The Improved Cookstove Sector in East Africa: Experience from the Developing Energy Enterprise Programme (DEEP)

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Acronyms and Abbreviations

ADP	Accenture Development Partnership
AIDS	Acquired Immunodeficiency Syndrome
ALRI	Acute Lower Respiratory Infections
CAMARTEC	Centre for Agricultural Mechanization and Rural Technology
CCT	Controlled Cooking Test
CIRCODU	Centre for Integrated Research and Community Development Uganda
cm	Centimetres
CO	Carbon Monoxide
COSTECH	Tanzanian Commission for Science and Technology
CREEC	Centre for Research in Energy and Energy Conservation
CRSPK	Coastal Rural Support Project Kenya
DEEP	Developing Energy Enterprise Project
DfID	Department for International Development (UK)
DGIS	Netherlands Directorate-General for International Cooperation
EAETDN	East African Energy Technology Development Network
EU	European Union
EUEI PDF	European Union Energy Initiative Partnership Dialogue Facility
FAO	Food and Agriculture Organization (of the United Nations)
g	Grams
GACC	Global Alliance for Clean Cookstoves
GDP	Gross Domestic Product
GIZ	Gesellschaftfür Internationale Zusammenarbeit
GVEP	Global Village Energy Partnership
HIV	Human Immunodeficiency Virus
IAP	Indoor Air Pollution
ICS	Improved Cookstoves
IDB	Inter-American Development Bank
ILF	International Lifeline Fund
ITDG	Intermediate Technology Development Group
IWA	International Workshop Agreement
KCJ	Kenyan Ceramic Jiko
KEBS	Kenya Bureau of Standard
KENGO	Kenya Energy and Environment Organization
KES	Kenyan Shillings
KIRDI	Kenya Industrial Research Development Institute
KPT	Kitchen Performance Test

KWFT	Kenyan Women Finance Trust
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goals
MEM	Ministry of Energy and Minerals
MOE	Ministry of Energy
MSME	Micro, Small & Medium Enterprises
NEMA	National Environment Management Authority
NGO	Non-governmental Organisation
PCIA	Partnership for Clean Indoor Air
PM	Particulate Matter
POA	Program of Activities
PREEP	Promotion of Renewable Energy and Energy Efficiency Program
ProBEC	Programme for Basic Energy and Conservation
REA	Rural Energy Agency
SACCO	Savings and Credit Cooperatives
SE4ALL	Sustainable Energy for All
SIDO	Small Industries Development Organisation
SME's	Small, Medium Enterprises
SNV	Netherlands Development Organization
TaTEDO	Tanzania Traditional Energy Development and Environment Organisation
TB	Tuberculosis
TBS	Tanzania Bureau of Standards
TZS	Tanzanian Shillings
UBS	Uganda Bureau of Standards
UCB-PATS	University of California Berkeley Particle and Temperature Sensor
UGX	Ugandan Shillings
UK	United Kingdom
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UON	University of Nairobi
USAID	United States Agency for International Development
USD	US Dollars
VER	Verified Emissions Reductions
WBT	Water Boiling Test
WHO	World Health Organization

Executive Summary

This report aims to analyse and document GVEP International's experience working with improved cookstove businesses in East Africa through its Developing Energy Enterprise Programme (DEEP). In addition it examines results from stove testing done on cookstoves produced under the DEEP program. Based on this experience the report finally goes on to present a strategy for GVEP International to take its cookstove work forward in the future.

The task of cooking is an essential part of life for people around the globe, yet in East Africa it is a task that can consume many hours of the day and have far reaching consequences on health and the environment as well as social and economic impacts.

Activity in the cookstove sector in Kenya, Uganda and Tanzania has been on-going for several decades with support from stakeholders in a number of sectors including government, donors, non-governmental organizations (NGOs), the private sector and academia. This has resulted in a range of stoves being available in the market, many locally manufactured. However the quality of the stoves in the market and awareness of quality amongst the end user is often low and varies across the region. Chapter 2 & 3 of this report describe the context of improved cookstoves in East Africa and provide an overview of the cookstove markets in each of the three countries.

The Developing Energy Enterprises Programme East Africa (DEEP) is a five year initiative established in 2008 to provide the crucial support necessary to enable the development of a sustainable and widespread industry of micro and small energy enterprises in Kenya, Uganda and Tanzania. As of June 2012, the programme works with 975 energy entrepreneurs with 492 involved in the cookstove sector. Chapter 4 of this report provides information on cookstove businesses within DEEP and describes the support that DEEP has provided to these businesses, covering topics including financial management, creating market linkages and improving access to finance. It details some of the main challenges these businesses face such as lack of appropriate marketing skills, access to capital and maintaining quality within their products and goes on to list key lessons learnt from the programme.

To assess the performance of stoves being produced under DEEP, 12 stoves were tested at facilities in Kenya and Uganda. Chapter 5 presents results of the stove testing and shows that the performance of the stoves varies across the program.

Whilst all of the stoves reduced fuel consumption compared to traditional methods some charcoal stoves increased exposure to CO and variation in the results highlighted the difficulties in comparing measurements across different stoves and testing centres. The results suggest that there is considerable scope to improve the performance of local artisan stoves without significantly increasing their price.

Based on GVEP International's experience Chapter 6 presents ways in which GVEP can continue to intervene in the cookstove value chain and develop the support it offers to cookstove businesses moving forward. This includes concentrating on a smaller number of high potential businesses and supporting them to scale up their businesses by creating a package of support for cookstove entrepreneurs. This package would include improving on product design and quality, business planning for scale up, appropriate access to finance, expanding market reach and empowering the consumer.

Chapter 1: Introduction

Cooking is a common task completed by households around the world on a daily basis. Within East Africa much of this cooking takes place with biomass, on open fires and rudimentary stoves. Concern around biomass use, its effect on the local environment and its health, economic and social impacts has been on the international agenda intermittently for many years. As a result donor led programs have promoted improved cookstove technologies in East Africa over the past 30 years, which in some cases have taken on a semi-commercial basis.

In 2008 GVEP International began implementing the Developing Energy Enterprise Programme East Africa (DEEP) which aims to develop a network of micro and small energy entrepreneurs to increase access to energy in underserved areas of East Africa. The programme works with a range of energy technologies including improved cookstoves, solar and briquettes. However, through the types of businesses mobilised and existing activities it has built on, a large proportion of the businesses it works with are within the improved cookstove sector. This report aims to introduce some of the context around the improved cookstove sector in East Africa and experience from the Developing Energy Enterprise Programme working with cookstove entrepreneurs. It also sets out how GVEP International intends to build on this experience and take its stove work forward in the future.

1.1. GVEP International

GVEP International is an international non-profit organisation seeking to reduce poverty through accelerated access to modern energy services. Using business led solutions the dedicated team of energy and finance professionals operates through regional hubs in Africa and The Caribbean, and supported by a small UK head office. The approach taken supports and nurtures micro, small and medium enterprises in the energy economy, helps connect them with funders and investors, in addition to working with public sector bodies to try to create an environment which is supportive of energy SMEs. Through the website, a wide network of businesses, investors, government agencies, NGOs, donors and researchers are connected. Some of our key work is in:

- **Supporting the development of energy enterprises:** GVEP works to increase the effectiveness of established product and service providers and supports micro and small enterprises to expand or diversify their businesses.

