Pre-feasibility study for an improved cook stoves project in Northern Ghana

Submitted to:

CARE Danmark

Danish Energy Agency

October 2009

ENERGICA

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List of Abbreviations

CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CSIR	Centre for Scientific and Industrial Research
ER	Emission Reduction
GAMA	Greater Accra Metropolitan Area. Comprises Accra and Tema Metropolitan Areas as well as urban areas in Ga East and Ga West Districts
GHG	Green House Gas
GLSS5	Ghana Living Standard Survey, Round 5
GRATIS	Ghana Regional Appropriate Technology Industrial Service
GSS	Ghana Statistical Service
IRI	Industrial Research Institute
KCJ	Kenya Ceramic Jiko (energy efficient charcoal stove)
KNUST	Kwame Nkrumah University for Science and Technology in Kumasi, Ghana
LED	Light Emitting Diode
MFI	Microfinance Institution
NGO	Non-governmental Organization
NPA	National Petroleum Authority
PoA	Program of Activities
SNEP	Strategic National Energy Plan
ToR	Terms of Reference
WB	World Bank

Energy and monetary units

DKK	Danish kroner
GHS	New Ghana Cedis
kWh	kilowatt-hour
TJ	Terra Joule
USD	United States Dollar

1 Preface

A contract was signed between the Danish Energy Agency and CARE Danmark on 10 June 2009 to carry out a pre-feasibility study for a CDM Program of Activities (PoA) on improved cook stoves in Northern Ghana. Based on the Contract a consultancy contract was signed between CARE Danmark and Energica in Ghana on 11 June 2009 to carry out information gathering and analysis in relation to the household energy part. A CDM specialist will be hired separately by CARE to provide advice on CDM procedures and registration. The work of the CDM specialist is not included in this report.

This pre-feasibility report is based on the Terms of Reference for the assignment, enclosed with the signed contract. The inception note submitted in June 2009 and discussed at a meeting on the 18 June in Accra presented the consultant's comment to the ToR, the proposed methodology for the work and a time schedule for the work.

The team fulfilling the assignment consisted of Christine Wennerberg, team leader and Michael Wuddah-Martey, household energy specialist. The team was supported by Ulrich Bang, sustainable energy advisor to CARE International in Ghana.

This report is based on desk studies, field visits to Northern Ghana and analysis and interviews with a number of key people involved the stove business, rural development and the energy sector at large. Lists of people and documents consulted are in annex.

Missions to the North of Ghana were conducted in June and July 2009 and follow up meetings in Accra were done in September 2009.

2 Introduction

2.1 Context

The northern part of the country has two main weathers, a rainy one and a very dry one. Travelling through the area during the rainy season in may seem that the northern part of the country is generally self sufficient in wood resources when considered on the total land mass.

However, in the dry season there are large areas within the Upper East Region that could be described as developing desert characteristics.

Supply of charcoal and firewood to urban areas like Tamale, Bolgatanga and Wa are from communities, which are normally 10 or more km away. Some of the major charcoal supply areas for Tamale are Alipe and surrounding areas, some 32 km away on the Kimtampo/Tamale road. For Bolgatanga, the Walewale area is worthy of note. Due to the centralized nature of the supply of firewood and charcoal to Wa, supply comes both from the western and eastern parts of the town of Wa.

In the case of rural areas, households collect wood from their farms and community forests for cooking. This is normally a daily task for women and children further increasing the pressure on daily chores. Household firewood collection is normally done by collecting dead wood or by breaking branches of live trees. It is rare that households cut down healthy trees for firewood purposes.

Land clearing and professional charcoal and firewood traders who often cut live trees for the supply of the urban woodfuel markets, have lead to increasing scarcity of areas for firewood collection and distance to collect firewood have increased especially around urban centres.

The prices of woodfuels have been increasing steadily due mainly to fuel price increase but also because of increases in the stump value of wood. A shift in the wood species used for firewood consumption was already registered in the woodfuel baseline study of 2001 as compared to earlier studies (1988), as the preferred species have become scarcer. Finally, economic trees like shea butter and dawadawa which where previously not exploited for charcoal and firewood are now being used.

Charcoal production in the northern part of Ghana is done by two main parties. The commercial large-scale producers and the thousands of women who produce charcoal as a means of supplementing their incomes. Commercial charcoal producers pay token fees for live trees, in some case economic trees, to make charcoal whilst the rural women collect fallen branches to produce theirs.

The charcoal produced by the women is often produced with very high energy losses as the women often do not have the time and skills to properly look after the kilns. Efficiencies of 8-9 kg of firewood to 1 kg of charcoal are not uncommon. The professional charcoal producers obtain efficiencies of 5-6 kg per kg of charcoal produced.




Although beyond the scope of this report, it is important to note that charcoal producers in the country continue to use the traditional earth mound method, which has an efficiency of around 18% (weight terms). Other more improved technologies like the improved Casamance kiln shown above can contribute immensely towards reducing waste in charcoal production if disseminated on a large scale.

Improved stoves have been promoted in Ghana on and off for decades. A serious effort was done in the early 90s where the World Bank supported a the selection and trial and testing of a number of charcoal stoves for the Ghanaian market. The work resulted in the dissemination of approximately 12,000 Ahibenso stoves, produced both a centralised factory as well as by a number of trained artisans. Although few stoves still exist in the market in Accra, the promotion and production have not been sustained as commercialisation and access to producer finance was not ensured after Government support ended. The artisan version of the stove did not live up to the industrialised version promoted in TV and other media and was not adopted by the potential consumers.

Self-build mud stoves have been promoted by various NGOs in rural areas for decades but with limited success, mainly due to user disappointment and frequent need for maintenance and repair.

Currently there are no registered CDM projects on improved stoves in Ghana. A number of NGO’s are in various stages of developing voluntary programmes, e.g. Enterpise Works who is preparing a proposal consideration using the KCJ (Gyapa) designed stove. The company Toyola is near completion of their registration for a similar stove design and project in Ghana. The funding from the voluntary programmes is used to subsidise the cost of the stove.

2.2 Objective

The overall objective of the assignment is to collect sufficient information to allow for an assessment and decision by CARE and the Danish Energy Agency on project focus and scope of a CDM Program of Activities on improved cook stoves project in Northern Ghana.

2.3 Methodology

General approach

It is the aim that the process of conducting the study will result in the presentation of business models and a roll out strategy that is founded on quality information and knowledge of the stakeholders likely to be involved. The participatory approach is regarded as the most efficient way of ensuring this involvement and capture of local knowledge. Women will be main informants at user and retail level. All data will, if possible, be gender specific.

Stakeholder consultation is viewed in a very broad sense as covering all levels from the user and purchaser of stoves to retailers, manufacturers and traders, NGO's and community groups, to the regional authorities and institutions and the national policy level. By linking the specialist process (data collection and analysis) with the political level and the direct stakeholders likely to be involved in the implementation it is believed that the chance of receiving the necessary support and success is more likely to be achieved.

It is the experience from other interventions that preparation and implementation of the project would be more smooth and efficient if due consideration is made to informing and/or involving all parties from the outset. Bilateral meetings, interviews and official correspondence and targeted dissemination of results would be sufficient in most cases. If necessary, smaller workshops to discuss results or specific issues will be carried out. Throughout the project period the consultants' team will work closely with the staff of CARE and coordinate all activities on the ground with the Regional Manager for CARE in Tamale as well as with the Sustainable Energy Advisor in Accra.

Household energy demand

The analysis of household energy demand for cooking is based on existing literature and survey results. Key documents are the wood-fuel surveys made as part of the Danish Energy Sector Support 2000-2003 and general statistics and surveys related to livelihoods of Ghanaians over the past 10 years.

A small qualitative survey will be made in selected communities to capture possible new developments.

Stove assessment

The three stone open fire stove using wood as fuel is by far the most common way of cooking in Northern Ghana and is almost exclusively used in rural households. Only in Upper East where there is a scarcity of firewood are other fuels used such as crop residues and dung. It is only in urban areas that commercial fuels exist - in the rural areas wood fuel or crop residues are gathered for free in and around the communities.

The efficiency of a stove depend on several factors:

1. Skill / training of the cook tending the stove
2. Fuel (diameter, moisture content, density, wood species, etc.)
3. Stove design
4. Fit of the pot to the stove
5. Type of food and type of cooking performed

All factors are important and should be considered when aiming at improving the efficiency and thus reducing the fuel use for any given technology. This report mainly focuses on the stove design but all parameters should be kept in mind when designing the promotion and training approach.

When designing a stove program from scratch the criteria are many :

Social: cooking task (boiling, frying, baking, grilling, steaming etc), utensils used, size of cooking operation, affordability, culinary practices.

Engineering: power output, pot and pan sizes and shape, materials available, knowhow and skills needed for manufacturing

Developmental & ecological: fuel access, smoke problems (indoor/outdoor cooking), potential for job creation, etc.

Considerable resources have been used over the years for developing and testing stoves for the Ghanaian urban market. The approach is therefore to, a much as possible, to build on existing structures and knowledge. Focus has therefore been on stoves already been tested and accepted and entrepreneurs already active in the area.

The rural market, however, has largely been neglected as saved fuel costs made little sense in a rural non-monetary market dominated by households with very little cash income. Firewood has also been regarded as the fuel of the poor, low prestigious and dirty. The use of carbon financing changes the possibilities for approaching this market.

Based on previous experience, literature review and an assessment of the potential for wider dissemination, the following project options are proposed as relevant in Northern Ghana:

For rural households:

a) Self-made mud-stove;

b) Clay stove made by professional stove makers (also know as the smoke-less stove);

c) Improved firewood stove – produced by artisans.

d) Improved firewood stoves - industrially produced (in Ghana or imported)

For low income urban/peri-urban households:

e) Improved charcoal stove – produced by artisans (Gyapa, Toyola, others);

f) Improved charcoal stoves - industrially produced (in Ghana or imported)

Each of these six technologies options represents different levels of capacity, knowledge, financing, organisational setup and thus strategy for roll-out. The six

options will form the basis for further investigations of feasibility, potential for emission reductions and for discussions with stakeholders and possible partners on implementation strategies, incentives and business set-up. The supply chain for each stove is analysed in the following with regard to issues, costs and barriers.

Interviews with artisans and retailers in three urban areas in the North will be carried out to make an assessment of capacity and knowledge of stove production.

Existing manufacturers or chain of manufacturing improved stoves will be identified and interviewed for inputs to roll out strategies and as possible cooperation partners.

3 Household characteristics in Northern Ghana

This section builds on two main sources of information: the latest population census carried out in 2000 and the latest two Ghana Living Standard Surveys, round 4 and 5, often referred to as GLSS4 and GLSS5. The GLSS5 builds on detailed household interviews in 8,500 representative households covering all regions in Ghana. The interviews for GLSS5 were carried out during the period from September 2005 to September 2006. GLSS4 was carried out in 1998/1999. GLSSs are the main tool for monitoring poverty levels in Ghana and other key indicators of development. Results from previous rounds carried out in 1992 and 1999 (Round 3 and 4) can be compared directly.

All information of the GLSS are split into 'urban' and 'rural' with the urban data split further into Greater Accra Metropolitan Area (GAMA) and ' other urban' whereas 'rural' is split into three ecological zones: Coastal, Forest and Savannah. The three Northern regions are within the Savannah region. The Strategic National Energy Plan of Ghana uses the same division of data as energy demand and household characteristics related energy consumption patterns seem to relate the same categories. (For energy planning purposes the urban categories have been split further into three income levels as well based on quintiles relation). In the data presentation focus is on 'other urban' and 'rural Savannah, and the three northern regions. For comparison, the data is presented with the national average or other data when relevant.

3.1 Poverty and employment characteristics

The three northern regions in Ghana are by far the poorest areas in Ghana although significant improvements have been seen since 1999. Upper West has overtaken Upper East as the region with the highest poverty levels.

Table 3-1 Households per quintiles, mean annual household expenditure and per capita expenditure by region.

						Mean annual household expenditure	Mean annual per capita expenditure
	Quintile						
Region	1	2	3	4	5	(GH¢)	(GH¢)
Western	5.8	16.7	18.5	23.1	35.9	1,924	648
Centra	17.0	13.7	21.0	23.8	34.5	1,810	676
Greater Accra	4.6	9.1	15.5	24.7	46.1	2,907	1,050
Volta	12.7	23.2	21.4	20.3	22.4	1,514	491
Eastern	4.9	14.3	23.1	25.7	31.9	1,794	613
Ashanti	7.9	14.6	16.3	22.3	38.9	1,967	682
Brong Ahafo	11.0	19.8	21.1	21.5	26.5	1,614	514
Northern	32.9	20.7	15.4	15.3	15.6	1,529	362
Upper East	54.8	19.1	13.0	7.2	5.9	1,066	229
Upper West	76.7	12.5	5.3	2.4	3.1	901	166
Ghana	12.6	15.5	18.2	21.6	32.0	1,918	644
GLSS5, page 95							

Note: Expenditure levels are regarded as a more reliable wealth indicator than income as people are more reluctant to declare income than expenditure for various reasons.

Households in Ghana in general spend half of the household income on food. In rural Savannah, however, 74% of the income is spent on food meaning that very few resources are available for other needs: less than 3% is used on housing and less than 5% is used on electricity, gas and other fuels. (GLSS5 table 9.5). Cooking fuels are not considered as part of household food expenditure.

