	the applicability of the baseline CC1 is to be re-assessed five years after their approval by the board.
Baseline emission factor: Emission factors of the baseline CC1 as found in the "consolidated GHG database for the informal charcoal sector"	n.a.				For CC1 only: Not limited in time as the technology has not evolved over time.	For CC1 only: Not required

Selection of performance tests found:

The performance tests included in the calculation of indicators of the "*consolidated GHG database for the informal charcoal sector"* have to comply with the following rules:
- The values provided either directly provide the wood to charcoal yield on a dry wood basis or a calculation of the dry yield based on known parameters is possible. Note: The dry yield is used as the carbon content in wood is a fixed fraction of the dry mass of wood.
- The performance tests can either represent accurately the reality practiced and/or represent an improved practice for this technology (e.g. most trained and professional charcoal makers; driest wood, larger kilns than usual etc.).
- Values included for performance test (or a range of several performance tests) can only be included once in the database. In the case of different sources of literature quoting the same value, the most accurate of them is to be chosen, others are to be rejected. The source study associated with the measurements is always to be preferred over secondary sources which merely quote the primary source.

Disaggregation:

Technology:

- Baseline CC1: Only "traditional kilns" in accordance with the definition provided. All types of kilns fitting this definition are to be included. This includes among others Earth Pit Kilns (EPK) and Earth Mound Kilns (EMK) are the most known types of traditional kilns. Earth pit kilns are on average less efficient as found in Seidel, 2008 and WorldBank, 2009. As such, a small share of EPK in the performance tests identified is conservative.

- Other baselines: Project proponents are encouraged to proposed new values and approaches to determine the baseline for countries where the use of improved technologies such as the Casamance kiln is widespread.

Product:

- Only performance tests in which charcoal is produced from wood are taken into account as this represents the baseline practice. Performance test of carbonization of other types of biomass (e.g. coconut shells) are rejected.
- Wood input
  - No distinction in wood species used is made.
  - The moisture content of wood is to taken into account if it is required for the calculation of the dry yield. Tests either are based on specifically dried wood (this is conservative as the baseline yield will be higher – associated baseline emissions will be lower), or on wood used under normal operating circumstances such as the use of green wood which is sometimes practiced (this is accurate).
- Calorific value of the charcoal: the heating value largely depends on the carbon content of the charcoal. Charcoals generally present carbon content of around 85%[17]. Comparing charcoals of different types would in turn require adjusting them to "standardised charcoal" by correcting for their heating value.

Time

- The performance tests have been carried out in the last 40 years.
- No restriction on the time of year the performance test has been performed.

Space

- The performance tests are representative of the conditions found for most LDCs and LICs. The tests have either been performed in any LDC/LIC or have been performed in a climate representative of LDCs/LICs.

Calculation basis:

All wood to charcoal yields are expressed on a dry-wood basis.

Methane emission factors are expressed per tonne of charcoal.

If possible the carbon content in charcoal is provided in order to ensure the comparability of project and baseline emissions (project and baseline charcoal NCVs might differ).

The fraction of different carbon products resulting from the charcoal making process is calculated from the performance tests for which such information is available.

10.3 <u>Expected balance of emission reductions:</u>

The key indicators derived from the "consolidated GHG database for the informal charcoal sector" are expected to be conservative for the following reasons:

[17] Typically charcoal processes operated at 500°C yield a carbon content of charcoal of 86% (FAO, 1987).

- While pit kilns are also in use in traditional charcoal making, the overwhelming majority of performance tests collected are for earth mound kilns which exhibit a higher yield than pit kilns.
- The methane emission factor is calculated on the basis of Smith, 1999 and Pennise, 2001. Both sets of experiments used much drier than the normal practice and achieve a higher dry basis yield than usual. As such, methane emissions might have been strongly underestimated compared to the normal practice.
- The carbon in brands is assumed to be not emitted. This is a conservative oversimplification. Indeed, brands might often be left to decay and would in turn in reality turn into CO_2. Other cases such as the brand being sold or re-used in a subsequent kiln can also occur.
- The proposed standardized wood carbon content is 45%. In reality, a wide variety of wood are likely to be used with a carbon content ranging from 43% to over 50% (on a dry mass basis).

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