- **Access to finance:** Start-up, small energy businesses and consumers often find it difficult to secure essential financing for the businesses or for the products. GVEP helps the process by linking entrepreneurs to various financing institutions through a loan guarantee programme, and through investments. Additionally, some initiatives are on-going on stimulating consumer product demand through end use consumer financing initiatives, often liaising with suppliers of qualified products.

- **Energy contests:** GVEP has teamed with partners such as the Inter-American Development Bank (IDB), GIZ and the Bid Network to run competitions for business energy ideas aimed at delivering access to clean energy to people. In 2011, a business competition has been launched in the Caribbean supported by DfID.

- **Consultancy:** GVEP undertakes consultancy assignments in the areas of business coaching, technical advice, finance, monitoring and evaluation, programme design and policy development.

- **Policy Work:** GVEP works with governments and donors of specific countries to influence their policy in ways which support the involvement of MSMEs in meeting the energy demand in rural and peri-urban communities. We are primarily concerned with forms of cleaner energy in off-grid areas of developing countries.

GVEP's experience has shown that income-generating businesses deliver longer lasting benefits than direct donations, so supporting energy businesses should achieve more energy access per $ of aid.

1.2. The Developing Energy Enterprise Project East Africa

The Developing Energy Enterprises Project East Africa (DEEP) is a five year initiative established in 2008 to provide the crucial support necessary to enable the development of a sustainable and widespread industry of micro and small energy enterprises in Kenya, Uganda and Tanzania. The implementers of DEEP East Africa recognise the constraints and challenges faced by the energy entrepreneurs, especially the lack of business and technical capacity and inadequate access to finance.

DEEP supports the development of energy enterprises formed by, and for, rural and peri-urban entrepreneurs by assisting them with the identification of viable energy market opportunities, technology options, and service structures to generate revenue and sustain business. DEEP will also assist entrepreneurs through training and mentoring to develop business plans and access the necessary financing, thereby enabling businesses to survive and grow sustainably.

GVEP International is the lead co-ordinator of the DEEP programme working in close collaboration with IT Power East Africa as its technology partner. During the first three years of the project mobilisation support was provided by Coastal Rural Support Project Kenya (CRSPK), Practical Action East Africa and East African Energy Technology Development Network (EAETDN). More information about the Developing Energy Enterprise programme can be found in Chapter 3 of this report.

1.3. Background to the Report

The Developing Energy Enterprise Programme has been running for four years, through which GVEP International has gained considerable experience working with micro and small enterprises in the improved cookstove sector. As part of on-going efforts to communicate the work of the programme and understand the sectors it is operating in, GVEP International commenced a study into the improved cookstove sector in East Africa, looking at the sector as a whole and the experience from its DEEP programme.

Based on initial research into the cookstove markets in East Africa for this study, GVEP International was commissioned by The Global Alliance for Clean Cookstoves (GACC) to undertake in-depth mapping of the sector in Kenya, Uganda and Tanzania. The Global Alliance for Clean Cookstoves (www.cleancookstoves.org), is an innovative public-private initiative working to save lives, improve livelihoods, empower women, and combat climate change by creating a thriving global market for clean and efficient household cooking solutions.

The sector mapping was completed using a toolkit developed by Accenture Development Partnership (ADP), the not-for-profit arm of the global management firm Accenture, which covered five thematic areas;

1. Macro Environment
2. Health and Social Impact
3. Consumer Assessments
4. Cookstove Industry
5. Carbon Financing

The assessment process involved reviewing existing reports and research, interviewing a range of key stakeholders in the sector and conducting site visits with cookstove manufacturers. These assessments will feed in to the on-going work of The Alliance in the region and were presented to stakeholder at The Alliance's regional workshop held in Nairobi in April 2012. The full assessments can be found at http://www.gvepinternational.org/en/business/studies-and-reports whilst a summary of some of the key finding is summarized in Chapter 2.

Following on from these assessments this report concentrates on GVEP International's experience from the Developing Energy Enterprise Programme working with micro and small cookstove entrepreneurs and highlights how GVEP International plans to take its cookstove work forward in the future. It also presents findings from stove performance tests that were carried out on a selection of stoves manufactured under the DEEP program.

Chapter 2: The Context of Improved Cookstoves within East Africa

The task of cooking is an essential part of life for people around the globe, yet in East Africa it is a task that can consume many hours of the day and have far reaching consequences on health and the environment as well as social and economic impacts.

Within this chapter the scene is set in East Africa by looking at some of the wider issues that influence the improved cookstove (ICS) market such as the demographics of a country, reliance on biomass, rates of deforestation and the impact of rising fuel costs. Nearly 2 million people a year die prematurely from illness attributable to indoor air pollution caused by the use of solid fuel globally (1) (2004 data). This topic is a further overwhelming motivation in the drive to switch to cleaner cooking stoves and fuels and will also be introduced in this chapter.

2.1. Country Demographics

Kenya, Uganda and Tanzania make up three of the 5 countries comprising the East Africa Community. Tanzania is the largest of the East African countries both in size and population and like Kenya lies on the Indian Ocean, whereas Uganda the smallest of the three is a landlocked country. When the East African country borders were created during the colonial period they bought together a mix of ethnic groups, languages and religions, which has resulted in nation states comprising a diverse range of people each with their own customs, practices and traditions.

Table 1: Population demographics for Kenya, Uganda & Tanzania

Population Demographic	Kenya	Uganda	Tanzania
Total Population (2010)[1]	40,512,682	33,424,683	44,841,226
Population Growth Rate (CAGR)[1]	2.6%	3.2%	3%
Rural/Urban Split (%)[1]	78% / 22%	87% / 13%	74%/26%
Rural Population (2010) [1]	31,518,867	28,979,200	33,003,142
Rate of Urbanisation (annual change)[2]	4.2%	4.8%	4.7%
Average Household Size	5[3]	4.7[4]	4.8[5]
Literacy – Total (%)[1]	87%	73%	73%
Life Expectancy (years) [1]	56	54	57
% of population below international poverty line[6][7]	20%	29%	68%

[1] World Bank Indicators
[2] CIA, The World Factbook
[3] Kenya National Bureau of Statistics (KNBS)
[4] Uganda National Household Survey 2009/10, UNBS
[5] Tanzania Household Budget Survey 2007, NBS
[6] International poverty line set at $1.25 a day
[7] UNICEF Statistics

All of the East African countries are characterised by growing populations, putting increasing pressure on resources and facilities. The majority of the population lives in rural areas although urban areas are growing as more people migrate there in search of work and better services.