More than 90% of households in rural Savannah owns a farm or keep livestock, in fact 92% of all draught animals, 84% of cattle and 73% of pigs and 60% of sheep and goats in Ghana are concentrated in rural Savannah. The agricultural activities are mainly taken care of by the men, but 29% of women take part as well. (GLSS5 table 7.1 and 7.3)

Two-thirds of the households in rural Savannah are involved in processing their produce and this is almost entirely the responsibility of women (94%). In addition 44% of the households operate a business – this is also dominated by women (78%) (GLSS5 table 7.12, and 8.1).

Financial resources for non-farm activities are mainly sourced from savings or from relatives and friends. Only 2.4% of non-farm enterprises obtain financial resources from the banks and other financial institutions for its principal activity (2.7% for men and 2.2% for females). However, females receive assistance from NGOs cooperatives and government agencies for 1.4% whereas men virtually don't receive funding from here at all (0.1%). (GLSS5 table 8.2 and 8.3).

3.2 Household numbers and size in Northern Ghana

Two main demographic parameters are important when assessing the potential for improved stoves and emission reductions, namely the number of households (cooking units) and the household size (cooking needs).

The estimation on the total number of households in Ghana for midyear 2006, based on GLSS5, was around 5.5 million of which 2.4 were urban and 3.1 rural. The estimation for the three northern regions was a total of 805,000 households.

According to the GLSSs the household sizes have reduced significantly in all regions in Ghana since 1999 except for Upper West Region. The average household sizes, population and number of households are shown in the table overleaf.

In 2000 the population in the three northern regions was 3.3 million according to the census. The projection of the population in 2006 by GSS was 4.6 million based on GLSS5 and 3.8 based on the census – increases of 39% and 15% respectively.

The total number of rural households in the three Northern regions in the year 2000 was 380,000 according to the census. The estimations based on the GLSS5 for mid year 2006 indicate the household number in the three northern regions to have increased to 805,000 and the related average household size declined from 7.0 to 5.7(a decrease of 19%) The rapid increase in household numbers according to GLSS5 is due to a combination of the increase in overall population and a concurrent decrease in the household sizes.

Table 3-2 Household size, estimated population in households and estimated households by region and locality

Region/Locality	Mean Household Size 2000 Census* March 2000	Mean Household Size 2005/2006 GLSS 5	Population in Households Projected from Census** (Millions)	Population in Households 2005/2006 GLSS 5 (Millions)	Estimated no. of households (Thousands) GLSS 5 (2006)	Estimated no. of households (Thousands) GLSS 4 (1999)
Ghana	**5.1**	**4.0**	**21.9**	**22.2**	**5,538**	**4,210**
Western	4.7	3.9	2.2	2.2	580	420
Central	4.4	3.6	1.7	1.9	548	540
Greater Accra	4.6	3.4	3.7	3.1	921	730
Volta	4.7	4.0	1.9	1.7	420	380
Eastern	4.6	3.7	2.2	3.0	802	570
Ashanti	5.3	3.9	4.3	3.7	963	740
Brong Ahafo	5.3	4.1	2.1	2.0	501	450
Northern	7.4	5.5	2.1	2.7	484	200
Upper East	7.2	5.3	1.0	1.1	200	60
Upper West	6.4	6.5	0.7	0.8	121	150
Urban	**4.7**	**3.5**	**9.6**	**8.4**	**2,392**	**1,700**
Accra GAMA)***		3.3		2.6	796	550
Other Urban		3.6		5.8	1,596	1,150
Rural	**5.4**	**4.4**	**12.3**	**13.8**	**3,146**	**2,510**
Rural Coastal		3.6		2.4	675	650
Rural Forest		4.1		6.2	1,520	1,290
Rural Savannah		5.4		5.1	951	570
Note: *March 2000, **Midyear 2006, ***GAMA means Greater Accra Metropolitan Area.						
GLSS5 page 4, and GLSS4 page 1						

The level of urbanisation in 2000 according to the census was quite low: 27% in Northern Region, 16% in Upper East and 18% in Upper West. As the overall level of urbanisation only has changed very little from the GLSS4 to GLSS5 (from 37% to 38%) it seems reasonable to assume the same distribution for an estimation of the number of households in 2009. “Urban” in Ghana is defined as localities with a population of 500 and above.

Table 3-3 Projection of the number of households in Northern Ghana for 2009

	Own projection based on GLSS 4 and GLSS 5 on number of		
	of rural HH	of urban HH	of total HH
Region	**2009**	**2009**	**2009**
Northern	516,000	191,000	707,000
Upper East	190,000	36,000	226,000
Upper West	134,000	29,000	163,000
Total	840,000	256,000	1,096,000

In 2000, according to the census the five largest localities in Northern Ghana had a total population of 410,000 inhabitants representing only 65,000 households.

Table 3-4 5 largest localities in the three Northern regions, Census 2000

Locality	Region	Population	No of Households
Tamale	Northern	202,317	33,079
Wa	Upper West	66,664	11,369
Bawku	Upper East	51,379	7,119
Bolgatanga	Upper East	49,162	10,091
Yendi	Northern	40,336	3,122
Total		409,858	64,780

Applying the estimated growth rate of 'number of households' in 'other urban' from GLSS4 to GLSS5 of 4.8% p.a. it seems reasonable to assume that the number of households in these 5 cities have increased to about 100,000 households in 2009.

To summarise, the expected number of households in 2009 in the three northern regions is:

100,000 households in the 5 largest urban localities

156,000 households in other urban areas

840,000 households in rural areas.

This seems sufficient to justify a project of 50,000+ stoves even with relatively low penetration rates. The trend towards smaller household sizes and reduced time spend on cooking would indicate that total fuel consumption per household is decreasing as well.

3.3 Cooking practices

The 2000 Census includes statistics on "cooking space" by region, but the urban – rural split is unfortunately not presented in the summary report. The cooking space is not included in the GLSS reports.

Table 3-5 Cooking space related to housing units in the three northern regions. A housing unit may include several households.

Cooking space - occupied housing units						
	Northern		Upper East		Upper West	
	Pct	Number	Pct	Number	Pct	Number
Indoor	26%	65,053	44%	63,436	54%	43,286
Structure with roof, no walls	9%	23,143	8%	10,872	9%	7,039
Outdoor	60%	146,492	46%	65,906	34%	27,423
No cooking space	4%	10,111	2%	3,595	3%	2,340
Other	0%	732	0%	549	1%	500
Total	100%	245,531	100%	144,358	100%	80,588

Source: 2000 Population & Housing Census, Summary Report of Final Results, Table 16, page 40

As can be seen from Table 3-5 significant differences exist between the three regions. Outdoor cooking is most prevalent in Northern region where more than half of cooking takes place outdoors, whereas the opposite is the case in Upper West. Significant potential therefore exist for improving indoor air pollution as approximately 45% of the cooking space in the three regions overall is either indoors or takes place in a structure with roof.

The urban – rural split is, however, presented in the GLSS, but related to ecological zones and not region. Together the two sources provide a fairly good overview of fuel for cooking both at regional level and the urban-rural characteristics.

Table 3-6 Households by locality and by main source of cooking (percent) GLSS5 2006

	Urban Areas			Rural Areas				Ghana
	Accra	Other						
Source of Cooking fuel	(GAMA)	Urban	All	Coastal	Forest	Savannah	All	
None, No Cooking	9.2	6.2	7.2	3.6	2.4	0.9	2.2	4.4
Wood	1.0	27.2	18.5	70.5	83.2	82.3	80.2	53.5
Charcoal	52	52.9	52.6	23.3	12.3	9.5	13.8	30.6
Gas	34.5	12.8	20	2	1.9	0.6	1.5	9.5
Electricity	1.1	0.2	0.5	0.1	0.1	0.1	0.1	0.3
Kerosene	2.2	0.7	1.2	0.5	0.1	0.1	0.2	0.6
Crop residue/Sawdust	0.0	0.0	0.0	0.0	0.0	6.5	2.0	1.1
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	100	100	100	100	100	100	100	100

GSS5, table 6.9, page 71

Table 3-7 Main source of cooking by occupied housing units – Census 2000

	Northern		Upper East		Upper West	
Main fuel for cooking	Pct	Number	Pct	Number	Pct	Number
No cooking	1%	3,438	1%	959	1%	702
Wood	85%	205,392	67%	95,982	80%	64,319
Charcoal	12%	28,679	12%	16,795	17%	13,331
Gas	1%	2,391	1%	1,228	1%	538
Electricity	1%	1,758	0%	430	0%	292
Kerosene	1%	3,212	2%	2,704	1%	1,074
Other	0%	661	18%	26,260	1%	402
Total	100%	242,093	100%	143,399	100%	79,956

Source: 2000 Population & Housing Census, Summary Report of Final Results, Table 16, page 40


When comparing the information on main source of cooking from GLSS4 to GLSS5 the following main trends are seen:

- In Greater Accra the use of LPG has increased and more than on third of the households now use LPG as their main source of cooking. Less than 5% use firewood, electricity or kerosene. Charcoal usage has declined from 71% to 52% indicating a shift from charcoal to LPG.
- In the category 'Other Urban' there has also been a shift towards LPG (from 5% to 12%) with slight decreases in both firewood and charcoal shares. Kerosene and electricity use for cooking is negligible (constitute less than 1%).
- Rural Savannah has only seen minor changes: there's a shift towards more charcoal on the expense of firewood. Firewood is, however, still by far the most preferred cooking fuel. The use of other fuels (crop residues, sawdust) has seen a slight increase from 5.1% to 6.5% Kerosene use has declined and LPG increased but these sources constitute together with electricity less than 1%.

From the census data, Table 3-7, and other surveys made over the years it is known that use of 'other fuels' in rural Savannah is related to the use of cow dung and crop residues in rural households in Upper East Region.

Ownership of LPG, kerosene and electric stoves are captured in the GLSS but not that of charcoal and firewood.

Information from other surveys indicates that 3-stones or a mud support is used when cooking using firewood and the traditional metal coalpot utilised for charcoal cooking.

Table 3-8 Household ownership of stoves by locality (percent)

	Urban			Rural				
	Accra	Other	All				All	
Group (subgroup)	(GAMA)	Urban	Urban	Coastal	Forest	Savannah	Rural	Ghana
Stove (kerosene)	10.2	8.6	9.1	5.6	4.6	3.0	4.3	6.4
Stove (gas)	38.1	20.2	26.1	4.4	3.9	1.4	3.2	13.1
Stove (electric)	5.1	2.3	3.2	0.5	0.7	0.1	0.5	1.7
GLSS5 Table 10.7								

Figure 3-1 Commercial cooking in Tamale - 3-stone and coalpot (left), LPG 4 - burner at display at fair in Accra (right)

It should be noted that the ownership of stoves shown in the table above is higher than the share of households using the specific fuel as their main source of cooking. This is due to the fact that many households have more than one stove and often need an alternative stove for back-up in case of fuel supply problems or for special occasions or dishes. Historically, government has supported the use of gas stoves and improved charcoal stoves, whereas kerosene has only been promoted for lighting in rural areas. Electric stoves and electricity is generally regarded as too expensive for cooking.




Ghanaians in the north have been cooking their main meals of tuo zaafe, rice, yam, banku etc. using the traditional 3 stone stove and coalpot for centuries.

The adaptability and flexibility of these technologies to the cooking practices of the people are high and come at no or a very little cost.

A review of a number of improved household energy conservation activities relating to cooking in 2000 and 2003 (Baseline survey and Woodfuel survey by BBRI) shows that few households take advantage of this. With respect to covering food when cooking which is one of the simplest and most known conservation methods, about 54% of respondents do this. In the case of presoaking of beans more than 50% of respondents do so. Cooks also barely lower the fire after the food has started boiling unless it is at the simmering stage. Hence most of them boil soup and water vigorously. In many cases also, the fire is lit and burning long before the pot is placed on it.

Cost of fuel for cooking is mainly relevant in urban areas as most fuels in rural areas are not commercialised. To illustrate the fuel cost of cooking an example of monthly

fuel costs (running costs) for a family of 7 based on fuel costs in Tamale in September 2009 is shown in Table 3-9.

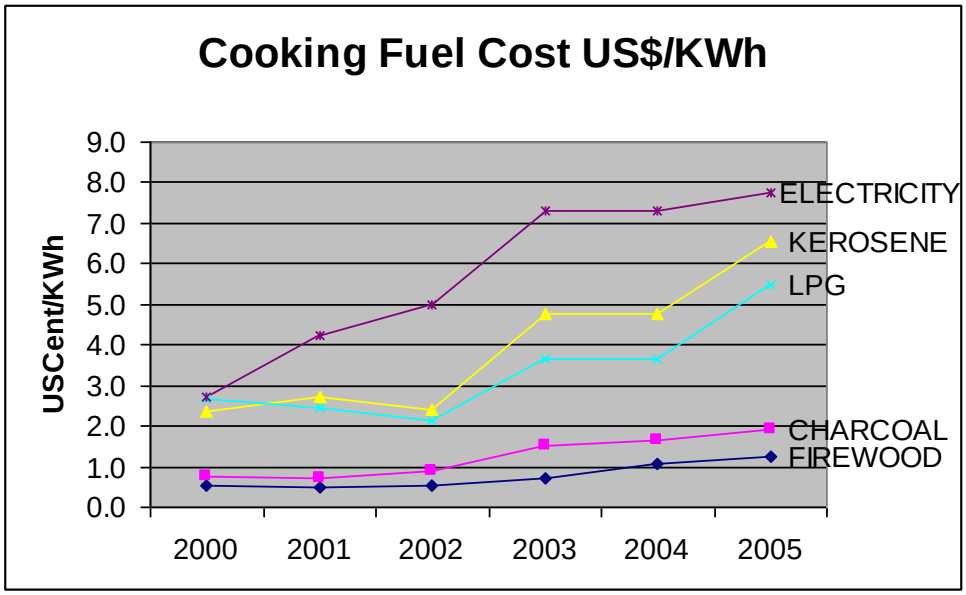
Table 3-9 Typical cost of fuel for cooking for an urban household, Sept. 2009, based on a need for useful energy for cooking of 420 GJ per month

Unit	Three stone wood fuel	Traditional coal pot	LPG stove	Kerosene stove
MJ/kg	15	30	47.5	44.75
%	11%	16%	55%	50%
kg/month	255	88	16	19
Cedis/kg	0.45	1.56	0.83	1.17
Cedis/month	115	137	13	22

The terminology 'useful energy' refers to the energy that is actually used to cook the food and is thus independent of fuel and stove. This example could be provided by a 2.3 kW stove for approximately 100 min per day in 30 days. The monthly cost of cooking does not include the capital cost of acquiring the stove (and bottle in the case of LPG)

The figure below illustrates the household fuel costs in relation to the energy content of the fuel. The figure thus does not take the efficiency of the cooking device into account.

