China-Ghana South-South Cooperation on Renewable Energy Technology Transfer (RETT)

PRE-FEASIBILITY STUDY ON THE ADOPTION OF CLEAN BIOMASS COOKSTOVES AND MOVABLE CHARCOAL KILNS IN GHANA

Stakeholder consultation workshop
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PART 1

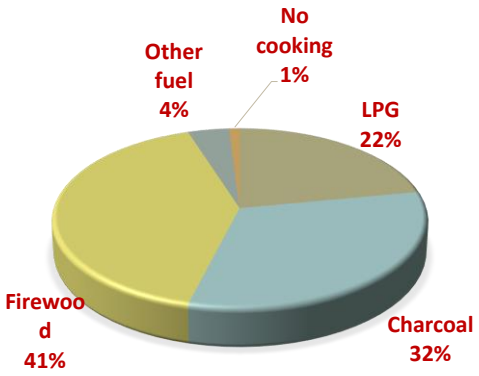
PREFEASIBILITY STUDY ON THE ADOPTION OF CLEAN BIOMASS COOKSTOVES IN GHANA

OUTLINE

- Introduction
- Objective of the assignment
- Criteria for shortlisting projects/ site selection
- Methodology
- Shortlisted projects and their characteristics
- Financials – investment, operation and revenue
- Cost Benefit Analysis (Payback period)

INTRODUCTION

- Ghana continues to depend heavily on wood for heating applications
- Technologies (cookstoves) utilized are mostly inefficient
- Approx. 20 million tonnes of wood consumed annually



GLSS 6, 2014

OBJECTIVES OF ASSIGNMENT

- Develop criteria and standards for the transfer of efficient cookstove technologies from China to Ghana
- Compile a list of readily available cookstove technologies in China suitable for technology transfer
- Review a list of existing cookstove in Ghana
- Identify the major fuels and stoves used by the schools,
- Determine the amount of money spent on fuel per capita,
- Estimate the economic benefits of adopting the efficient stoves.

SCOPE OF ASSIGNMENT

The study focused on senior high schools with boarding facilities in Upper East, Upper West, and Northern region.

CRITERIA FOR TECHNOLOGY ADOPTION

Technical Factors	Economic Factors	Socio-cultural Factors
• Fuel adaptability • Emissions • Durability • Ease of construction • Efficiency • Safety • Availability of construction materials • Ease of maintenance	• Price • High rate of return • Jobs	• Ability to cook different meals • Aesthetics • Consumer preference

- Standardized Technology Evaluation Process (STEP) was used in ranking the factors in order of importance

CRITERIA FOR SITE SELECTION

i. Per capita expenditure on fuel (biomass)
ii. Willingness to adopt the new stoves and provide feedback
iii. Availability of kitchen space

Approach

i. Utilization of well-structured questionnaire to collect data from the school authorities (Bursars and Matrons)
ii. Field visits and Personal interaction with officers of institutions during collection of data
iii. 28 schools were surveyed in 3 regions

TYPES OF FUEL AND STOVES USED IN SCHOOLS

- Firewood is the predominant fuel used by most schools
- Firewood stoves come in different forms (see pictures in next slides)
- Stoves are made from different materials including mud, bricks, concrete, metal, and stone.
- Kitchens use several of the stoves simultaneously to prepare meals
- The size of cooking pots ranges from '10' to '60'
- Some schools have LPG but it is not readily available

TYPES OF STOVES

Traditional Cookstove
Made of stone

Traditional Cookstove
Made of clay

TYPES OF STOVES

Made from concrete (Portland cement and Sand)

TYPES OF STOVES

TYPES OF STOVES

TRADITIONAL WOOD COOKSTOVES | Made from metal (tyre rim)