Table 2: Economic Indicators for Kenya, Uganda and Tanzania

Key Economic Indicators	Kenya	Uganda	Tanzania
GDP (2010)[8]	$32,198,151,217	$17,010,765,767	$22,915,004,425
GDP Per Capita (PPP) (2010)[8]	$795	$509	$524
GDP Growth (Annual) (2010) [8]	5.6%	5.2%	7%
Inflation Rate (2011 est.)[9]	11%	13.7%	11.1%
GDP composition (2011 est.) [9]	Agriculture: 22.2%, Industry: 16.4% and Services: 64.6%	Agriculture: 21.8%, Industry: 26.1% and Services: 52.1%	Agriculture: 27.8%, Industry: 24.2% and Services: 48%

Kenya has the biggest economy in East Africa although it has been hampered in the past by corruption and in recent years by high inflation and currency depreciation. Tanzania's economy is smaller but it has sustained high rates of growth in recent years and is expected to continue so. Like many East African countries Tanzania relies heavily on agriculture which employs about 80% of the work force. Uganda has also maintained a relatively strong growth rate but experienced high inflation in 2011 which led to protests over increasing consumer prices. Perceived levels of corruption as reported by Transparency International are rising in Uganda.

Gender

Countries in East Africa follow a traditional patriarchal society especially within rural communities. Discrimination and violence against women can be common although many governments have enacted new laws to try and improve the gender disparities and within the government Ministries are dedicated to mainstreaming gender issues throughout sector policy.

The majority of women in East Africa work in agriculture. They are also heavily involved in the informal sector and make up 40-50% of the micro enterprise sector in each country. Men predominate in the formal sector and make up the large proportion of formal employees. They are also more likely to migrate to urban areas in search of work whilst the women look after the rural home.

[8] World Bank Indicators
[9] CIA World Factbook

Within the home women are responsible for domestic tasks, providing water and firewood and caring for the elderly and sick. Their working day can often be double that of a man. Customary laws often discriminate against women especially on issues of property inheritance and land. In Kenya women hold around 1% of registered land titles outright limiting their economic progress (2).

Table 3: Gender Indicators for Kenya, Uganda and Tanzania

Gender Indicators	Kenya		Uganda		Tanzania	
	Male	Female	Male	Female	Male	Female
Primary school attendance[10]	72%	75%	83%	82%	79%	82%
Youth Literacy (15-24 yrs)[10]	92%	94%	90%	85%	78%	76%
Labour participation rate (2010)[11]	72%	61%	80%	76%	90%	88%
Seats held in national government (2011)[11]	90%	10%	65%	35%	64%	36%

2.2. Fuel Use in East Africa

Studies suggest that in the developing world nearly 3 billion people rely on traditional cooking methods such as an open fire or basic cook stoves to prepare their meals, using solid fuels such as wood, charcoal, crop residues and animal dung (3). A study by the United Nations Development Programme (UNDP) and the World Health Organization (WHO) in 2009, looking at the energy access situation in developing countries, reported that 600 million of these people live in sub-Saharan Africa where access to modern fuels is as low as 17% and 69% of the population rely on wood as their primary cooking fuel (4).

Table 4 shows that within East Africa itself access to modern fuels[12] is highest in Kenya at 17% with around 13% of the population relying on kerosene, 4% on gas and less than 1% on electricity to meet their cooking needs. Access to modern fuels is lower in neighbouring countries - 3% in Tanzania and estimated at less than 1% in Uganda.

[10] UNICEF Statistics
[11] World Bank Indicators
[12] Modern fuels refer to Electricity, Gas and Kerosene

Table 4: The percentage of the population in sub-Saharan Africa that use different types of cooking fuel (4)

Primary Cooking Fuel Used	Percentage of total population in each region			
	sub-Saharan Africa	Kenya	Uganda	Tanzania
Electricity	6	0.6	0	0.3
Gas	4	3.5	0.1	0.2
Kerosene	7	13.2	0.3	2.3
Charcoal	11	13.3	13	19
Wood	69	68.7	85.8	77.6
Dung	1	0	0	0
Coal	1	0	0	0
Other	1	0.7	0.8	0.5
Year of data		2005 - 2006	2007-2008	2006

The majority of people in East Africa rely heavily on wood as their primary cooking fuel with charcoal following as the second most common fuel. However, significant differences exist between fuel use in urban and rural settings. Although access to modern fuel is 17.3% for the total population of Kenya, 58.4% of the urban population has access to modern fuels compared to 3.6% of those living in rural area, highlighting the uneven spread of modern energy resources within these countries.

Reflecting the relatively high percentage of the urban population with access to modern fuels, kerosene is the most commonly used cooking fuel in urban areas in Kenya followed by charcoal as shown in Table 4. In rural populations the main cooking fuel by far is wood fuel. Kerosene use in Uganda and Tanzania is much lower where the most common urban cooking fuel is charcoal and wood fuel is substantially relied upon for cooking in rural areas (Figure 2 and Figure 3). Low access to modern fuels in Uganda results in the rural population demonstrating the highest use of wood fuel for cooking and the urban population the highest use of charcoal within the three countries.

Although $9 billion was invested in 2009 to provide access to energy globally, the International Energy Agency estimates that, with population growth, this current level of investment will mean that 2.7 billion people will still remain without access to clean cooking facilities in 2030 (5).

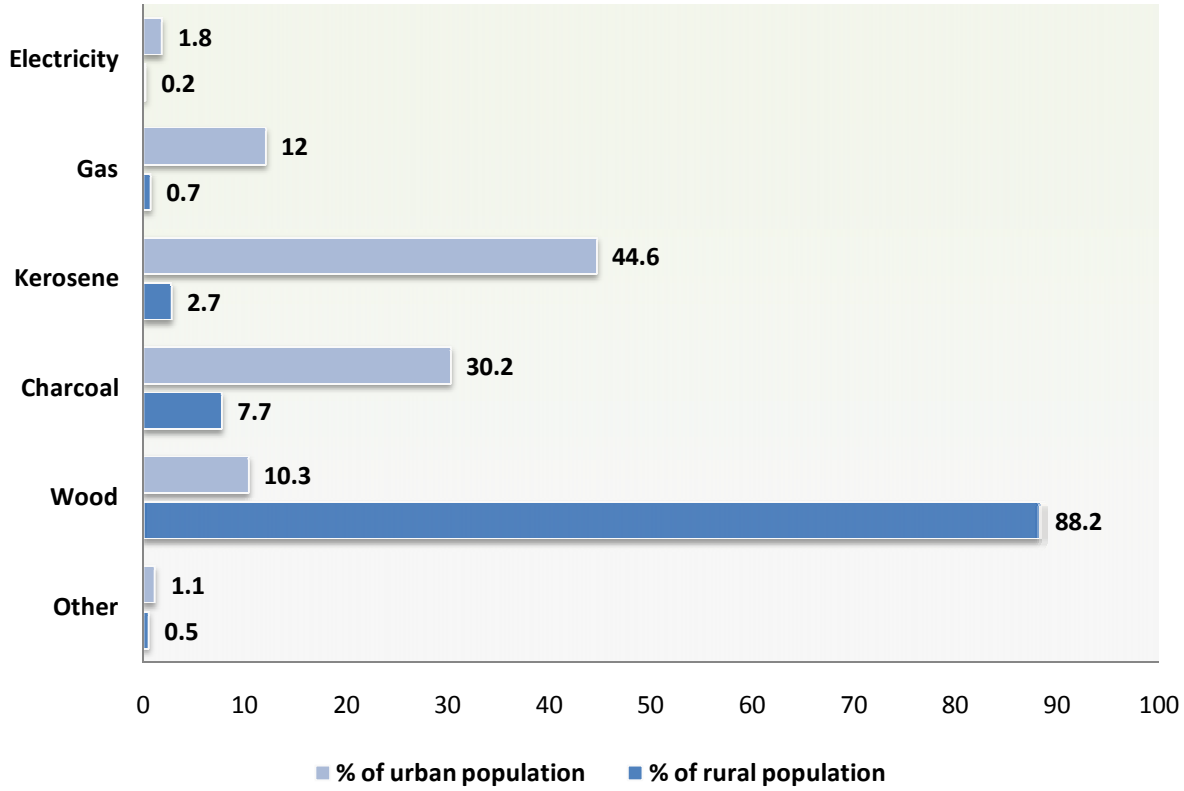


Figure 1: Primary fuels used for cooking in Kenya (for total, rural & urban population) (4)