Figure 3-2 Historic data on fuel prices in Ghana related to their energy content (Wisdom Ahiataku – reducing indoor air pollution, May 2007)



Using firewood and charcoal for cooking is mainly due to the availability of the fuel and the lower cost of appliances. Also the fact that firewood and charcoal can be bought "small small", that is in small quantities at a time, makes it seem more affordable. The gap between the traditional fuels and conventional fuels is compensated by the higher efficiency of the conventional stoves, especially for the LPG stove.

LPG is by far regarded as the cleanest cooking fuel by households in Ghana both in terms of fuel handling and use and is far more popular than kerosene for cooking. Electricity is regarded as expensive and is only used by very few. Government policy on promotion of LPG makes it the cheapest alternative if the household can afford the stove and the up-front coast of the LPG bottle.

Please refer to Annex 3 for the latest announced maximum fuel prices, tax and cross-subsidisation for petroleum products.

3.4 Data related to communication and roll-out

This section provide general statistical information related to issues believed to have relevance to the development of a roll out strategy for a stoves program in Northern Ghana: access to electricity, radio&TV, transportation means, literacy and religion.

Half of all households in Ghana are connected to the electricity grid and use electricity for lighting and appliances. Large differences still exist between urban and rural and between north and south. Although the share of electrified households in rural Savannah has increased significantly from 4% in 1999 to 17% in 2006, it is still far below the rural average of 27% and the urban average of 79%. The alternative source of lighting is kerosene. Households using gas lamps, torches, candles and solar energy and generators add up to less than 2% in rural Savannah.

Table 3-10 Proportion of households owning various assets (percent)

	Urban			Rural				
Group (subgroup)	Accra (GAMA)	Other Urban	All Urban	Coastal	Forest	Savannah	All Rural	Ghana
Radio	38.2	44.2	42.2	52.3	59.6	51.9	55.7	49.9
Video player	32.8	23.5	26.6	6.0	6.3	3.0	5.2	14.4
TV	72.9	47.9	56.2	19.9	19.7	7.0	15.9	33.3
Computer & accessorie	12.6	4.4	7.2	0.5	1.4	0.7	1.0	3.7
Mobile phone	50.1	30.1	36.7	8.0	8.4	3.0	6.7	19.7
Generator	0.5	0.3	0.3	0.6	0.8	0.9	0.8	0.6
Bicycle	5.4	19.1	14.5	14.0	18.3	65.7	31.7	24.3
Motor cycle	0.8	3.6	2.7	0.6	1.1	6.9	2.7	2.7
Car	9.5	4.1	5.9	1.2	1.7	0.9	1.4	3.3
GLSS5 Table 10.7								

Ownership of radios in Savannah does not differ from the rest of the rural areas, more than half of the households has a radio of some sort. Mobile phone ownership is relatively low, but could have increased significantly since 2006 where the data stems from. Households in rural Savannah have a significant ownership of bicycles and motorcycles, as around two-thirds of rural households posses a bicycle.

Rural Savannah is also significantly different from the rest of the country when it comes to region and literacy. Religious beliefs in Rural Savannah are almost equally distributed among the three main religions, Christianity, Traditional beliefs and Islam. Urban areas tend to have a high share of Christians and a very low share of Traditional believers. An overview of literacy and region are provided in

Table 3-11 and Table 3-12.

Table 3-11 Household heads by religion and locality

Religion	Other urban	Rural Savannah	Total Ghana
Christians	72.9	36.3	66.7
Islam	19.6	27.6	16.5
Traditional	1.7	30.7	9.2
No religion	5.7	5.4	7.4
Other	0.1	0.0	0.1
Total	100	100	100
GLSS5 table 1.10, page 9			

In rural Savannah, less than 30% of the male population and less than 20% of women are literate in English and Ghanaian languages. No data on literacy in Arabic exists but might be significant as Koran schools are wide-spread and generally of reasonable standard.

The low level of literacy and the inhomogeneous nature of the rural communities when it comes to traditions (indoor/outdoor cooking), religion (possibility of working with religious associations) and also language mastering means that promotion emphasis should be on face-to-face interaction and demonstration, tailor made for the different communities.

Table 3-12 Literacy of population of 5 years and older, by sex and locality

	Locality	English only	Ghanaian languages only	English & Ghanaian languages	Total literate	Illiterate	Total
Male							
	Other urban	19.4	1.6	49.5	70.5	29.5	100
	Rural Savannah	10.9	2.4	13.6	26.9	73.1	100
	Ghana	17.8	2.3	36.6	56.7	43.3	100
Female							
	Other urban	17.6	2.8	35	55.4	44.6	100
	Rural Savannah	8.4	1.3	6.6	16.3	83.7	100
	Ghana	14.9	2.9	24.3	42.1	57.9	100
GLSS5,table 2.7b, page 15							

3.5 Indicative household survey – verification of cooking practices and others

A minor field survey covering the three regions was carried out in July 2009 to collect information on cooking practices and verify indications from literature. A kitchen test of charcoal stoves was carried out in a few selected households over a seven day period in the three urban centres of Tamale, Wa and Bolgatanga to get a feel of charcoal consumption.

Field visits to rural areas were concentrated in West Gonja, Bolgatanga and West Mamprusi Districts. These locations were chosen mainly because the same areas

were used during the district energy profile studies made as part of the Danida funded project Traditional Energy Resources in 2001. Questionnaires to be used for the collection of data and form the basis of interviews and discussions during the field visits were developed for kitchen tests, service demand, perception of improved stoves and market survey of stoves.

The study was aimed mostly at the low and middle income households in both urban and rural areas since the results were targeted at the charcoal and firewood market, stoves and technologies.

For the household sector, the study was conducted, using a simple random sampling approach, to determine the type of stoves used, household sizes, fuel sources, problems with the traditional stoves, users knowledge of improved stoves, amount of money spent on fuel, the number of meals cooked, the cooking location, and number of meals cooked per day amongst others.

It should be emphasised that the sample size is too small to allow for representation and results are only indicative. The rural areas visited (Bongo rural, Wa rural and Walewale) show some emerging urban characteristics (e.g. due to easy access from main roads) and are probably not representative of smaller rural communities less accessible from the main roads.

Fuel use pattern for cooking

The study showed a high reliance on charcoal and firewood for the target locations. It also showed that most households purchased the fuel they use for cooking. This was even the case in the rural areas visited. For the same reasons as stated above this may not be representative of smaller rural communities.

Indications are that 5 years ago firewood using households in specific areas of the Northern and Upper West Region had to travel a maximum distance of 1km for firewood, now there have to do double that. In the case of the Upper East Region they need to travel much further than that.

The study showed that more than 90% of charcoal using households used the traditional coalpot for cooking. They identified burns and heat from the stove as their major problems. For the traditional coalpots respondents indicated that it was easily available on the market in various sizes, metal types, shapes and prices.

In the case of firewood users, all of them were found to be using the open fire for cooking whether indoors or outside. The following problems with the open fire were identified by users:

- Too smoky
- Difficult to use in the rain
- Consumes a lot of firewood
- Need for constant monitoring
- Too much heat from the stove

However numerous advantages of the open fire given were that:

- It is easy to make to own specification
- It is free
- It is easy adaptable to various cooking pots and sizes
- Cooks food fast

On the whole it seems that people use charcoal and firewood because it is easily available in the community and appliances cheaper than other alternatives.

Cooking practices

The main meals identified and prepared include tuo zaafe (tz), rice, banku, tubaani, yam, porridge, beans, rice balls, soup (groundnut, palm oil), stew, boiling of water, konkuaoli and kwaosee amongst others. Most of the main meals involve some form of stirring, hence the need for robust stoves.

All the households were found to be using traditional stoves like the coalpot and open fire. On improved stoves about 60% had heard of the existence of such stoves either from the radio, television or friends and relatives, with more than 90% interested in acquiring one.

The price range for improved firewood stoves given by respondents as being between GH¢3.00 and GH¢10.00. For the charcoal stoves users were prepared to pay anything between GH¢5.00 and GH¢20.00.

About 60% of the households prepared their meals outside, which mean that improved stoves to be promoted need to be movable and not stationary. It also indicates that for large minority cooking indoors, the idea of promoting chimney stoves is relevant.

About 60% of respondents belong to an association or recognized group through which improved stoves and cooking practices could be channelled.

An attempt to establish the needs of the households revealed that given an amount of GH¢10.00 more than 70% of the respondents would purchase foodstuff and buy charcoal or firewood in bulk. 30% of the respondents preferred to invest in farming and or trading.

Table 3-13 Results of indicative household survey, June 2009 (percent)

DESCRIPTION	Northern		Upper East		Upper West	
	Urban	Rural	Urban	Rural	Urban	Rural
Fuel Use Pattern for Cooking						
Charcoal	52	57	15	17	53	13
Firewood	17	10	40	54	10	77
Firewood & stalks				21		
Charcoal & Firewood	14	19	45	8	23	10
LP gas	17	10			13	
Charcoal & LP gas		5				
Mode of Fuel Acquisition						
Purchase	100	88	94	79	100	40
Collect	-	12	6	21	-	60
No. of cooked meals/day						
Average	2.3	2.3	2.6	2.5	2.4	2.1
Household size						
Average	7.4	6.8	7.3	7.0	5.8	6.0
Cooking Place						
Indoor	21	24	33	40	63	24
Outdoor	66	57	47	60	29	57
Verandah	14	19	13		8	19
Indoors & outdoors		-	7			
Awareness of improved stove						
knowledge, yes	32	67	35	9	46	8
Average cost of existing stove						
firewood	4.3			4	3.0	3.0
Coapot	6.2	6	7	6	8.6	6.5
Willingness to pay for						
improved firewood stove	4.8	5	8	7	11.0	4.8
improved charcoal stove	8.3	9.6	9.9	9.4	10.2	8.6
No of respondents	29	21	20	24	30	30

Mensurative survey

The small mensurative survey was undertaken in three urban areas by weighing the actual quantity of woodfuel and charcoal used by 21 households for cooking on a daily basis over a period of one week. Results are presented in Annex D for Upper East and Upper West. Data for Tamale (Northern Region) have been discarded, as data seem corrupted.

The average household size and number of meals cooked seem in line with previous studies and statistics. The amount of firewood and charcoal used, however, varies significantly between the two areas. The sample size is too small to conclude on but gives an indication of the level of fuel consumption. The households using firewood all used 3 stones and the traditional coal pot was used for the charcoal cooking.

The openness and interest of the respondents to improved stoves and their willingness to pay show no immediate barrier to an improved stove program. Even thought the high share of respondents buying their fuel might not be representative of rural households in general it does indicate that fuel seem to be commercialised to a high degree even in peri-urban or emerging urban communities in the North.

Table 3-14 Summary results of mensurative survey, June 2009

Fuel Type	Upper East			Upper West		
	HH size	Meals/day	kg/person/day	HH size	Meals/day	kg/person/day
Firewood	8.7	2.2	0.49	5.3	2.2	0.73
Charcoal	6.5	2.3	0.87	5.5	2.0	0.61

4 Stove technology assessment

Stoves are often classified according to four main criteria:

- Fuel type
- Construction material
- Function – mono function or multifunction
- Portability – fixed (single, double pot holes) or portable

Six different stove concepts were selected for this study – four fire-wood stoves and two charcoal stoves. The stove are either made of clay, ceramics and/or metal. Portability and flexibility is often an issue in Ghana and all the stoves except the clay stove for firewood are portable.

The reference technology for firewood is the three-stone open fire and for charcoal the traditional coalpot made by scrap metal by local artisans.

Apart from the industrial produced stoves and the improved firewood stove, the stoves are all well-known in Ghana and have been subject to testing by Mechanical Engineering Department of the University of Science and Technology in Kumasi, KNUST, Enterprise Works, New Energy and CSIR amongst others.

These tests have been based on the VITA standards and stove testing methodology. Major test conducted where the water boiling and kitchen performance tests.

Over the years numerous stove designs have been developed and tested in African countries. The stoves developed and found to fit the Ghanaian market are the local versions of the Kenyan Ceramic Jico (KCJ) stove now known under the names Gyapa or Toyola stove and the Ahibenso charcoal stove promoted in the 1990s. New models have been emerging over the past 2-3 years as international attention to indoor air pollution and potential for GHG emission reductions seem to have increased significantly.