CHARACTERISTICS OF SHORTLISTED SCHOOLS

PROFILE OF SELECTED SCHOOLS

No	Name of School	District	Feeding Population	Type of fuel/stove	Fuel cost, GHS	Cost of new stove, GHS	Size of Pot, L
16	Zamse SHTS	Bolgatanga, UE	1220	Firewood	3000	150	30, 40, 50, 60
17	Bolga SHS	Bolgatanga, UE	2821	Firewood	10,800		30, 40, 50, 60
				LPG	1,410		
21	Bunkpurugu SHS	Bunkpurugu Yunyoo , NR	1120	Firewood	3200		30, 45, 50
22	Gambaga Girls SHS	Mamprusi East, NR	1025	Firewood	2600		10, 30, 50, 60
23	Nakpanduri SHS	Bunkpurugu Yunyoo, NR	937	Firewood	2000		15, 30, 50, 60
26	Wulugu SHS	Mamprusi West, NR	1102	Firewood	1140		10, 15, 30, 50, 60

PER CAPITA EXPENDITURE ON FUEL FOR SELECTED SCHOOLS

No	Name of School	District	Feeding Population	Amount spent on fuel per month, GHS	Expenditure per capita
1	Tamale School of hygiene	Synarigu, NR	260	600	2.31
2	Bunkpurugu SHS	Bunkpurugu Yunyoo , NR	1120	3200	2.86
3	Gambaga Girls SHS	Mamprusi East, NR	1025	2600	2.54
		Upper West Region			
4	St John Technical Sch	Nandom, UW	500	1650	**3.30**
5	Nandom SHS	Nandom, UW	635	2,000	3.15
6	NJ Ahmadiya College of Edu	Wa, UW	900	2200	2.44
7	Zamse SHTS	Bolgatanga, UE	1220	3000	2.46
8	Bolga SHS	Bolgatanga, UE	2821	10,800	**3.83**

SCHOOLS SELECTED FOR DEMONSTRATION

- Based on the per capita expenditure and other factors, three schools selected in each region as potential demonstration sites as follows:

  - Bunkpurugu SHS
  - St. Johns SHTS
  - Bolga SHS

Characteristics of Bunkpurugu

Parameter	Details	
Name of Institution	Bunkpurugu SHS	
Location: region, district, town	Northern Region, Bunkpurugu Yunyoo Distrct	
Number of students	Boarding students	Day students
	1120	96
Average number of people fed daily	Staff	Students
	None	1120
Quantity of firewood used per term	12 trips of small car	
Amount spent on firewood per month	GHS 3200	
Sizes of pots used	30, 45, 50 and 60	
Type of Stove	Three stone	
Life span	Long time (> 10 years)	
Cost of Stove	Free	

Characteristics of St Johns SHS

Parameter	Details	
Name of Institution	St. John's Technical and Vocational Institute	
Location: region, district, town	Nandom District, Upper West	
Number of students	Boarding students	Day students
	500	
Average number of people fed daily	Staff	Students
	85	310
Amount spent on firewood per month	GHS 1650	
Sizes of pots used	30, 45, 50 and 60	
Type of Stove	Concrete type	
Life span	Long time (> 10 years)	
Cost of Stove	Free	

Characteristics of Bolga SHS

Parameter	Details	
Name of Institution	Bolga SHS	
Location: region, district, town	Telensi, Upper East	
Number of students	Boarding students	Day students
	2821	
Average number of people fed daily	Staff	Students
	64	2821
Amount spent on firewood per month	GHS 10,800	
Sizes of pots used	30, 45, 50 and 60	
Type of Stove	Mud stoves, three-stone	
Life span	Long time (> 10 years)	
Cost of Stove	Free	

COST BENEFIT ANALYSIS

The aim of the cost benefit analysis it to answer the following questions:

1. *Is there a viable business case for the schools to switch to clean and efficient cookstoves?*
2. *What financial model/mechanism is needed to make adoption of clean cookstoves an interesting alternative for the schools?*

Limitations of methodology

- Use of clean and efficient cookstoves provide both financial, environmental and health benefits. The analysis performed in this work does not consider the environmental and health benefits, this also has some economic implications.