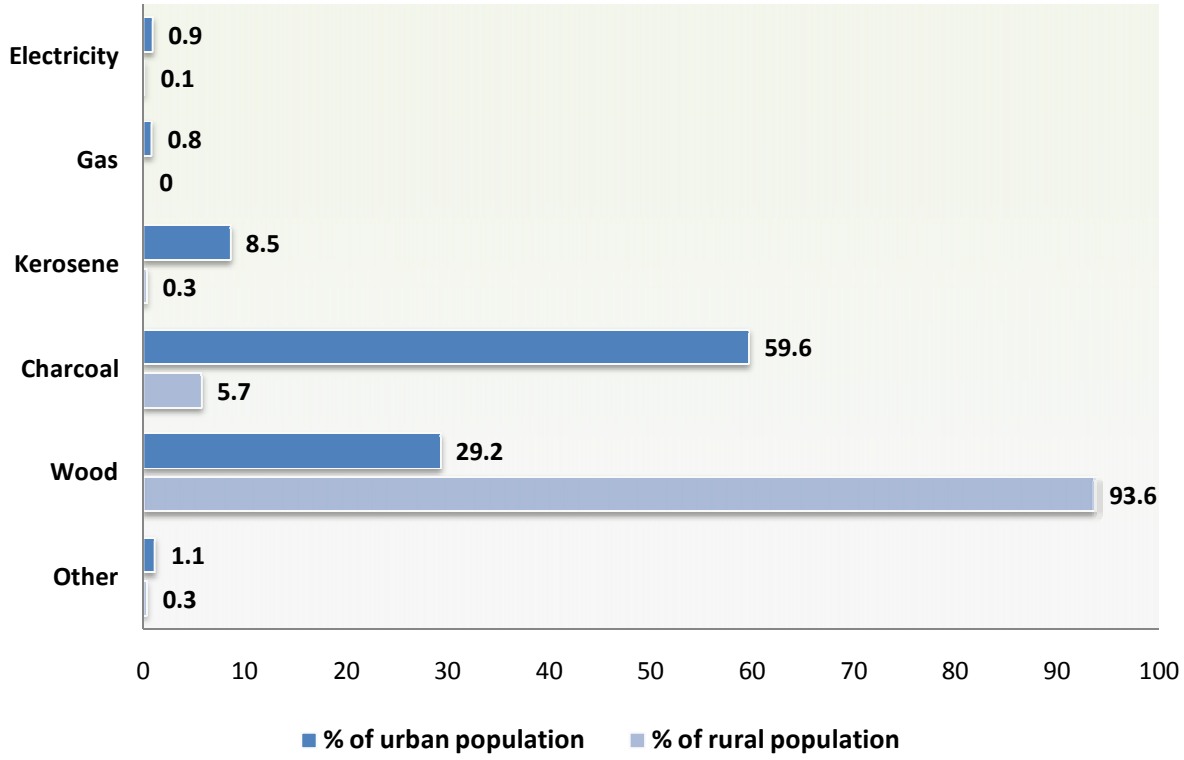


Figure 2: Primary fuels used for cooking in Uganda (for total, rural & urban population) (4)

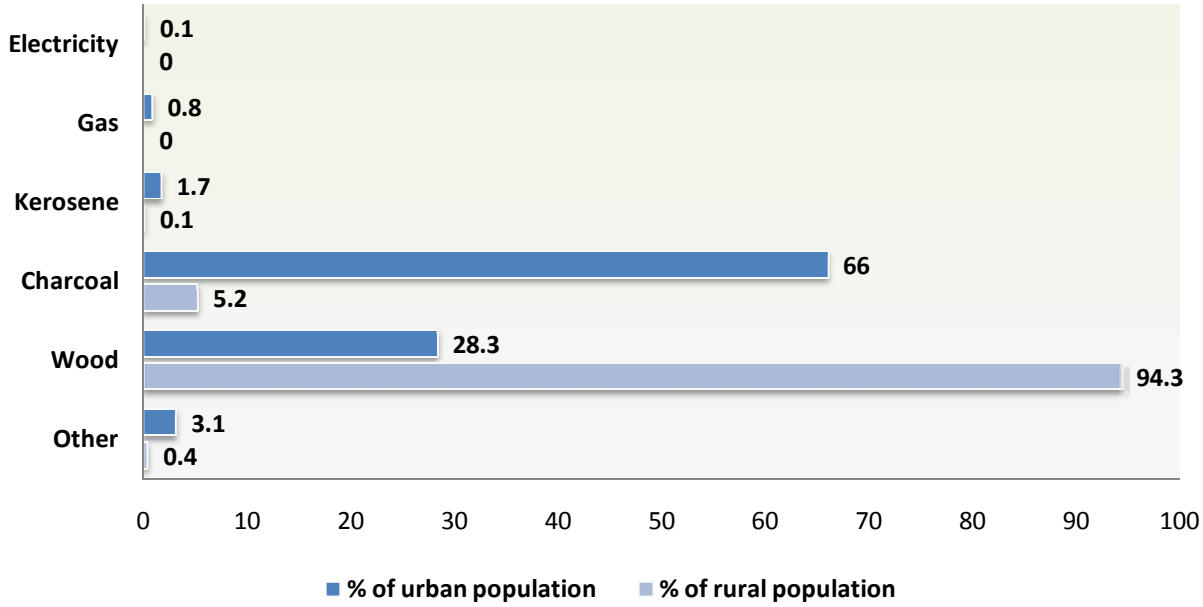


Figure 3: Primary fuels used for cooking in Tanzania (for total, rural & urban population) (4)

2.3. Rising Fuel Prices

Fuel prices have increased steadily throughout East Africa over the last decade and the past year alone has seen significant hikes in the price of fuel and other commodities increasing the cost of living for many people who were already struggling to afford the basic essentials of life. Between August and September 2011 charcoal prices shot up in several parts of Uganda from 28,000 UGX ($10) per bag to 70,000 UGX ($25) in the space of two weeks. Although these prices have since come down many predict further price hikes in the future (6). In Tanzania the price of charcoal steadily increased between 2004 to 2007 with retail prices in Dar-es-Salaam increasing from below 5,000 TZS ($3.14) a bag in 2003 to over 20,000 TZS ($12.50) in 2007, by late 2008 this price had reached 25,000 TZS ($15.62) (7) and is currently estimated to cost around 40,000 TZS ($25).