4.1 Firewood stoves

An overview of current available stoves in the market in Ghana and their characteristics is shown in the table below together with examples of industrial produced stoves not yet available on the Ghanaian market.

Table 4-1 Firewood stoves

Picture	Description	Efficiency	Price Range (¢)
	Most common stove Free Easily adaptable to cooking and cooking shapes and sizes Easy to use Very smoky and wasteful in fuel utilization	11-15% As low as 8% in household cooking testing	Free

Picture	Description	Efficiency	Price Range (¢)
Three-stone open fire	Health risk to women and children		
 Metal Stove	Made of scrap sheet metal Lifetime of 2-4 years Easily available on the market – an urban alternative to 3-stones Portable and easy to carry Low cost	20-27%	3 - 5
 Vehicle Rim	Made from used vehicle rims Very robust Heavy to carry Lifetime: 5-7 years, the riveted model 3-5 years. Replacement of support after 3 years	20-27%	3-10
 Mud stove – self made	Made from mixture of clay, cow dung and rice straw. Supported by 3 stones Easy to build with local materials and labour. Needs frequent maintenance by owner (re-smearing) Adaptable to cooking needs and family's own pots – can be made portable Big variations in designs and quality.	15-25% Efficiency gains uncertain.	Free
 Clay Stove with chimney (CSIR)	Made from mixture of clay, cow dung and rice straw. Has metal grate as support and requires clay bricks Smokeless due to chimney Easy to build with local materials and labour Adaptable to cooking needs, but only fits a specific pot size. Requires regular repair (re-	Savings of 20% compared to 3-stone open fire	12 – 20

Picture	Description	Efficiency	Price Range (¢)
	spearing) Promoted in Northern Ghana – 1000 stove in trial. Lifetime estimated to 5 years		
 Toyola firewood stove	Made of scrap metal with a ceramic liner. Require high degree of ceramics expertise, quality clay and access to kiln Portable Not marketed yet in Ghana, but prototype exist. Liner can also be used for fixed or portable clay stoves and are build into e.g. larger multi pot institutional stoves	Savings up to 60%	approx. 9
Enterprise Works/Vita firewood stove	Made of scrap metal with a ceramic liner. Require high degree of ceramics expertise, quality clay and access to kiln Portable and with adjustable skirt to fit different pot sizes Not marketed yet in Ghana, but prototype exist. Trial production of several hundred pieces for an NGO has been made.	Undergoing test.	N.a.
 Metal Stove	Made up of sheet metal. Not yet in circulation but is tested in Northern Ghana by the NGO, New Energy Need for laboratory and field tests Can also be used with sawdust	n/a	N.a.

Picture	Description	Efficiency	Price Range (¢)
 Envirofit B-1100	Industrialised improved firewood stove Launched in India but on its way to several African countries. Envirofit is an NGO based in Colorado, US. Development supported by the Shell foundation and Colorado state university. Portable, all biomass types can be used. Produced in China	Savings up to 50%	Cost from 10 - 20 USD (from 500 -100 indian rupees)
 Phillips smokeless stove	Industrialised improved firewood stove Launched in India by Phillips in 2008 for a trial. Electronically controlled fan forces air through the stove leading to better fuel to air ratio. Usable for small pieces of wood. Very low fuel consumption. Smoke free and portable. Produced in China.	Savings up to 80%	N.a.

In the case of improved firewood stoves, the CSIR and the NGO, New Energy have engaged in series of tests and modifications all aimed at ensuring that the new stoves are really improved as they relate to efficiency, indoor air pollution reduction or fuel savings.

The one pot chimney stove has been developed by CSIR and is in the testing stages. More than 1,000 pieces are in use by households in Tumu in the Upper West Region.

However for improved firewood stoves more tests are required in order to prove during market demonstrations and actual use the immense benefits the rural households would be receiving by adopting improved stoves, which on occasions are accompanied by revised cooking practices.

Enterprice Works/Vita (see below) in Ghana has due to a specific request recently made a trial production of improved firewood cookstove and a prototype firewood stove is currently undergoing testing in the US. Difficulties encountered with the firewood stove have been problems with adaptability – it should fit several pot sizes and the height of the stove should allow for women to sit on a stool and stir the pot.

There is, however a limit to how low a stove can be made without compromising on the design parameters e.g. in relation to the height of the firewood chamber and thus the air flow through it.

Also the manufacturer of the Toyola charcoal stove has a prototype for an improved firewood stove that they are interested in developing further for artisanal production. The ceramic liner is used is also used for build-in stoves both in households and institutions.

Internationally, several initiatives for introducing large-scale industrial production of energy efficient fuel wood stoves have emerged over the past 2-3 years aiming at affordable stoves and cookers for the household sector in the developing world. Several of these have been test launched in Asia (Envirofit, Phillips) and will probably expand to selected African countries during 2010.

4.2 Charcoal stoves

Charcoal stoves traditionally are used by urban households and are widely used all over Ghana. With an increasing use of charcoal in rural areas it is beginning to emerge here as well.

An overview of the most common charcoal stoves in Ghana is presented below.

Table 4-2 Charcoal stoves

Picture	Description	Efficiency	Price Range (¢)
 Traditional Coalpot – Welded	Made of thick scrap/new metal Could also be riveted or cast. Most popular charcoal stove Easily available Adaptable to cooking needs Lifetime between 3-15 years for welded stove, 2-4 years for riveted and cast models	15-23	5 - 11
 Gyapa Coalpot or Toyola	Local stoves based on the Kenya Ceramic Jico (KCJ) Metal casing with ceramic liner Ceramic liner requires replacement very 2 years Significantly reduces indoor air pollution Lifetime between 3-5 years	45%	14-18

Picture	Description	Efficiency	Price Range (¢)
 Ahibenso Coalpot	Metal casing with metal grate Grate replacement every 2-3 years, no ceramics Lifetime between 3 – 7 years Promoted from 1992 but is only found in a few places in Accra	30-39%	14-18

A review of the tests indicates that the KCJ is the most efficient charcoal stove, with an efficiency of about 45%. This translates into large savings for the households and even larger ones if dissemination improves. Enterprise works and Toyola promoting improved charcoal stoves have done extensive test on the Jiko stove and have conclusive evidence on efficiency, durability and consumption. More details on the supply chain of Toyola and Enterprise Works/Vita are presented in section 4.5 below.

4.3 Metal stove production and marketing – survey results in Northern Ghana

The metal stove production and marketing chain is quite a simple one and mostly involves direct dealings between the producer and retailer. In many cases the producer is male with the retailer a female.

Most of the metal welding and artisanal shops are very small and use simple tools like hammer, chisel and small welding machines. There is usually one master and two or three apprentices. Retailers also either sell along the streets, in shops or at the market place.

Due to the nature of stove purchases and availability of skill, producers do not rely on the production of coalpots alone but other metal products like dustbins, watering cans, cooking utensils, gates etc. In all cases the marketing arrangement depends on the confidence in the client. There are a number of major scenarios:

- Full payment when order is made
- Part payment when order is made and balance upon supply
- Part payment when order is made and balance upon sale by client
- Supply to client and payment made after the sale of goods.

The study showed that local metal workshops and artisans within the target locations have the capacity to produce improved stoves.

So far new and improved stoves introduced like the Ahibenso coalpot, Gyapa stove (KCJ), mud stove etc. have been produced according to specifications and standards. Indeed some of these products are developing markets due to their proven performances and satisfaction with users.

They however lack the necessary equipment and manpower to produce improved metal stoves on a large scale due to the more sophisticated nature of these new designs, increased production time and capital investment requirements.

Local artisans and metal workshops can be found in almost all suburbs of major urban areas within the northern savannah. Normally there work in small shops or sheds.

TAMALE

In view of the relatively high concentration of metal and fabrication workshops in Tamale as compared to other urban areas in the northern part of Ghana, there is a much higher industrial and artisan capacity base for the production of improved and more efficient charcoal and firewood stoves to meet market demand.

Although raw materials are not in abundant supply, the good road network to major urban centres like Kumasi ensures that the availability of raw materials does not pose a treat to they meeting the local demand.

Indeed the metal components of improved stoves like the Gyapa and Toyola are already being made. In the case of Toyola artisans are contracted to make individual components like the door, handle, supports etc. These are then assembled under Toyola supervision. Capacity for the production of the clay liners is yet to be developed in the northern part of the country such that these have to be made in Kumasi or Accra and transported.

In the case of the Gyapa stoves, most of them arrive as already produced project from Accra and Kumasi, very little local project is done.

Although no Ahibenso coalpots were identified during the survey either on the market or in artisans' workshops, artisans mentioned having the capacity to produce these stoves if a market could be provided

WA

Metal and fabrication workshops in Wa together with local artisans have the technical capacity to produce all types of welded and riveted products including stoves, coalpots, dustbins, gates and watercans amongst many others.

The availability of metal and fabrication workshops is inadequate to meet the demands of retailers dealing in stoves. The main problem seems to be the lack of access to raw materials for which reason they sometimes fail to meet production schedules.

Due to the nature of the road network and the sources of raw materials being in Kumasi or Accra products end up more expensive than completed stoves purchased in the mentioned areas and transported to Wa.

BOLGATANGA

Artisans in Bolgatanga are able to get access to raw materials for the production of stoves due to the good road network. However prices are higher than those in Tamale. The artisans were found to have the relevant skills and know how for the production of various designs of metal implements including stoves

Summary

The table below shows the cost of building charcoal and firewood stoves as gathered from discussions with local artisans and metal and fabrication companies in the three regional capitals.

Stove Description	Production Cost in ¢		
	Tamale	Bolgatanga	Wa
Gyapa/ Toyola Coalpot*	6.00-8.00	7.00-9.00	9.00-10.00
Ahibenso Coalpot	9.00-10.00	10.00-11.00	10.00-12.00
Local Metal Stove	5.00-7.00	5.00 – 8.00	6.00 – 8.00
CSIR Stove**	12.00-15.00	13.00-15.00	12.00-15.00

Source: Survey Data, 2009

*This stove cost from the artisans does not include the cost of making the grate which is a ceramic liner. The estimated production cost of this liner is about 2 cedis.

** The direct cost per stove for a larger roll-out program is estimated to be approximately 19 cedis (cost of moulds (0.85 cedis per stove) and training plus15 cedis for fire grates and iron bars). Note the table presents cost as assumed by artisans.

The amount quoted for the mud stove is based on self-building with technical support from a production unit or extension service. The same stoves are cheaper in Tamale which acts as a transit point as compared to Bolgatanga and Wa. Wa happens to have the most expensive stove costs due mainly to inaccessibility to raw materials.

Metal workers especially in Wa find it difficult getting access to metal. This is further compounded by scrap metal dealers who purchase spent metal and transport to Accra for sale. The result is higher prices of metal and delays in production time thereby making it more profitable for stove retailers to buy stoves from Kumasi about 300km away for sale.

In order to be involved in the production of more efficient, relatively more expensive and profitable stoves, the artisans need to be provided with adequate training to ensure adherence to specification, whilst being supported with credit to purchase raw materials in bulk. It is possible, however, due to mechanised processes and improved economies of scale, imported stoves could be cheaper than locally produced ones depending on the transactions and distribution cost. For imported stoves or stove parts there could be an issue of security of supply, which has to be assessed more thoroughly.

Due to differences in the costs of the components of the price build-up stove prices vary in all the three major urban centres within the Northern part of Ghana (ie. Tamale, Wa and Bolgatanga).

Just like other parts if the country retailers do not stick to the selling of one product. It is therefore common to find sellers of coalpots also involved in the sale of other products normally cooking utensils.

The highest selling coalpot is the riveted traditional coalpot which has a lifetime of between 6 months to I year and is the cheapest coalpot on the market.

There is also the traditional coalpot made from cast metal. These have a lifetime of between 2-3 years and are double the cost of the rivetted coalpot.

Then the welded traditional coalpot whose lifetime depends on the thickness of the metal used. They range from 3-10 years. These are about 4 times the price of the riveted ones.

The most common improved charcoal stove on the market is the Gyapa or Toyola coalpot, which is based on the ceramic Jiko design and is being marketed by Enterprise Works and Toyola separately. These stoves have a lifetime of between 2–3 years and are about twice as expensive as the welded traditional coalpots.

With respect to firewood, the only improved stoves found on the market were made of metal. They were either used vehicle rims, or riveted metal ones. This should be expected since majority of households are thought to use the 3 stone stove, which is not available on the market. The table below shows the current stove prices on the market to the consumer as identified during the survey.

Table 4-3 Current stove prices in the market

Stove Name	Tamale (¢)	Bolgatanga (¢)	Wa (¢)
Charcoal Stoves			
Traditional Coalpot			
Welded Size 1	6.00 - 8.00	7.00 - 9.00	7.00 -10.00
Rivetted Size 1	2.00 - 3.00	3.00 - 5.00	3.00 - 5.00
Cast Metal Size 1	3.00 - 4.00	2.00 - 4.00	3.00 - 4.00
Ahibenso Coalpot	n/a	n/a	n/a
Gyapa Coalpot	13.00 - 15.00	14.00 - 16.00	14.00 - 16.00
Toyola	13.00 - 15.00	14.00 - 16.00	14.00 - 15.00

Firewood Stoves			
Vehicle Rim riveted	2.00 – 3.00	2.00 – 3.00	2.00 – 4.00
Vehicle Rim	8.00 – 9.00	7.00 – 9.00	8.00 - 10.00
Metal Stove	2.00-3.00	2.00- 3.00	2.00 - 3.00

Source: Survey Data (June 2009)

A number of improved stove programmes are underway in the northern part of the country. However due to limited resources, lack of follow-up capability and inadequate strategic planning they have not been able to make the required impacts as far as improving woodfuel utilization efficiency on appreciable scales are concerned.