PROPOSED FINANCING MODELS

- Two financing models proposed for consideration in replacing existing stoves in schools with high per capita expenditure on fuel.

Model 1

Requires the schools to directly finance the purchase of the stoves without going for loan or at no interest

Model 2

Proposes a hire purchase agreement where the school will pay for the stoves from fuel savings over one year period at a commercial interest rate

DATA USED FOR PAYBACK CALCULATION

Parameter	Value	Value used
Cost of an institutional stove	$ 1000 -$1200	$ 1200
Capacity of stove	100 L	
Estimated feeding population per stove	300	250
Thermal efficiency of stove	44 % - 50 %	
Fuel saving compared with 3 stone stoves	80 % – 90 %	60 %
Life span	7 – 10 years	5 years
Interest rate	30 %	30 %
Exchange rate (USD/GHS)	4	4
Maintenance	2 % of TCI	
Cost of traditional three-stone stove	GHS 0 per stove	GHS 0
Cost of tyre rim stove	GHS 150 – GHS 250	GHS 150

RESULTS OF PAYBACK PERIOD

Bunkpurugu SHS	
	Payback time (Years)
Model 1 (No interest)	1.2
Model 2 (30% interest p.a)	2.1
St John Senior Technical	
	Payback time (Years)
Model 1	0.9
Model 2	1.6
Bolga SHS	
	Payback time (years)
Model 1	0.7
Model 2	1.2

SAMPLE CASH FLOW CALCULATION

Interest Rate	0%										
Discount rate	10%										
Cost		**Year**									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Initial investment	21504	0	0	0	0	0	0	0	0	0	0
Maintenance (Repainting, 2% of TIC)	0	430.08	430.08	430.08	430.08	430.08	430.08	430.08	430.08	430.08	430.08
Total cost	**21504**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**
Discount factor (Discount rate = 10%)	1	0.90909	0.82645	0.751315	0.683013	0.62092	0.564474	0.51316	0.46651	0.424098	0.385543
Net Present Cost	21504	390.982	355.438	323.1255	293.7504	267.046	242.7689	220.699	200.635	182.3959	165.8145
Cummulative	21504	21895	22250.4	22573.55	22867.3	23134.3	23377.11	23597.8	23798.4	23980.84	24146.66
Benefits											
Fuel savings		19200	19200	19200	19200	19200	19200	19200	19200	19200	19200
Total Benefits	**0**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**
Discount factor	1	0.90909	0.82645	0.751315	0.683013	0.62092	0.564474	0.51316	0.46651	0.424098	0.385543
Net present benefits		17454.5	15867.8	14425.24	13113.86	11921.7	10837.9	9852.64	8956.94	8142.674	7402.431
Cummulative PV benefit		17454.5	33322.3	47747.56	60861.42	72783.1	83621.01	93473.6	102431	110573.3	117975.7
Cum Benefit - Cum Cost	-21504	-4440.4	11071.9	25174.01	37994.12	49648.8	60243.89	69875.8	78632.1	86592.42	93829.05

Interest Rate	30%										
Cost		**Year**									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
System cost	21504	0	0	0	0	0	0	0	0	0	0
Maintenance	0	430.08	430.08	430.08	430.08	430.08	430.08	430.08	430.08	430.08	430.08
Total cost	**21504**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**	**430.08**
Discount factor (Discount rate = 30%)	1	0.76923	0.59172	0.455166	0.350128	0.26933	0.207176	0.15937	0.12259	0.0943	0.072538
Net Present Cost	21504	330.831	254.485	195.7579	150.583	115.833	89.10234	68.5403	52.7233	40.55637	31.19721
Cummulative	21504	21834.8	22089.3	22285.07	22435.66	22551.5	22640.59	22709.1	22761.9	22802.41	22833.61
Benefits											
Fuel savings		19200	19200	19200	19200	19200	19200	19200	19200	19200	19200
Total Benefits	**0**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**	**19200**
Discount factor	1	0.76923	0.59172	0.455166	0.350128	0.26933	0.207176	0.15937	0.12259	0.0943	0.072538
Net present benefits		14769.2	11360.9	8739.19	6722.454	5171.12	3977.783	3059.83	2353.72	1810.552	1392.732
Cummulative PV benefit		14769.2	26130.2	34869.37	41591.82	46762.9	50740.72	53800.6	56154.3	57964.83	59357.56
Cum Benefit - Cum Cost	-21504	-7065.6	4040.86	12584.29	19156.16	24211.4	28100.13	31091.4	33392.4	35162.41	36523.95