Figure 4: A charcoal vendor in an urban slum, Nairobi, Kenya

Charcoal prices can be seasonal with sudden increase often blamed on the onset of rainy seasons when transportation of charcoal from sites of production is difficult due to the poor state of roads in these areas. As forest reserves around towns are exhausted, sources of wood for charcoal must be sourced from further away, again increasing the transportation costs and price for the consumer. The increase in global oil and food prices has also driven up the price of charcoal as the cost of living has increased in general.

These hikes in global prices have led to high rates of inflation; inflation was estimated to be at 14% in Uganda in April 2011. On a domestic scale the rising fuel costs mean that households are forced to spend a higher proportion of their limited income on fuel meaning that other expenditures such as food, school fees and other household bills are often forfeited. The increase in fuel prices is forcing people to switch to cheaper alternatives. For example people have turned back to charcoal as the cost of paraffin increases and many of those already using charcoal have switched back to wood fuel as a cheaper alternative, putting further pressure on the supply and increasing rates of deforestation.

2.4. Trends in deforestation

With such a high dependence on fuel wood and charcoal for cooking in East Africa it is not surprising that the region has experienced continued loss of forested areas over the past two decades. East Africa had an estimated forest cover of 73,197,000 hectares in 2010. Between 1990-2000 forest area reduced by 0.92% in East Africa and during the period 2000-2010 this rate of reduction increased to 1.01% annually (8). As can be seen from Table 5 Tanzania has the most extensive forest cover out of the three countries while the percentage reduction in forest cover is greatest in Uganda. Deforestation has already seen Uganda lose nearly 1/3 of its forest in the last 20 years and the National Environment Management Authority (NEMA) warns that if deforestation continues at its present rate there will be no forest left in Uganda in 40 years time (9).

Table 5: Forest area and area change in East Africa (8)

Region	Extent of forest 2010 / % of land area	Annual change rate / %	
		1990 - 2000	2000 - 2010
Kenya	6	-0.3	-0.3
Uganda	15	-2.0	-2.6
Tanzania	38	-1.0	-1.1
Total East Africa	18	-0.9	-1.0

The majority of wood harvested from forested areas is used for fuel. Indeed, some 90% of all wood harvested in Kenya is thought to be for wood fuel, with over half of this being for subsistence and non-commercial use. Wood is also harvested to make wood related products, for building and industry and the FAO estimated that 90,000 people were employed in the forestry sector in East Africa in 2006. It is likely that many more people are employed informally through the wood harvested with reports estimating that 700,000 people are employed in the informal charcoal industry in Kenya which is estimated to be worth 32 billion KES a year (10).

Although a contributing factor, the harvesting of fuel wood it is not the sole cause of these levels of deforestation. East African countries are experiencing growing populations which is putting large demand on land which has been cleared for agriculture and settlements.

Poverty is a contributing factor with many people in rural areas left with no option but to over exploit the natural resources available in the area. Poor policy in the past has also led to lack of control over wood resources.

The effects of deforestation can be far reaching. As woodlands surrounding towns and villages are cleared and not replaced people must travel further to harvest wood for fuel and industry encroaching on previously untouched areas of woodland. Wood and charcoal must be transported further often increasing the price of these commodities. On a local scale those collecting wood (mainly women and children) are forced to search further and spend more time away from the household often in isolated and dangerous areas. Competition for available resources can often lead to heightened tensions between local communities as well as political issues, as was demonstrated by the eviction of settlements from the Mau Forest in Kenya in 2009 (11).

Deforestation can have serious effects on natural ecosystems. The forest acts as a sponge, soaking up rainfall brought by tropical storms while anchoring soils and releasing water in a controlled way. Loss of forest cover can lead to rapid run off into rivers heightening their level and leading to downstream flooding (12). In 2010 mudslides in the hilly Bududa district of Uganda killed about 300 people and displaced over 5,000 residents. It was established that human activity on the hills had depleted the tree cover and weakened the soils underneath, leading to the disaster following torrential rains in the area (13). Deforestation can also lead to reductions in rainfall and water supply which can contribute to subsequent droughts which have affected parts of East Africa over the last decade. There are also knock on effects in industry, reducing agricultural productivity and availability of resources for those that depend on products from the forest for their business.

Recently government policy has been introduced to try to curb the current trends in deforestation. Some of these initiatives include better regulation of the charcoal industry, which has largely been viewed as illegal in the past, to promote it as a viable business that can be operated in a sustainable manner. However production of sustainable charcoal on a commercial basis is a relatively new idea within East Africa and currently few suppliers exist. Most initiatives are donor supported such as efforts by the Swiss Agency for Development and Cooperation (SDC) in Tanzania and Woodlands 2000 Trust in Kenya. However challenges exist to produce eco-charcoal at a price that is competitive to bush charcoal due to additional labour costs, transport cost, taxation and bureaucracy in obtaining the necessary permits.

Funding is also being made available to invest in countries to prepare them for programs focused on reducing emissions from deforestation and forest degradation (REDD) which will pay countries to enhance or maintain their forest carbon stocks. The two main mechanisms for funding are through the World Bank's Forest Carbon Partnership Facility[13]and the United Nations REDD (UN-REDD) program[14].

[13] http://www.forestcarbonpartnership.org/fcp/
[14] http://www.un-redd.org/

Additionally, there are voluntary carbon markets and the Clean Development Mechanism / Afforestation and Reforestation mechanism(14). Since then REDD+ has been introduced to broaden strategies beyond deforestation and forest degradation, to include the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in reducing emissions.

Details of the REDD and REDD+ framework are still being finalised and a lot of work so far has been in preparing developing countries for national REDD strategies which involves establishing baselines, consulting stakeholder and defining policy and governance frameworks. Wildlife Work's Kasigau Corridor REDD project in Kenya is the first ever to be issued Voluntary Carbon Units (VCUs) for REDD under the Voluntary Carbon Standard (VCS). The project incorporates several elements centred on job creation including education, production of eco products and establishing wildlife rangers. It also includes an eco-charcoal project that produces charcoal briquettes from sustainably harvested wood[15].

2.5. Indoor Air Pollution

The use of biomass with basic cooking devices combined with unsuitable cooking space is the main cause of Indoor Air Pollution (IAP) in East Africa. Low grade biomass and agricultural residues used as cooking fuel can increase this exposure and the use of poor quality kerosene 'candles' that generate a lot of soot is widespread in rural areas. Traditional charcoal stoves burning poor quality charcoal can cause exposure to high levels of carbon monoxide (CO).

Women are the main cooks in East Africa and are the main group exposed to IAP. In addition women often keep small children close to them during the preparation of meals exposing them also to dangerous levels of smoke and emissions. This is combined with small kitchens often in makeshift huts that offer little ventilation to dispel these toxic fumes.