4.4 Production and marketing of clay stoves

Many NGO's have been involved in training women in communities in the self construction of the mud stove. However due to lack of follow-up it is difficult to estimate the number of such stoves produced and those still in use. The major problem with the training method of disseminating these stoves in the fact that the quality, standards and performance of these stoves cannot be assured since they are self built. The result is that in many instances the stoves do no perform as described and users shift back to the traditional open fire.

The portential for large-scale implementation however exists in an environment where rural folk have the human and materials resources to construction clay related products. This is due to the seemingly abundance of clay for building within these areas. Most rural households are constructed using clayey soils. Professional stove builders exist, but mainly for commercial (e.g. production of local beer) or institutional stoves.

The Industrial Research Institute has been promoting a one-pot chimney stove in the Upper East and Northern regions. The dissemination of the stove is linked to the installation of solar LED lighting systems. So far more than 1,000 models have been installed. IRI partnered with Plan International and New Energy for the Tumu and Northern Region dissemination programmes respectively. The major problems being encountered with these new stoves is cracking. Due to the metal grate and fire, the clay does not hold for long periods. The stoves have been disseminated by IRI in collaboration with NGOs with the only requirement that the user have to provide his or her own man-power for building the stove and the necessary clay bricks. Metal parts, moulds and training has been paid for through donor funding.

The local capacity therefore exists for the self construction or artisan made improved firewood stoves which are clay related. However training and monitoring procedures need to be put in place that would ensure standardization of stoves such that high increased efficiencies are achieved and maintained. Main cost component of the stoves are the metal parts and training cost. Dissemination via professional stove makers as well as mass production of grates and other necessary metal parts would lower costs significantly. The savings on village training would be around 3 cedis per stove in direct costs.

4.5 Stove production and marketing of improved artisan stoves

Enterprice Works/Vita

The Gyapa stove has been developed and marketed by Enterprise Works/Vita in Ghana since 1992. Enterprise Works/Vita receive their funding from external sources such as the USAID and the Shell foundation for training of artisans and retailers, linking these up, advertising and promotion as well as quality monitoring and testing of the stove. Extensive external testing of the stove has been made and cooperation has been established with several universities abroad.

Retailers place their orders for stoves at the manufacturers and sell in outlets and at markets. All manufacturers and retailers are registered and trained by Enterprise Works/Vita who also monitors production and sales. The manufacturers buy the ceramic liners directly from the ceramists.

Retailing is mainly concentrated in the urban areas in the South.

Three sizes are made: a small model for bachelors, a normal household version and a larger stove for commercial users. Carbon finance is used to lowering the purchase price of the stove.

The monthly production is now reaching 6000 stoves that are sold by 400 retailers. 5 certified ceramists produce the ceramic liner, which is the heart of the stove.

Main problem encountered is the lack of finance for upgrading of production facilities and pre-financing of materials.

Toyola

The Toyola charcoal stove is an improved charcoal stove based on the Gyapa design using a ceramic liner in a casing made from scrap metal. Toyola is owned by two Ghanian entreprenurs who started up in 2006 with a loan from the AREED (Africa Rural Energy Enterprise Development) programme for pre-financing materials and for vehicles. This loan has been repaid and new loans have been obtained. The aim for 2007 was 6,000 stoves. Sales of 20,000 stoves were reached, 30,000 stoves in 2008 and it is hoped to reach 50,000 stoves this year with carbon financing.

Toyola pre-finance orders at local artisans for the various part of the stove (handles, body, lid, etc.) except the ceramic liner that is made at a central facility in Eastern Region overlooked by a certified ceramist. In 2009 they are active in all regions in Ghana and are now planning to set up a production of ceramic liners in Tamale to serve the northern part of the country.

The Toyola marketing model is centered around the being in direct contact with the potential buyer or user and make extensive use of part-payments or sales in instalments as savings become evident. Customers are rewarded for further sale and often act as agents for Toyola leading to high penetration rates and low retail costs. Due to customer demand a LED solar lamp has been added to the portfolio and sold in a similar manner – based on savings on kerosene.

Main problems encountered are the up-front financing of the end-user credits and the non-interest from rural banks and micro-finance institutions to the energy market segment. A micro-finance scheme for end-user financing in cooperation with a local bank would ease up administrative capacity and increase production capacity due to release of funds for production materials and promotion.

Ahibenso

In the beginning of the 90s, the Ministry of Energy undertook comprehensive field and laboratory tests on the Ahibenso coalpot. These tests showed high levels of savings, adaptability and cooking performance of the stove. It also showed a high preference of the stove to charcoal users. 12,000 stoves were pre-financed by the Ministry of Energy and disseminated and comprehensive promotion through radio and television made.

Apart form one industrial producer set up by government, artisan production was also promoted through training, but financial support was not sustained by Government. The stove exists in the market in Accra but is not sold in large numbers and outlets are few. The focus was on dissemination and acceptance of the stove by consumers and little attention was put on commercialisation and setting up sustainable credit facilities for artisans to purchase metal sheets and tools. Materials purchased with Government assistance were in some cases diverted into other products with higher profit margins. The stoves were initially distributed to women's groups on a hire-purchase basis to test affordability. Retail and production profit margins were low in order to keep costs of the stove down, but also making sale and production of the stove less attractive.

No evidence of the stove was found in Tamale, Wa and Bolgatanga during the survey period.

4.6 Stove selection

The outset was to look at two market segments - the urban and rural segment and six stoves technologies:

For rural areas:

a) Self-made mud-stove;

b) Clay stove made by professional stove makers (also know as the smoke-less stove);

c) Improved firewood stove – produced by artisans.

d) Improved firewood stoves - industrially produced (in Ghana or imported)

For urban/peri-urban:

e) Improved charcoal stove – produced by artisans (Gyapa, Ahibenso, others);

f) Improved charcoal stoves - industrially produced (in Ghana or imported)

An overview of the stove value chain is presented below from materials to after-sales and monitoring. The main barriers or challenge at each level for technology shift are indicated.

Table 4-4 Stove value chain – main barriers and challenges for different stove technologies

	Materials	Production of parts	Assembly	Distribution	Retail	Sales	After sales/monitoring
a. Self made mud stove	Materials are readily available	Costly and time-consuming training of households, community groups and village artisans. Costly and difficult to scale up rapidly	Training of each household, community groups and village artisans. Costly and difficult to scale up rapidly	On site.	None	Consumer education and instruction in use at village and household level. Seasonal	Regular follow-up to ensure maintenance (re-smearing). Larger sample size due to inhomogeneous stoves and quality variations
b. Clay stove - artisan	Materials are readily available in rural areas,	Training of artisans with skills in pottery. Need low cost production of metal grates - e.g. centralised industrial production via GRATIS or similar. Possibly short term micro-credits for purchase of grate and moulds.	Training of artisans with skills in pottery. Possibly training of trainers. Production capacity per artisan would be low due to long construction time	On site	None	Payment in few instalments/micro credit or savings scheme necessary Consumer education and instruction in use. Mobility of stove builders Limited to dry season and post harvest periods	Regular follow-up to ensure maintenance (re-smearing). Larger sample size due to inhomogeneous size and shape of stoves Warranty and quality audits necessary.
c. Improved firewood stove artisan	Sufficient supply of low cost scrap metal. Alternatively new metal sheets at higher cost. Availability of clay and additives with the right properties. Access to capital to purchase input is a barrier.	Pre-financing of materials and tools. Training of artisans in production and quality requirements. Ceramic liner production requires highly skilled ceramists and kiln. Ensure high quality of product.	Organisation of transport of parts for assembly. Training of artisans. Easy to scale up rapidly. Quality and approval procedures. Testing and	Require pick-up car or small truck Can be costly	Pre-financing and storage facilities	Payment in few instalments/micro credit or savings scheme necessary Consumer education, awareness and instruction in use at village level. Demonstration and incentives needed to ensure high penetration	Warranty needed of 2-3 years. Easy and quick replacement of liner/stove if cracked or damaged is difficult if sales are not direct. Sample size can be kept low if strong quality assurance and strict standards are enforced.

	Materials	Production of parts	Assembly	Distribution	Retail	Sales	After sales/monitoring
			adjustment of designs on-going			Limited to dry season and post harvest periods as cash is available and communities accessible.	
d. Improved firewood stove industrial	If in Ghana: Supply and cost of metal sheets, high quality clay and additives needed If imported: none	If in Ghana: Investment in centralised production facilities and tools. Liner may be imported. Security of supply of stoves or parts if imported may see delays due to importation/customs delays. Request for substantial pre-financing if imports	Training of workers. Business assistance services required. Financing. Quality and approval procedures. Would require long time to set up and establish but with high capacity once in operation.	Require investment in trucks and establishment of distributed storage facilities	Pre-financing and storage facilities	Payment in few instalments/micro credit or savings scheme necessary Consumer education, awareness raising and instruction in use at village level Demonstration and incentives needed to ensure high penetration	Warranty needed of 2-3 years. Easy and quick replacement of liner/stove if cracked or damaged is difficult if sales are not direct. Low monitoring costs due to standardized stove (smaller sample needed).
e. Improved charcoal stove KCJ	Sufficient supply of low cost scrap metal. Alternatively new metal sheets at higher cost. Availability of clay and additives with the right properties.	Pre-financing of materials and tools. Training of artisans in production and quality requirements. Ceramic liner production requires highly skilled ceramists and kiln.	Organisation of transport of parts for assembly. Training of artisans. Quality and approval procedures.	Require pick-up car or small truck	Pre-financing and storage facilities	Payment in few instalments/micro credit or savings scheme necessary Consumer education and instruction in use Demonstration and media may be effective	Warranty needed of 2-3 years. Easy and quick replacement of liner/stove if cracked or damaged is difficult if sales are not direct. Sample size and costs can be kept low if strong quality assurance and strict

	Materials	Production of parts	Assembly	Distribution	Retail	Sales	After sales/monitoring
							standards are enforced.
f. Improved charcoal stove industrial	If in Ghana: Supply and cost of metal sheets, high quality clay and additives needed If imported: none	If in Ghana: Investment in centralised production facilities and tools for metal parts. Liner may be imported. Security of supply of stoves or parts if imported may see delays due to importation/customs delays.	Training of workers. Business assistance services required. Financing. Quality and approval procedures. Would require long time to set up and establish but with high capacity once in operation.	Require investment in trucks and establishment of distributed storage facilities	Pre-financing and storage facilities	Payment in few instalments/micro credit or savings scheme necessary Consumer education and instruction in use Demonstration and media campaign would be effective	Warranty needed of 2-3 years. Easy and quick replacement of liner/stove if cracked or damaged is needed. Low monitoring costs due to standardised stove design and easy access to customers in urban areas (smaller sample needed).

It is evident that the main challenges are related to the technology shift in rural areas (fire wood stoves) due to the lower population density, lack of knowledge of improved stoves, low or no cost of alternative fuel and appliance and need for credits.

The key challenges that introduction of new stoves in rural areas needs to address are:

- Availability and pre-financing of sufficient low cost (scrap) input materials at production level
- Cost of training, quality assurance and uniform performance of stoves
- Lack of structures for production, storage and dissemination
- How to ensure large-scale and rapid dissemination in rural areas – incentives and consumer finance models
- Lack of awareness on reduced fuel collection/cost, time savings in cooking reduced respiratory hazards,
- General mistrust

Table 4-5 Quick stove assessment matrix

		Cost of program set-up	Potential for large scale roll out	Quality & Ease of monitoring	Existing structures	Development co-benefits and sustainability
a	Self made mud-stove	High	Low	Low	Medium	Low/medium
b	Artisan clay stove	Medium	Low	Low	Low	Medium
c	Improved firewood stove - artisan	Medium	High	Medium	Medium	High
d	Improved firewood stove - industrial	Low	High	High	Nil	Low
e	KCJ charcoal stove	Medium	High	Medium	High	High
f	Improved charcoal stove industrialised	Low	High	High	Low	Low

Firewood stove

Enough tests have not been undertaken on the firewood stoves based upon which target communities could select the most appropriate stove. There is the need for the

introduction of a diverse range of improved firewood stoves, field trials and cooking demonstrations as a means of selecting the most appropriate stove to roll out. This provides scope for the introduction of a diverse range of stoves for testing, monitoring, evaluation and final selection.

Since studies have shown that more than 60% of rural households have not heard of improved stoves at all, there is therefore a limit on their ability to make informed choices on an important household item like an improved stove. The stove needs to be used and evaluated.

The stove technology with the highest potential for carbon financing and large-scale roll-out is, however, assessed to be an improved firewood stove, made from metal sheets with a ceramic liner. Production set-up and concepts are already in place for charcoal stoves and could with few changes be adapted to the rural and urban market for firewood stoves. The organisation of the production of the stove with many individual artisans involved on a contractual basis is flexible, reduces cost and allows for quick up-scaling of production capacity, provided training, quality control and some pre-financing of material are provided. The essential part would be setting up a local facility for production of the ceramic liner at a central location in the North. With the expansion plans of ceramic production facilities for the improved charcoal stove (Gyapa and Toyola) this is likely to get in place within a year. The ceramic liner is the key to controlling numbers and quality of the stoves.