Part 11

ADOPTION OF MOVABLE KILNS FOR CHARCOAL PRODUCTION

INTRODUCTION

- Charcoal production plays an important role in Ghana's socio-economic development
- This activity contributes extensively to household income for the producers
- Charcoal production for the local market is largely informal and unregulated
- Those intended for export are supposed to be licensed and regulated by EC

INTRODUCTION

- Charcoal production is dominated by traditional earth mound technology (5-25%)

(Traditional earth mound – raised)

Other technologies in Ghana

Movable metal Kiln

Brick Kiln

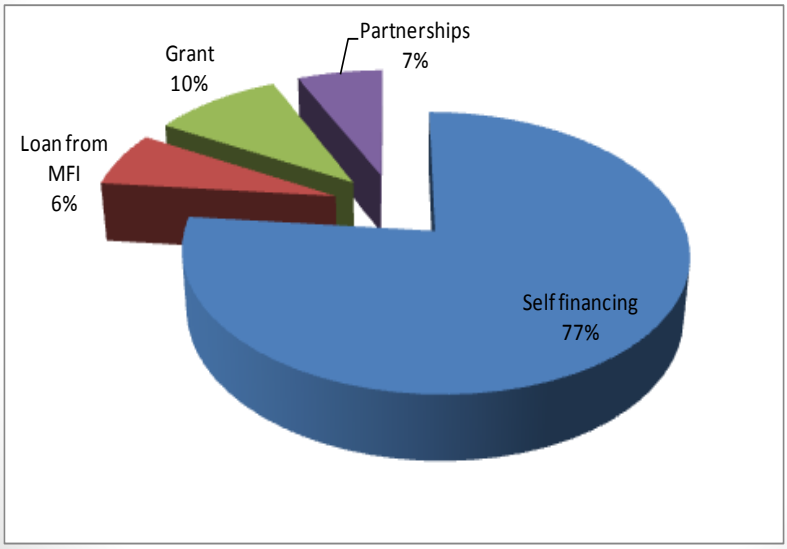
Field Work

Four districts were visited in the Brong Ahafo Region

- Atebubu
- Kintampo
- Pru West
- Wenchi

158 producers were interviewed

How business is financed

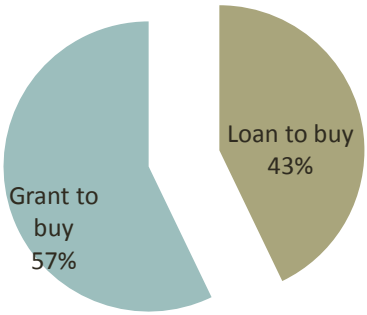


Characteristics of selected site

- All production sites visited have similar characteristics
- However, we are recommending a production site in Atebubu called Fakwasi
- The producers here have an association of charcoal producers

Business model

- We are proposing a combination of a grant/loan scheme for acquiring the kilns



Conclusions (Cookstoves)

- There is a strong economic case for schools using firewood to switch to efficient and well engineered firewood stoves
- Initial results show schools with per capita expenditure of more than 2 cedis could payback initial investment with 2 years
- Specifically, Bolga SHS with per capita expenditure of 3.8 cedis would make over 187,000 cedis in fuel saving in five years
- It is recommended that technology transfer from china should include research and technology review of the Chinese stoves.

Thank you for your attention

Questions/comments/suggestions