Table 6: Who is exposed to indoor air pollution? (14)

Group	Numbers Exposed			
	Kenya	Uganda	Tanzania	Total
Women and children exposed through using traditional open fires	9.9 million	7.8 million	10.6 million	28.3 million
Institutional cooks and kitchen helpers	100,000	57,000	265,000	422,000
Secondary students age 13-19 who study with the Kerosene "candle"	3.3 million	2.4 million	2.8 million	8.5million
Women and children exposed to carbon monoxide by using charcoal stoves	2.48 million	944,000	1.9 million	5.324 million
Number of deaths per year attributes to IAP[16]	14,300	19,700	18,900	52,900

[15] http://www.wildlifeworks.com/redd/
[16] World Health Organisation, Country Burden of Disease, 2009

Figure 5: Smoke emitted from burning biomass in Kenya (Photo source: Practical Action Consulting)

Health impacts of IAP include acute respiratory infections such as pneumonia, chronic obstructive pulmonary disease and lung cancer. Nearly half of deaths among children under five years old from acute lower respiratory infections (ALRI) are due to particulate matter inhaled from indoor air pollution from household solid fuels (WHO, 2009) (1). IAP also exacerbates the condition of HIV/AIDS patients as it accelerates immunity breakdown. In addition, harmful gases in wood smoke (e.g. sulphur dioxide and carbon monoxide) cause conditions such as mental impairment and cardiovascular disease. There is also evidence of links between indoor air pollution and low birth weight, TB, ischaemic heart disease, nasopharyngeal and laryngeal cancers (1). In the short term IAP can cause eye problems, severe headaches and coughs. The number of people exposed to Indoor Air Pollution is expected to grow in line with population growth in East Africa.

Although there have been some programs trying to reduce IAP in the past most cookstove programmes did not have IAP reduction as a primary objective but as a side benefit on top of energy efficiency or fuel replacement focuses. These programs have been donor led and have lacked commercial sustainability and resulted in minimal adoption on the ground. Recent evidence from health researchers suggests that the vast majority of biomass based 'improved stoves' do not reduce exposure to particulates to levels sufficient to have a significant impact on long term health risks(15).Some improved charcoal stoves can actually increase exposure to carbon monoxide. Stoves burning LPG and alcohol fuel are cleaner and adding fans to wood burning stoves can reduce emissions (17). However, biomass stoves which achieve significant fuel savings, very low emissions and which meet the needs of the customer are complicated to make and expensive. Many of the existing stove designs widely available in the market focus on fuel efficiency and do not provide a solution to the health challenges. Whilst stoves with chimneys can help to reduce smoke inside the home, taking the smoke outside does nothing for the impact on outdoor air pollution or climate change (18). Awareness of Indoor Air Pollution is very low both within government and with the consumer.

Chapter 3: Overview of the Cookstove Markets in Kenya, Uganda and Tanzania

As part of Market Assessments conducted on behalf of the Global Alliance for Clean Cookstove in 2012, an in-depth analysis of the cookstove sector in Kenya, Uganda and Tanzania was completed. The assessments concentrated on five thematic areas namely;

1. Macro Environment
2. Health and Social Impact
3. Consumer Assessment
4. Industry Assessment
5. Carbon Finance

This chapter presents an overview of the cookstove industry in each country and the main findings and trends from the assessment. The full assessment can be accessed on The Alliance website through the following link http://www.gvepinternational.org/en/business/studies-and-reports.

3.1. Market Overview

Activity in the cookstove sector in Kenya, Uganda and Tanzania has been on-going for several decades with support from stakeholders in a number of sectors including government, donors, non-governmental organizations (NGOs), the private sector and academia. This has resulted in a range of stoves being available in the market, many locally manufactured. However the quality of the stoves in the market and awareness of quality amongst the end user is often low and varies across the region.

Throughout the three countries biomass is the most common form of cooking fuel. Wood stoves are prevalent in rural areas where firewood is more accessible and can often be collected for free. Charcoal stoves are prevalent in urban areas where fuel is commonly purchased. In reality many households use multiple fuels to meet their cooking needs and hence own several stoves. The fuel used may depend on the time of day, season, food being cooked or money available to the household. For example a quick task such as heating tea in the morning may be done on a kerosene stove whilst a task such as boiling beans done using charcoal.

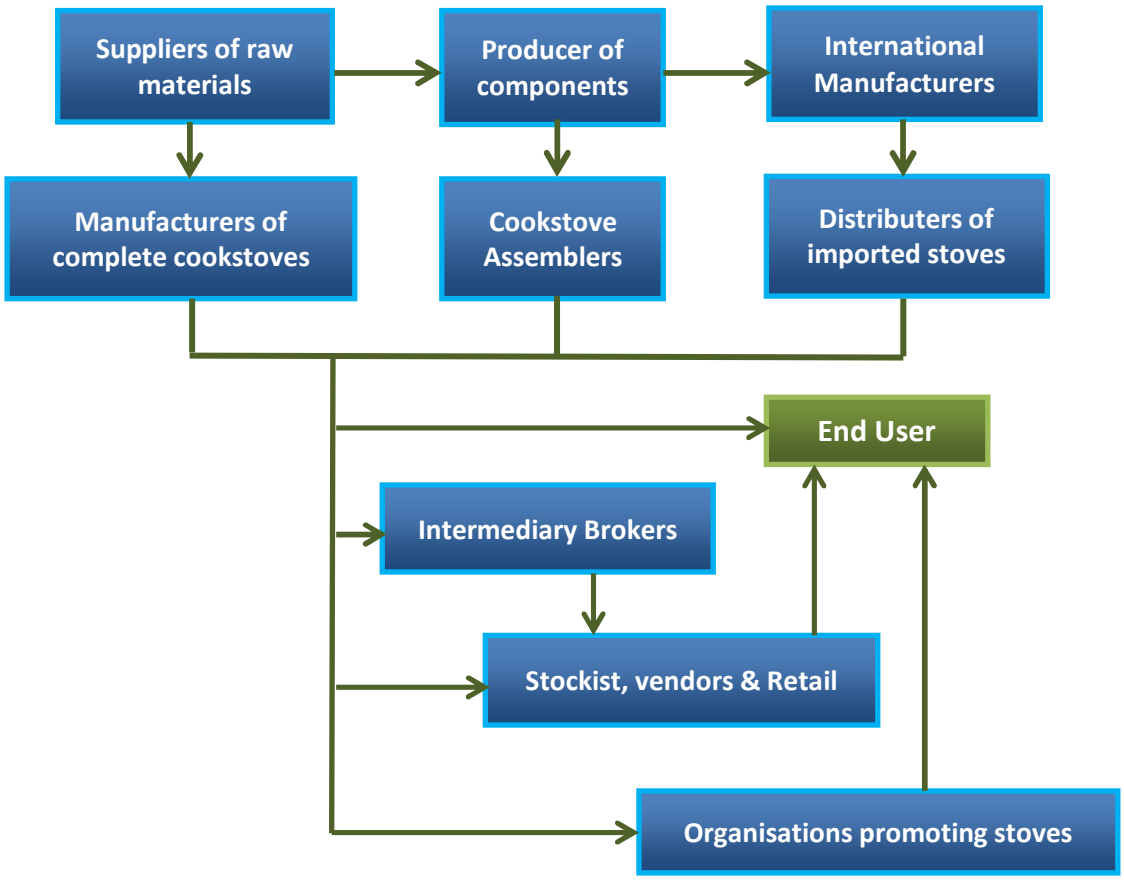
Each of the East African countries is promoting cooking with biogas under the National Biogas Program. Uptake of biogas still remains relatively low due to high upfront costs and its application to a specific, mainly rural, market. In Uganda and Tanzania only approximately 3000 of the target 12,000 digesters have so far been built. LPG is viewed as a fuel for middle and upper class urban dwellers and uptake remains low due to high upfront costs of the stove and gas cylinder and poor availability outside urban areas. Within each of the fuel supply chains many middlemen exist, each adding their mark up and increasing the price to the end user.