Trial sales and testing would need to made to determine acceptability and fine tune design to fit local cooking practices and preferences. The main challenge, however, is to convince the households to purchase a stove when the alternative is non-cash fuel and non-cash appliance. Issues of health, time saving, cleanliness, modernity, etc. would need to play an important role in promotion.

Charcoal stoves

In the case of charcoal stoves, the most popular improved stove is the Gyapa or Toyola coalpot, which is based on the KCJ and is being promoted by Enterprise Works and Toyola Company respectively. The various stove components are manufactured locally. However the ceramic liner is produced down south to ensure standardization and transported to the marketing centres for assembling.

The Ahibenso coalpot, which is also highly efficient seems to have completely disappeared. This is due primarily to the fact that after Government withdrawal no systems were put in place to sustain the production, marketing and use of the product. The acceptability of the stove was very high since more than 12,000 stoves were sold throughout the country within 1 year, with about 2,000 in the target area.

To introduce a new stove model at this stage may involve a high level of promotional and educational campaign. However considering the fact that the KCJ is already being rolled out by two companies, and a submission for carbon financing is being prepared or already in place, the available options include to work with Enterprise Works or Toyola to promote the KCJ in rural or emerging urban areas. Problems of double counting would, however, be difficult to deal with.

Industrialising some parts of the production chain, e.g. metal cutting machinery instead of hand cutting, might reduce cost and improve quality. With the production numbers envisaged, a need for using new metal sheets would emerge, as scrap metal already is scarce in some part of the North.

As both companies already are involved in the carbon finance market for their charcoal stove focus should rather be on the firewood market segment, which in the rural Savannah still accounts for more than 80% of the households.

5 Baseline

The aim of this section is to calculate the generation of emission reductions/stove/year and in stove lifetime using the identified baseline. The main basis for the identification and calculation of the baseline is the Indicative Simplified Baseline and Monitoring Methodologies for Selected Small-Scale CDM Project Activity Category – Type II – Energy Efficiency Improvement Projects.

This category includes energy efficiency technology measures for non-renewable biomass applications. Subsequently improving the efficiency of existing woodfuel cookstoves and/or replacing the old technologies with improved and more efficient woodfuel cookstoves qualifies.

For the purposes of this project the indicative baseline boundary would be the northern savannah comprising the three Northern Regions (ie. Northern, Upper East and Upper West Regions).

5.1 Non-renewable biomass

To date there does not exist a national or regional baseline for the ration of the non-renewable biomass in Ghana. Consultations with the Energy Commission resulted in agreement that Energy Commission would take the lead the development of a national position in collaboration with Forestry Commission and the Environmental Protection Agency who is the Ghanaian DNA. This proposal could seek funding from the numerous initiatives for CDM capacity development.

The complexity of differentiating between renewable and non-renewable biomass is beyond the scope of this report. However for information purposes it is worthy to note that renewable biomass would relate to areas where because of sustainable practices forest, wood and cropland resources are not being depleted resulting from wood for energy utilization. The reverse could hold for non-renewable biomass.

It is generally accepted that current fuelwood demand has outstripped the annual growth of wood available for firewood consumption. Annex E provides a summary of the woodfuel inventory as of the year 2000 based on work of the Forestry Commission and the FAO. The total annual supply of firewood was estimated at 18 million tons.

Indicators changes in biomass use was presented in Chapter 2 based on the last two Ghana Living Standards Surveys conducted in GLSS4 1998/99 and GLSS5 in 2005/06. An indicator of scarcity of woody biomass is average time spent on collection and distance.

Table 5-1 Average time spent per day on collecting firewood, by locality and sex, GLSS4 and GLSS5

		Proportion doing that activity (%)	Average time spent (minutes per day)					
			Other urban		Rural Savannah		Ghana	
Activity	Sex	2006	1999	2006	1999	2006	1999	2006
Collecting firewood	Male	16.9	51	25	33	32	30	25
	Female	37.5	45	26	46	40	37	30
	All	27.6	47	26	43	38	35	29

GLSS5 table 4.19 and 4.20, page 47 and 48, GLSS4 table 4.15 and 4.16 page 39 and 40.

Detailed research by the NGO network Energia into the wood collection dynamics show that time spent on firewood collection and distance doesn't always provide a good indicator of scarcity. E.g. when families are short of man-power due to e.g. migration, women tend to collect poorer quality of wood nearer to their homes on a daily basis. With more man-power one or two persons can go for a longer trip to e.g. once a week to fetch good pieces that would last for longer.

Data presented in Chapter 2 of this report indeed shows that the household sizes are diminishing significantly except from the Upper West Region.

Currently there is no information within the national statistics or related studies specific to the non-renewable biomass ratio for Ghana. For the purposes of this report therefore, we would use the wood regeneration statistics with the wood consumption figures on a national level as presented in the Strategic National Energy Plan (SNEP). The result would show the percentage of total woodfuel consumption that is non-renewable.

In 2004, it was estimated that although Ghana had a woodfuel supply of up to 30 million tonnes per annum, only between 18 to 20 million tonnes was potentially available for charcoal and firewood users. At that time total woodfuel demand was around 17.2 million tonnes and so the non-renewable ratio was just around 0. However using projections provided in the SNEP, woodfuel utilization has outstripped our potential supply to the extent that in some scenarios, the non-renewable ratio is between 14% to 60%. Furthermore the woodfuel supply will also decrease due to reduction in forest cover. This has not been factored into the analyses.

This is presented in the table below under various growth scenarios as defined by the Energy Commission in the Strategic National Energy Plan from 2006-2020.

DESCRIPTION	**2004**	**2008**	**2012**
SCENARIO 1 - GPRS High Economic Growth			
Wood equivalent of charcoal consumption (m/tonnes)	8.5	23.6	25.4
Firewood consumption (m/tonnes)	8.7	17.5	20.8
Total woodfuel consumption (m/tonnes)	**17.2**	**41.1**	**46.2**
Potential Primary Woodfuel Supply (m/tonnes)	18.0	18.0	18.0
Non-Renewable Biomass Ratio	**0.05**	**0.56**	**0.61**

DESCRIPTION	2004	2008	2012
SCENARIO 2 - GPRS Mod. High Economic Growth			
Wood equivalent of charcoal consumption (m/tonnes)	8.5	16.9	18.7
Firewood consumption (m/tonnes)	8.7	13.9	16.4
Total woodfuel consumption (m/tonnes)	**17.2**	**30.8**	**35.1**
Potential Primary Woodfuel Supply (m/tonnes)	18.0	18.0	18.0
Non-Renewable Biomass Ratio	**0.05**	**0.42**	**0.49**
SCENARIO 3 - GPRS Business as Usual			
Wood equivalent of charcoal consumption (m/tonnes)	8.5	10.2	12
Firewood consumption (m/tonnes)	8.7	10.3	12
Total woodfuel consumption (m/tonnes)	**17.2**	**20.5**	**24**
Potential Primary Woodfuel Supply (m/tonnes)	18.0	18.0	18
Non-Renewable Biomass Ratio	**0.05**	**0.14**	**0.33**

Source: Energy Commission, SNEP (2007)

The Plan emphasizes that in order to address shortfalls of wood for charcoal and firewood use on a national basis, under the business as usual scenario, wood stocks would need to increase from an estimated 750,000 hectares in 2006 to around 2.5 million in 2012. This needs also to be complemented with the promotion of more efficient charcoal and firewood stoves, together with conservation programmes.

From the table, the non-renewable biomass ratio varies greatly depending on the scenario considered. Over the past years economic growth in Ghana could be said to have been much higher than business as usual. We would therefore assume that growth has been moderately high and use that scenario for the CER generation calculation.

Calculations of emission reduction have been made using a preliminary value of NRR of 47% as well as a default value of 75% until an official value is available.

5.2 Emission reduction

The major assumption for determining the emission reductions that form the basis of the baseline is that in the absence of the proposed project activity green house gas emission alternatives like the burning of fossil fuels through the use of LPgas or kerosene would be employed.

The formula as defined in II.G–Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass is as follows:

$$ERy = (B_{ysavings}) \times (F_{NRB,y}) \times (NCV_{woodfuel}) \times (EF_{\text{projected fossil fuel}})$$

Where:

ER_y: Emission reductions during the year y in tCO_2e

$B_{y,savings}$: Quantity of biomass that is saved in tonnes

$f_{NRB,y}$: Fraction of biomass saved by the project activity in year y that can be established as non renewable biomass using survey methods

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

$EF_{projected\_fossil\ fuel}$ Emission factor for the substitution of non-renewable biomass by similar consumers.

The substitution fuel likely to be used by similar consumers is taken as 71.5 tCO_2/TJ for Kerosene, 63.0 tCO_2/TJ for Liquefied Petroleum Gas (LPG). However in the case of Ghana the most likely fuel substitute would be LPG since the Government programme and objective is to promote the increased use of LP gas for cooking as an alternative to charcoal and firewood.

In the absence of local data on the net calorific value of the non-renewable biomass (in this case woodfuel) in Ghana, IPCC default values are used. The same is the case for the projected fossil fuel indicators.

In identifying the quantity of biomass, which is saved the following formula as approved under the CDM is utilised.

$$B_{y,savings} = B_y \times \frac{\eta_{old}}{\eta_{new}}$$

Where:

$B_{y:}$ Quantity of woodfuel used in the absence of the project

H_{new} Efficiency of the system being deployed as part of the project activity (fraction)

η_{old} Efficiency of the system to be replaced, measured using representative sampling methods or based on referenced literature values.

Table 5-2 ER per stove per year for different values of NRB using LPG as alternative fossil fuel (t CO_2)

		Annual biomass	Biomass saving compared		Annual CER per stove for NRB, LPG			
		t/stove	to baseline	ton per year	25%	50%	75%	100%
	Three stone (baseline)	3.1025						
a	Mud stove - self made		20%	0.621	0.15	0.30	0.45	0.60
b	Artican Clay stove with chimney		25%	0.776	0.19	0.38	0.57	0.76
c	Improved firewood stove artisan		60%	1.862	0.45	0.91	1.36	1.81
d	Improve woodstove industrial		50%	1.551	0.38	0.76	1.13	1.51
	Traditional coalpot (baseline)	1.0707						
e	KCJ charcoal stove		50%	0.535	0.26	0.52	0.78	1.04
f	Improved charcoal industrial		50%	0.535	0.26	0.52	0.78	1.04

Note that the efficiency of the improved firewood artisan stove is preliminary and needs confirmation from testing.

A NRB of around 50% would lead to ER in the range of 0.3 – 0.91 t CO_2 per year per firewood stove and 0.52 t CO_2 per year per charcoal stove. If alternatively kerosene

is the alternative fossil fuel the resulting ER would be in the range of 0.33 – 1.0 t CO_2 per year per firewood stove and 0.57 CO_2 per year per charcoal stove corresponding to 10% higher ER.

Table 5-3 Example of ER for a improved firewood stoves program reaching an annual production capacity of 18,000 stove, replacement every 3 years (ER per stove 0.91 tCO2/year)

Year	Unit	start up	Year 1	Year 2	Year 3	Year 4	Year 5
New stoves	N	3,000	10,000	18,000	18,000	18,000	18,000
Existing operating stoves year start			3,000	13,000	25,000	33,000	33,000
Total Number of appliances operating	N	5,000	13,000	28,000	43,000	51,000	51,000
ERy	t CO2	4,537	11,797	25,409	39,022	46,282	46,282
ERacc		4,537	16,335	41,744	80,766	127,047	173,329

With an annual production of 18,000 stoves sustained ER per year of 46,000 tons should be attainable.

5.3 Additionality

The proposed improved household woodfuel stove project is based on a village by village transformation from the traditional inefficient stoves to the new more efficient designs.

The project is appropriate and fits with the eligibility criteria of the Clean Development Mechanism of the Kyoto agreement through its compliance with three major eligibility criteria:

Sustainable Development

Technological Additionality

Environmental Additionality

Financial Additionality

These are further elaborated below:

Sustainable Development

The proposed project will contribute positively to Ghana's progress towards sustainable development since it would improve the living standards of rural folk (especially women and children) by improving their health, workload, the environment and improve social equity.

The benefits of the improved stove project include the following:

The increased use of improved and more efficient woodfuel stoves will reduce deforestation pressures. It will also help in restoring the environment since less wood would be harvested for woodfuel.

Due to reduced energy and health expenses, together with improved health of women and children who normally do the cooking, the standard of living will increase at the household level.

Time and energy spent in gathering wood for cooking wood be reduced by 50% or more;

More time would be made available for productive and educational activities by children because of the reduced wood collection rate.

The improved stoves will cook faster thereby reducing cooking time and labour input.

In commercial firewood using households expenditure on fuel purchase would be reduced thereby making more income available for other pressing household requirements.

As a result of reducing or in some cases eliminating the smoke within the cooking environment, health of women and children in the household would improve drastically.

Reduced smoke a cleaner kitchen and smokeless clothes will enhance the physical well being and outlook of women and children in many rural communities considerably.

The project targets the poor sections of the target area thereby improving social equity.

Technological Additionality

Improved stoves happen to be more efficient and less hazardous than the traditional stoves. Households and artisans are exposed to new and more efficient ways of using local materials, labour and resources.

Programmes aimed at promoting these stoves also provide forums for improved cooking practices, health and environmental information dissemination.

The result is an improved technological environment, which would not exist without such a programme. Noticeable also is the fact that such training for rural households forms part of the non-localised cash requirements which without CER funding would not be implemented.

Environmental Additionality

Currently there is an increased and continued unsustainable exploitation of wood stocks for woodfuel purposes, this would continue unless an improved stoves project is implemented.

It is the conclusion of this study that without the implementation of an improved stoves programme, the low efficiency of end use devices in Ghana would continue to contribute significantly to deforestation, rural poverty and increased shortage of woodfuel resources.

In the traditional way of cooking, the heat utilization efficiency of firewood and charcoal stoves are about 11% and 16% respectively. The combination of high demand, aggravated by low use efficiency has contributed to deforestation, rural poverty and the rural energy shortage in various parts of northern Ghana.

This scarcity is also the result of the relatively dry climate together with growing land and population pressures. The more difficult it is the get woodfuel for cooking, the more labour and time used to obtain the supplies.

Today, judging from the limited reforestation programmes aimed at wood species for woodfuels and the longer distances that all producers, collectors and marketers travel to get supplies, it seems rational to conclude that stocks are being depleted rapidly.

Whilst traditional stoves have efficiencies of less than 20%, improved stove are between 30-40%. This means that in the dissemination of improved stoves households make direct savings in the consumption of woodfuels and agricultural residues. This unburnt fuel remains in the environment helping the carbon sink and increases the biomass stock through increased soil fertility.

Financial Additionality

It is worthy to note that a well planned and implemented improved stoves programme will ensure an increased and improved efficiency of energy use by rural households in Ghana.

To disseminate improved stoves like many other rural based products, there are the non-cash cost (ie. household labour and local materials) and the cash related costs (ie. materials, promotion and training). Rural households in Ghana have many cash needs and are therefore very limited cash available for making financial investment

decisions. However they possess abundant labour and local material resources, which need not be overemphasized. Therefore the non-cash needs of the project are within the capacity of local communities to provide. Promotion of stoves in rural areas has until now not been a policy priority for the Government of Ghana.

Revenues from the sales of CER would make it possible to finance the cash cost which are not localized. The financing of non-local cash costs related to efficient household energy utilization is one of factors preventing large-scale dissemination of stoves in many parts of the world including Ghana.

Considering the fact that the unavailability of capital to provide for investment on non-local materials, promotion, and training is a major barrier to the feasibility of an improved stoves project, without a CER intervention as some compensation to households for their emissions reductions make to an improved global environment the status quo would remain and the continued inefficient use of woodfuels by millions of households in Ghana would continue to increasingly contribute resource depletion and land degradation.

However the combination of local labour and materials together with CER financing would provide a model platform, which would make it feasible and viable for all stakeholders to adopt the improved stoves and should be pursued

6 Stove roll out strategies and partners

Today's approach to improved stoves projects is significantly different to that adopted previously. The main change is the requirements of reaching large numbers (e.g. to reach poverty reduction strategies, MDGs, ERs) and the use of a strong commercial approach.

Experience show that professional stove builders can be better trained at far lower costs than self-help groups; they are capable of producing stoves of a higher quality and at affordable prices, and to maintain the quality demanded by customers. Beneficiaries rarely demand quality, customers do.

GTZ, that has been active in household energy projects for decades has summarised their lessons learned in the following key points:

- A participatory, gender-sensitive approach improves prospects for technology acceptance.
- Technology acceptance requires that the products are of high quality, affordable, reliable and aesthetically pleasing and produce realistic, tangible benefits.
- Enabling framework conditions (e.g. fuel pricing policies, subsidies and policy measures, norms and quality standards for imported products, etc) are as important as a high-quality product.
- Easier access to credit lines, especially for women entrepreneurs, will speed up the dissemination rate.
- A well-functioning networking system optimizes knowledge transfer and exchange
- Integrated HE projects that are complementary to other sectors produce synergy effects and are therefore more cost-effective and yield faster results.
- Synergy effects can also be produced through co-implementation with other donors.
- Others, like the Grameen Shakti in Bangladesh have added that successful stove projects should:
- Avoid direct subsidies
- Link technology with income generation;
- Use innovative micro-credit schemes to reduce costs and reach economy of scale
- Train local technicians and manufacturers,
- Involve and motivate local communities

These findings are highly relevant and actual in Ghana as well and have been confirmed through interviews and observations that form part of this study in Ghana. Using this to guide a roll-out strategy for an improved stove project in Ghana would also be in line with CARE principles and values.

6.1 Sustainability

Sustainability of a program can be assessed both at the individual level, e.g. does the local stove manufacturer have the capacity to offer an improved stove after the lifetime of the first sold stove? Has the consumer the means to pay for the stove then? And at a more overall level: does the environment in which the stove program sits enable further development, do the various stakeholder do their part and is good governance promoted.

GTZ has, as a part of the program “Energising Development” in which more than 4 million households have been reached with energy efficient stoves since 2005,developed tools for assessing sustainability at both levels.

6.2 Strategies

Community education & awareness raising

The majority of the target group are illiterate and contact would need to be direct. Introduction of a new technology that affects the core of household chores would need to be very convincing and the option of asking questions, demonstration and trying it out for yourself etc would be very important.

Education on good kitchen management and efficient cooking practices should go hand in hand with information on health and savings benefits. Issues such as kitchen hygiene, health, smoking, child safety etc. would go well in hand with discussions of cooking practices and reducing harmful indoor air pollution.

Cooperation with local government, NGOs and local associations on a common approach would help sustain education and create synergies. The actual demonstration of stoves and visualisation of practices would make the education on other related issues more interesting and direct.

Awareness-raising activities should be targeted at a much wider audience than the direct project participants.

In order to ensure local collaboration would be ongoing, assistance should be provided in building relationships between manufacturers, officials from local authorities (district assemblies, forestry commission and EPA and third parties such as the local credit & savings (microfinance) institutions. The energy NGO based in Tamale, New Energy, would be a logical partner for community education activities.

Training of local artisans

Enterprise works has a long and extensive expertise in setting up training programs for training of local artisans in the design and construction of stoves. It is recommended that a stoves program build on this expertise and also involve institutions such as GRATIS Ghana Foundation and possibly Centre for Technology-Driven economic development (CTED) for inputs and tools for the industrialisation of the manufacturing chain.

The most critical part of the production chain is the ceramic liner the production of which require highly qualified ceramists and access to clay with the required properties as well as other materials to get a durable, and energy efficient stove.

In addition to training in the physical production of the stoves, new manufacturers would need start-up equipment and materials and advice on future pricing, as well as insight into marketing and promotion and quality assurance.

Minimum quality standards for efficient stoves need to be established and indicators for monitoring communicated to artisans.

Logistics for distribution of stoves

Improved stoves are heavy and bulky. Futhermore, the ceramic liner is sensitive to rough handling and need to be stacked well to avoid damages during transportation.

Artisans are well distributed in all major urban areas and production of stove parts and assembly can be done at a decentralised level provided that the ceramic liners are distributed and stocked efficiently. The challenging part is to get the stoves to the customers at low costs. Use of “road shows” to follow up on and coordinated with community education activities could be an effective way to reach high sales in short time. Follow up sales could be done by refitted tricycles able to go door to door. It is important to reach high penetration rates from the outset to reduce cost of distribution and means to encourage this should be explored with the local partners/associations.

Incentives could be awarding of on-sales to neighbours, bonus to the local community or local association for reaching a certain sale or penetration rate, etc..

Microfinance

Micro-finance institutions or rural banks that provide financial services for poor and low-income clients to finance their income-producing activities, build assets, etc. are not very developed in Ghana. However, households / micro enterprises can make use of the micro credit to implement energy efficiency measures under PoA‘s framework. This is clearly the trend in other parts of the world in this kind of projects. The micro-credit institution could also take part in the monitoring activities.

There is a clear need for including micro-finance element into the stoves program both at end-user level and at manufacturing levels. Innovative forms of micro-finance include finance through the intermediary of e.g. the main stove manufacturer. Such a scheme could be developed with local banks and Toyola. The loan could e.g. be paid to Toyola for the purchase of a large number of stoves where Toyola identifies the customers and guarantees stove performance and after sales services. And the customer repays the bank according to an agreed schedule developed for 2-3 typical customer categories.

Similar for artisans for materials or tools.

Part of the CDM funding could be used to set up a guarantee facility with a local bank and/or a microfinance institution.

Alternatively, funding could be channelled through AREED managed by KITE for the same purpose. KITE is currently discussing with local banks on setting up both a facility for end-user finance of energy equipment in Ghana as well as a loan guarantee facility for micro and small scale rural energy enterprises. Toyola is a successful example of the impact of such a support.

Project coordination, implementation and monitoring.

CARE would act as the managing entity. It has the necessary access to financial resources and necessary initial investments and has an established network with donors and local NGOs. CARE is currently involved in micro-savings schemes but would need to expand its networks with the formalised micro-finance sector.

Further, CARE has representation in Northern Ghana and through it's partners, proximity to the target group and proved experience in structuring and financing programs. Monitoring could be contracted to a local energy resource centre or NGO or financial institution. It is not recommended to hire university staff or students on consultancy contracts for this as availability of man-power depends heavily on the activities of the institution and could delay or compromise monitoring activities.

CARE would be responsible for the CDM PoA documentation and for developing the necessary cooperation agreements with manufacturers, field agents, testing organisations and other intermediaries.

Transfer of ownership of CER to CARE should be incorporated in agreements with households and micro enterprises.

Testing and Monitoring of Stove Performance

CARE would need to contract a credible testing and labelling organisation for the testing and monitoring of the stove performance. The involvement of a testing organisation could be utilised to continuously help assuring and developing the quality of the stoves as well.

A possible roll out strategy with focus on barriers, interventions and possible partners in an improved cook stove program is outlined in the following table.

The roll out strategy is based on the artisan produced improved firewood stove by either Toyola or Enterprise Works because these seems the most promising technologies and partners.

Table 6-1 Barriers, interventions and possible partners in an improved stove CDM program

	Stove production	Distribution	Marketing	Sale	After sales service
Barrier	Capital and finance Technical skills and production capacity for critical parts (liner)	High costs Fragile parts (liner) Bad infrastructure in remote rural areas	Low knowledge of advantages of Improved cook stoves Low population density. High illiteracy rates	New product/technology has to be superior to the old technology. Changing cooking practices is deeply rooted in any culture also in Ghana. No cost of current stove and no cost for fuel except opportunity cost of spending time on firewood collection.	No responsibility from producers Hard to find and access the seller again Mistrust
Intervention	Micro Finance Training and capacity building on liner production	Hub/storages in Wa, Tamale and Bolgatanga Sell at markets Directed marketing in communities when they are already meeting (VSLA meetings etc.) Use and recruit village ambassadors/agents for the product how can order on cell.	Focus on direct marketing. Information and general awareness raising using social marketing and/or radio as media.	Sell at markets and use road shows when timed according to when the HH has cash available. Direct sale with focus on health benefits and time saved Sell in combination with other produces (rural sale programs). Develop financial incentives schemes like transfer of revenue from carbon credits to end-user by mobile banking.	2-3 year warrant by producers or retailer Easier if stove producers also are responsible for the sale. A fragmented value chain challenges this. Strong policy on after -sale by producer.
Possible partners	MFI? Enterprise Works /Vita and/or Toyola New Energy, Gratis, CTED	Toyola Distributer of other goods like farm inputs, charcoal	Government, Donors and other NGOs interested health issues related to cooking. Toyola, New Energy and companies with focus on business to BOP (bottom of the pyramid).	Toyola or Enterprise Works/Vita Zain/MTN/Tigo	Toyola

The suggested strategy shall have to be researched further and a pilot is strongly recommended especially in relation to the sales model and key messages in the sales pitch. A first step would be to have a deeper understanding of the drivers for behavioural change in relation to cooking technology in rural communities. This research could feed into the final design of an improved firewood cook stove and field testing in the different regions in Northern Ghana. Finally a pilot using the most promising sales models is recommended in order to fine-tune the roll out strategy and ensures a high penetration rate and maximising the social benefits for communities.

The possibility of using mobile banking as a way to return and share revenue from carbon credits and hence create incentives to use and purchase the stoves has a big potential. Not only as an integrated part of a stove CDM PoA but also as a way of giving rural households access to the financial system. Today mobile banking is just taking of in Ghana. Mobile banking in Ghana is likely to be modelled on the Kenya Safaricom M-Pesa program. M-Pesa allows Safaricom customers to buy M-Pesa shillings along with airtime, and either keep them for their own future needs – savings – or allow someone else to withdraw them – transfers and payments. Introduced in March 2007, the system had 2.3 users by June 2008. At present, the minimum amount that can be withdrawn is Kshs 100, or about US$ 1.25, and the fee for a transfer is Kshs 30, or US$ 0.30, plus the cost of a regular SMS message.

While phone ownership is still low in rural Ghana, it is growing steadily if fewer than a quarter of households possess a phone a much greater percentage has access to a phone, with a neighbour or relative.

A rebate program for carbon money, direct to the end-user, could be put in place once there is widespread mobile banking in Ghana. This would require that the purchaser give a sim card at the time of purchase and that the person has access to a phone. The numbers on the sim cards would be transmitted up the supply chain, and recorded in a database. When carbon funds are received (net of expenses), an electronic transfer could be sent to the names on the database of those end-users who had actually earned the carbon funds. The phone number that they had given would receive an SMS with the code necessary to recover the funds. The end-user would then go to the nearest person authorized to pay on reception of the code.