Alternative fuels, such as briquettes made from recycled biomass waste, have been promoted throughout the three countries. However few medium scale businesses have taken off – user perceptions, pricing and availability have made it difficult to compete with traditional fuel sources. Biomass pellets have also been trialled, for example by Partners for Development in Tanzania, but face similar challenges to adoption. The introduction of carbon finance has proven a stimulus to the market in recent years with most cookstove projects linked to carbon finance provide a subsidized, and in some cases free, stove to the end user.

The majority of cookstove production is done by micro, small and medium size businesses within the informal sector, although some players are starting to realize larger production levels and international manufacturers are entering the market. Many different business models exist with some producers making individual components and others assembling and making complete stoves. Retailers and middlemen also exist along the value chain before the stove reaches the end user. The diagram below gives a simplified value chain diagram for the options that may exist, from stove manufacturing to the end user purchase.

The following sections give more details for each specific country. Further information regarding stoves types, stakeholders and programs for each country can be found in Appendix A, B & C.

Simplified value chain options for cookstove dissemination



3.2. Kenya

Development of the Sector

Improved cookstoves have been promoted in Kenya since the 1980s following the UN conference on new and renewable sources of energy held in Nairobi (16). Stakeholders involved in the initial dissemination activities included The Ministry of Energy, GIZ (formerly GTZ), Practical Action (formerly Intermediate Technology Development Group), Bellerive Foundation, USAID and UNICEF. Some of the initial programmes promoting improved cookstoves included the Kenya Renewable Energy Programme and Women and Energy Project which aimed to develop, design and dissemination improved stoves through providing training and technical assistance to local artisans.

One of the first stoves developed was the Kenya Ceramic Jiko (KCJ) which was adapted from the Thai Bucket Stove (17). Over the years the design has improved and today it has become a widely used stove available in the Kenyan market. Wood burning stoves were also introduced through early stove dissemination activities including the Mandeleo stove and the Jiko Kisasa, both low cost fixed wood burning stoves that can be assembled in homes using locally available materials. Later on rocket stove technology was introduced through GIZ both in a portable and fixed variety offering a high efficiency stove, although at a higher cost to the end user. Over the decades local innovation in stove design has occurred resulting in new variations such as the multipurpose Kuni Mbili and Uhai stove.

Industry Overview

Over the years these early stove designs have gained user acceptability and the training of local artisans has resulted in production centres establishing around the country. As a result the stove sector in Kenya has experienced some commercialisation and is more developed than its neighbours in East Africa. Studies suggest that between 50-60% of charcoal users use some sort of improved stove with uptake in Nairobi and Mombasa as high as 80%. Overall uptake of improved stoves in Kenya is estimated at 47% but the uptake of wood stoves is much lower than charcoal at around 4% - although it is higher in areas that have been the target of stove programs (18).

In addition to charcoal, kerosene stoves are used by many low income urban households because they are cheap and convenient to use, with a wide distribution network making the fuel readily available in small quantities (19). Recent initiatives are being trialled, such as Pima Gas marketed by Premier Gas, to increase the uptake of LPG by overcoming some of the initial barriers such as high up front cost *(see Appendix D*). Imported biomass stoves such as the Envirofit have entered the market through distributers such as Paradigm Project and East Africa Energy and Envirofit are setting up a production facility in the country.

The cookstove value chain in Kenya is fragmented with the majority of cookstove production done on a small to medium scale. Production of liners is often done separately in areas where good clay is available such as around Kisumu and Muranga.

These liners are then transported to other areas of the country where assembly is done, often within the 'Jua Kali' artisan sector. Liner producers often work in groups or close to each other, sharing tools and a kiln to reduce on business costs. Distribution costs can be high and road networks poor and many producers rely on wholesale buyers collecting products direct from them. The majority of production is done by hand with the exception of Fine Engineering who use mechanisation to produce the Jiko Poa stove. Burn Manufacturing are also planning to set up mechanised production of their stoves in country.

Enabling Environment

The government has been involved in stove dissemination since the first country activities and has partnered with programs mainly through the Ministry of Energy and Ministry of Agriculture. The resources they provide however have been limited and biomass energy often loses out to higher priorities around electricity access and generation. Recent initiatives around climate change prevention, universal energy access and Vision 2030 relate to the biomass sector and these issues are being incorporated into new policy, but so far action on the ground has been limited. Kenya has also joined the SE4All global initiative[17] led by the UN-Secretary-General, and has completed a rapid assessment to help determine the main challenges and opportunities in achieving the three goals of SE4ALL.

Stove testing facilities exist at universities such as The University of Nairobi and a further facility is being developed by GIZ and KIRDI. Kenya Bureau of Standard (KEBS) has developed a biomass stove standard but this has only been attained by a few producers and wider enforcement of the standard is challenging and has not taken place.

Accessing finance from Financial Institutes has proved a struggle for small producers in the past; however some institutions such as Faulu Advisory, KWFT and Unitas SACCO are starting to develop energy portfolios. Kenya has a relatively well resourced and developed carbon market with five registered cookstove Gold Standard projects and five POAs in validation focusing on cookstoves, with Kenya as a host country[18]. Although many of these projects such as the Paradigm Project and CO2Balance partner with local stove producers, local manufacturers have yet to benefit directly from the carbon revenue.

[17] http://www.sustainableenergyforall.org/about-us

[18] As registered in March 2012

3.3. Uganda

Development of the sector

Stove activities took off in Uganda in the 80's following on from momentum started in neighbouring Kenya. The Ministry of Energy (MOE) in Uganda was created in 1986 to provide a focal point for all energy planning and to improve co-ordination of such initiatives. In September 1986, Ugandans attended the KENGO regional stoves workshop in Nairobi which led to the MOE sponsoring the first Uganda National Stoves Workshop in May 1987 (20). The National Workshop set ambitious targets for stove adoption but limitations in technology and resources prevented the government in achieving these targets.

Industry Overview

The market in Uganda is not as developed as in neighbouring Kenya. Most improved cookstoves are available in and around Kampala and availability in more rural and remote areas is low. Estimates set the number of households using improved stoves at around 9% whilst over 72% of the population still uses the three stone fire for cooking (20). Within urban areas the use of improved stoves is estimated to be around 20% (21).

Several donor led programs have promoted improved cooking technologies, in particular GIZ through the Energy Advisory Project and Promotion of Renewable Energy and Energy Efficiency Program (PREEP). However Uganda is yet to sustain a broadly commercialised ICS market and many producers rely on the indirect subsidies that programmes provide through training and marketing support and fail to continue momentum once the program ends.