While theoretically workable, to use mobile banking to return carbon funds to individual end-users, a number of conditions have to be fulfilled:

- There has to be a phone service and connectivity
- Even within served parts, there are people who have no friend or relative with a phone and thus would have difficulty furnishing a phone number.
- Errors in memory by the end-user, or in transcription by the entrepreneur selling the clean energy product, would be difficult or impossible to detect.
- The cost of maintaining the database of numbers could be substantial, relative to the amount of each transaction.
- The mobile banking company would have to agree to negotiate a substantial reduction in fees in exchange for a large quantity of transactions.

The question of whether to return carbon funds to individual poor people, or to the class of poor people, is one that the partners will have to decide, once more information about the cost and practicality of the mobile banking option is available.

7 Economic feasibility and financial needs

The overall cost of a stove program will be developed after discussions/ negotiations with program partners on an overall set up.

The table below provides an overview of the main cost elements that need to be included and assessed based on this. Possible saving could be made by developing a common PDD with Enterprise works or Toyola on charcoal stoves and possibly institutional stoves as well if this is possible according to their existing agreements.

Table 7-1 Overview of PoA cost estimate (will be updated)

Cost components	Up front	Annual
Project design and CDM monitoring		
PoA DD and PIN	110,000	
Validation	50,000	
Implementation	100,000	
Registration fee per CER	0.20	
Verifications		30,000
Issuance fee per CER	0.20	
Monitoring		
Setting up database	1,000	
Procurement of Kitchen performance test instruments	2,700	
Man-power skilled		24,000
Man-power ground-work staff		36,000
Development of final stove design		
Field testing	20,000	
Develpment of production strategy and models	2,000	
Community education and awareness raising		
Development of training concept	2,000	
Road show (4 months per year after harvest season)	20,000	
Promotion and avertising items	10,000	
Training of local artisans		
adoptation of training courses	2,000	
Training course	30,000	
Logistics of distribution of stoves		
distribution margin per stove (1 EUR per stove)	49,000	18,000
Stove procurement		
Stove distribution and stove replacement	245,000	90,000
Other costs		500
Total costs	805,596	198,500
User payment (prod + distr= 6 EUR per stove)	294,000	108,000
CER minimum revenue required	511,596	90,500

The CER generated over 10 years for 49,000 stoves and an annual replacement of 18,000 stove, ER per stove 0.91 t CO2, are around 405,000 t CO2.

A user payment of 6 EUR is assumed, covering production and direct distribution costs.

A rough estimate of total costs is around EUR 1.3 million.

8 Conclusions

Detailed review of existing studies has been made and information presented on all key aspects related to preparation for an improved stoves project in Northern Ghana.

The target area covers three regions and an estimated 840,000 rural households of which approximately 90% use firewood as their main source of cooking. The potential for a large-scale stoves program even with overall low penetration rates is therefore present. To keep monitoring and dissemination costs low, an effort should be made to attain high penetration levels, e.g. a minimum of 50% in the specific communities involved.

ER per stove of 0.91 would lead to significant CER even for a modest programme of approximately 50,000 stoves over a 3 – 4 year period. A programme targeting an annual production of stoves of 18,000 after 3 years would be able to generate an amount of 46,000 CER annually or about 400,000 CER over a ten year period.

Customer contribution is recommended to cover production and direct distribution costs in order not to distort the local market and to ensure sustainability. CER revenue used for training and professionalization of artisans, community education and awareness raising, quality assurance, program management and monitoring and if possible community development activities. Alternatively CER could be used for paying down the cost of replacement stoves.

With a CER price above 10 EUR even a 50,000 stove program seems feasible.

Further research, however, in the design, acceptability and incentives scheme for the adaptation of an improved firewood stove should be made before a large-scale roll-out is made.

Annex A: List of people consulted

Organisation	Name	Position	Contact
Energy Commission	Joseph Essandoh-Yeddu	Head of strategic planning and policy	yeddu@yahoo.co.uk
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Energy Commission	Simpson Attiekus	Energy statistics	attiekus@energycom.gov.gh
Enterprice Works/ Vita	Atsu Titiati	Country Director	atsu@africaonline.com.gh
Enterprice Works/ Vita	Seth Maku	Component Program Manager	smagbeve@yahoo.com
KITE	Frank Atta-Owusu	Projects Manager	faowusu@kiteonline.net
Toyola	Suraj Wahab	Owner	024 5482842
Toyola	Ernest Kyei	Owner	024 9857141

Annex B: List of documents consulted

Key documents and description of their main content of relevance to the assignment.

Strategic National Energy Plan 2006-2020, Energy supply to the economy, Annex IV, Wood fuels and Renewables, Energy Commission, Ghana, July 2006

Energy for Poverty Reduction – Action Plan for Ghana – a targeted approach to delivery of modern energy services to the poor. Kite Ghana 2006

Prices of Cooking Fuels Study, UNDP and Energy Commission Ghana, 2006

This study was undertaken in 2006 for the Household Energy Programme of the UNDP and Energy Commission. The study covered cooking fuels in the three Northern Regions alone. It focused on cooking fuel sources, price build-up for cooking fuels, cost of using various fuels for cooking, cooking accessories and relative costs together with a proposed system for the periodic update on data on cooking fuels. Field data was collected from main markets in Tamale, Bolgatanga and Wa.

Energy Sector Technology Catalogue Ghana, Energy Commission, September 2004

Overview of relevant energy technologies used or to be used in Ghana. The catalogue contains technical and environmental data as well as cost information for 18 household cooking technologies including the three-stone open fire, traditional mud stove and improved stoves. The catalogue contains the background information used for energy modelling and scenario development in connection with the elaboration of the Strategic National Energy Plan for Ghana.

Traditional Energy Resources Component, Completion Report, 2003

Includes lessons learned from initiating a number of activities related to traditional energy in Northern Ghana, both on demand and supply side.

Estimation of Wood fuels Demand in the Household Sector of Ghana, BBRI for the Energy Commission, Ghana 2002

Estimation of various cooking fuel use in households in Ghana. The types of households included rural households in three ecological zones (Coastal, Forest and Savannah) and urban households according to income levels (high, middle and low). Focus was on establishing more accurate data on wood fuel and charcoal consumption.

District Energy Profile Studies, Danida 2001

The studies were undertaken in 2001 as part of the activities of the Danish Support to the Energy Sector – Traditional Energy Resources Project.

Baseline data was collected in six districts, two each from the Upper East, Upper West and Northern Regions. These were, West Mamprusi and Tamale (Northern Region), Bolgatanga and Bongo (Upper East Region) and Wa West and Wa (Upper West Region).

The study provided data on the fuel use pattern within these Regions for both urban and rural households, industry and commercial purposes. It also shows the quantities of the various fuels used, their sources, prices and volumes. It provides an estimate of the total quantity of energy used in these Districts for all purposes

including cooking, lighting, heating, pito brewing (local beer), chopbar operations, etc.

2000 Population and Housing Census, Summary Report of Final Results, Special Report on Urban localities, and Special Report on 20 Largest Localities, March 2002.

Statistics on population, household size, urban-rural proportions related to regions and districts. Information of main occupation of men and women, housing characteristics and facilities. Energy related information include: main source of cooking, cooking space characteristics and main source of lighting.

The Charcoal Cycle in Ghana – A baseline study - Technical supplement, consolidated report on the marketing of wood fuels in major urban centres in Ghana, by Nketiah, Hagen, Addo, 1988 and update in 2000 by Dakens Consultants, Kumasi

Ghana Living Standard Survey (GLSS5) 2005/06, and GLSS4 1998/99

Includes data on gender specific poverty levels, income and expenditure of households, main source of cooking and lighting, time spent on firewood collection as well as occupation and literacy. Data also includes housing characteristics and details on indoor pollution from cooking.

PoA Blueprint Book, Guidebook for PoA coordinators under CDM/JI, KfW Bankengruppe, May 2009.

A guide for woodfuel surveys, EC-FAO partnership programme (2000-2002) Sustainable Forest Management Programme

Annex C: Petroleum price build up Ghana, September 2009

PETROLEUM PRODUCTS PRICE BUILD UP, Effective September 1, 2009								
	PRICES IN GHANA PESEWAS							
	PREMIUM	KEROSENE	GAS OIL	MGOLOCAL**	RFO	LPG	PREMIX	UNIFIED
EX-REFINERY PRICE	80.4800	74.1074	89.3087	83.6542	58.4943	69.7096	38.9408	80.4800
EXCISE DUTY	2.7800	1.0375	1.8000	0.2945	3.2094	0.7246	0.0000	2.7800
DEBT RECOVERY LEVY	2.0000	0.0000	2.5000	2.5000	3.5000	5.0000	0.0000	2.0000
ROAD FUND	6.0000		6.0000					6.0000
ENERGY FUND	0.0500	0.0500	0.0500		0.0500			0.0500
EXPLORATION LEVY	0.1000	0.1000	0.1000	0.1000	0.1000		0.1000	0.1000
CROSS-SUBSIDY LEVY	5.0000	-4.8449	-2.6987	-6.2287	-1.3937	-18.4042	-0.3608	5.0000
PRIMARY DISTRIBUTION MARGIN	1.0000	1.0000	1.0000					1.0000
BOST MARGIN	1.5000	1.5000	1.5000					1.5000
EX-DEPOT	98.9100	72.9500	99.5600	80.3200	63.9600	57.0300	38.6800	98.9100
UPPF	5.3000	6.3000	5.3000	5.3000		6.3000	5.3000	
MARKETERS MARGIN (INTERGRATED)	7.2000	7.2000	7.2000	7.2000		6.2100	4.3200	
DEALERS MARGIN (PREMIX)							2.8800	
LPG FILLING PLANT COSTS/Premix Admin						3.7700	0.3000	
DISTRIBUTION COMPENSATION MARGIN						0.3000		
INDICATIVE MAXIMUM PRICE	111.4100	86.4500	112.0600	92.8200		73.6100	51.4800	
All Prices In Ghana Pesewas Per Litre except LPG in Gp/kg								

Source: National Petroleum Authority, Ghana

Annex D: Measurable survey results

MENSURATIVE SURVEY - UPPER EAST REGION

FIREWOOD

	Measured fuel use (kg in 7 days)	No. of meals cooked	Household size	kg/pers/meal	kg/pers/day
F1	55.8	14	6	0.66	1.33
F2	64.3	14	11	0.42	0.84
F2	63.5	18	9	0.39	1.01
Average	61.2	15	8.7	0.49	1.06

CHARCOAL

	Measured fuel use (kg in 7 days)	No. of meals cooked	Household size	kg/pers/meal	kg/pers/day
C1	31.5	19	6	0.28	0.75
C2	59.4	19	12	0.26	0.71
C3	35.8	14	5	0.51	1.02
C4	20.6	13	3	0.53	0.98
Average	36.8	16	6.5	0.39	0.87

MENSURATIVE SURVEY - UPPER WEST REGION

FIREWOOD

	Measured fuel use (kg in 7 days)	No. of meals cooked	Household size	kg/pers/meal	kg/pers/day
F1	36.96	14	8	0.33	0.66
F2	18.90	14	5	0.27	0.54
F3	20.52	18	3	0.38	0.98
Average	25.46	15	5.3	0.33	0.73

CHARCOAL

	Measured fuel use (kg in 7 days)	No. of meals cooked	Household size	kg/pers/meal	kg/pers/day
C1	43.50	16	8	0.34	0.78
C2	18.90	14	5	0.27	0.54
C3	11.40	10	3	0.38	0.54
C4	24.36	14	6	0.29	0.58
Average	24.54	14	5.5	0.32	0.61

Annex E Inventory of wood resources Ghana 2000

SOURCE	AREA	STOCKS	GROSS STOCKS	GROWTH RATE	PRODUCTIVITY	GROSS ANNUAL PRODUCTION	AVAILABILITY	ACCESSIBILITY	NET ANNUAL PRODUCTION	%	NET STOCKS	%
	M ha	t/ha	Mt	Per year	t/ha/year	Mt/year	Coefficient	Coefficient	Mt/year		Mt	
Savannah	8.500	30	255	0.03	0.90	7.650	0.75	0.70	4.016	22%	133.875	33%
High forest	1.600	160	256	0.02	3.20	5.120	0.50	0.60	1.536	9%	76.800	19%
Mangrove	0.400	120	48	0.04	4.80	1.920	0.45	0.80	0.691	4%	17.280	4%
Plantations	0.075	50	4	0.04	2.00	0.150	1.00	1.00	0.150	1%	3.750	1%
Farmed land in savannah	2.000	30	60	0.03	0.90	1.800	0.60	1.00	1.080	6%	36.000	9%
Farmed land in high forest	4.000	20	80	0.04	0.80	3.200	0.70	1.00	2.240	12%	56.000	14%
Cacao plantations	0.700	60	42	0.04	2.40	1.680	0.60	0.95	0.958	5%	23.940	6%
Coffee plantations	0.030	60	1.8	0.04	2.40	0.072	0.60	0.95	0.041	0%	1.026	0%
Live hedges	0.001	300	0.3	0.04	12.00	0.012	0.40	1.00	0.005	0%	0.120	0%
Coconut groves	0.025	80	2	0.02	1.60	0.040	0.50	1.00	0.020	0%	1.000	0%
Settlements	0.500	10	5	0.02	0.20	0.100	0.70	1.00	0.070	0%	3.500	1%
Forest fallow	3.000	20	60	0.15	3.00	9.000	0.80	1.00	7.200	40%	48.000	12%
Sub-total	20.831											
TOTAL	23.800		814			30.744			18.007	100%	401.291	100%

Source: FAO: A Guide for woodfuel surveys