Within urban areas the straight sided charcoal stove is the most popular design. Over the past five years two large producers of the charcoal stove have emerged; Ugastove that produce around 4000 stoves month in Kampala and International Lifeline Fund (ILF) producing around 1500 stoves in Lira and opening a new facility in Kampala. The rocket wood stove has also been promoted particularly in rural areas and GIZ has trained artisans in production and installation of the stoves. However many stoves of substandard quality exist in the market including cheap clay charcoal stoves which low income household favour even when they know they will not last long. Imported stoves such as the Jiko Poa and Envirofit wood stove have recently been introduced into the market, but initial sales have been concentrated in urban and peri urban areas. As a landlocked country Uganda relies on LPG supplies through Kenya which have proven unreliable in the past leading to a 6% fall in sales of LPG in 2010(22).

The majority of improved stove production is centred on Kampala, where the main market lies. Most production is done by hand with some larger producers trying to introduce mechanisation. Apart from the northern regions suitable clay for stove making is available in most parts of the country. Metallic materials are sourced from Kampala, however recent fluctuations in the price of raw materials are affecting stove producers, often leading to compromises in quality.

Most of the larger producers make complete cookstoves in centralised production. Some of these producers are accessing carbon credits through developers such as Impact Carbon and Uganda Carbon Bureau and for monitoring and evaluation purposes sit in a shorter value chain to allow for more control over distribution and tracking of stoves. Smaller producers tend to source individual components and assemble the complete stove.

Enabling Environment

The Ugandan government has partnered with cookstove programs in the past and the energy and forestry policy covers issues relating to the biomass sector. However priorities lie within electrification programs and a lack of resources have led to limited action on the ground from the government. However, Uganda has joined the SE4All global initiative and recently hosted a Technical Assistance Mission led by the EUEI PDF, which worked closely with the government and other stakeholders to develop a set of recommendations and potential energy projects[19]. A handful of stove testing facilities exist within Kampala with the most experienced being the Centre for Research in Energy and Energy Conservation (CREEC) based at Makerere University. The Uganda Bureau of Standards (UBS) has developed a standard for biomass stoves but very few producers have attained it and broad enforcement is lacking.

Several micro finance institutes such as Finca and Wekembe SACCO have started to develop energy portfolios and lend to the sector, but the majority of small scale producers still struggle to access finance. The carbon market in Uganda is fairly developed with some of the first cookstove projects within Africa. Ugastove is the longest operating and only registered Gold Standard VER project in the country with a further four cookstove POAs awaiting validation.

3.4. Tanzania

Development of the sector

Research and Development into improved cookstove began in Tanzania in the late 1980s. Some of the first stoves developed were the Morogoro wood and charcoal stoves through collaboration with local universities and international donors (23). In 1988 the Ministry of Energy and Minerals (MEM) with support from the World Bank sponsored efforts to adopt the Kenyan Ceramic Jiko into Tanzania. Further efforts have since been made by organisations such as COSTECH and TaTEDO to modify and disseminate these stoves. Local innovation has occurred leading to new stove designs such as the KUUTE and Jiko Bora.

Industry Overview

Whilst several donor funded initiatives have taken place to promote improved cookstoves funding is often short lived, sector activities are uncoordinated and there is a lack of focus on commercialisation. As a result the country is yet to sustain a commercial market outside of the main urban centres. Reports on the number of stoves in use vary.

[19] http://www.euei-pdf.org/country-studies/sustainable-energy-for-all-technical-assistance-mission-se4all-tam

In the market assessment carried out for the Global Alliance, GVEP estimated penetration to be around 400,000 households, with most of these stoves being charcoal burning. Improved stoves are more available around the urban centres of Dar-es-Salaam, Arusha, Morogoro, Dodoma and Mwanza, whilst access and awareness to improved stoves is very low in rural areas. Recent surveys by SNV (unpublished) suggest that use of charcoal stoves maybe more widespread. Major stakeholders in the sector are undertaking further research to try to arrive at a more accurate picture. Many of the stoves in the market are cheap and of low quality and it appears that consumers are not willing to pay a higher price for quality stoves.

A variety of locally made stoves are available in the market, most made by small informal businesses whose focus is on quantity and lowering costs rather than quality and design. Efforts have been made by NGOs to train artisans on quality stove production most notable by TaTEDO who have started SECCO a stove company in Dar-es-Sallam producing quality charcoal stoves, to try and promote commercial sustainability. However SECCO has struggled to find the market for these stoves and production remains at a modest scale of around 700 stoves per month.

Efforts have also been made to promote rocket stove technology both fixed stoves and portable. Many local producers were trained through the GIZ led ProBEC program, but many producers failed to sustain production when the program ended. Imported stoves have been introduced in the past few years with the most notable distribution efforts being made by L's Solution in Arusha. Quality clay is available in particular regions of the country and may be transported significant distances to producers, whilst most sheet metal is sourced in Dar-es-Salaam. Stove producers sell through retailers on a local scale and country wide distribution is rare due to the large distance to be covered and poor infrastructure.

Enabling Environment

The Ministry of Energy and Minerals is the lead body for stoves related issues although many other national bodies are also involved. The Ministry is currently developing a biomass energy strategy to develop policies for the sector and has joined the SE4All initiative. The Ministries efforts so far have been concentrated on electricity access and resources and action on the ground have been limited. Support to the sector is also provided by several parastatal organisations such as the Rural Energy Agency (REA), CAMARTEC and SIDO who conduct research and development and provide support to stove businesses. The Tanzania Bureau of Standards (TBS) is currently developing a standard for biomass stoves although enforcement will prove difficult.

Although NGOs have tried to stimulate the lending of funds to producers many still struggle to access them and few financial institutes have developed energy portfolios. Carbon projects are been developed in the country but the process is slow and hindered by bureaucratic procedures meaning few producers have yet to access this form of revenue.

Chapter 4: The Developing Energy Enterprise Programme – Experience in Improved Cookstove

4.1 The Developing Energy Enterprise Programme

The Developing Energy Enterprises Programme East Africa (DEEP) is a five year initiative established in 2008 to provide the crucial support necessary to enable the development of a sustainable and widespread industry of micro and small energy enterprises in Kenya, Uganda and Tanzania. The implementers of DEEP East Africa recognise the constraints and challenges faced by the energy entrepreneurs, especially the lack of business and technical capacity and inadequate access to finance.

DEEP supports the development of energy enterprises formed by, and for, rural and peri-urban entrepreneurs by assisting them with the identification of viable energy market opportunities, technology options, and service structures to generate revenue and sustain business. DEEP will also assist entrepreneurs through training and mentoring to develop business plans and access the necessary financing, thereby enabling businesses to survive and grow sustainably. As of June 2012, the programme works with 975 energy entrepreneurs, with the majority of businesses involved in improved cook stoves, solar technologies (charging, installation and lanterns) and briquette technology.

DEEP Targets:

- 1800 energy enterprises trained
- 420 businesses active at the end of the programme

Final beneficiaries:

- 1.8 million people accessing energy products and services from supported enterprises
- 1300 households receiving income from employment in supported energy enterprises
- 1300 households receiving incomes from employment in enterprises enabled by energy services provided by supported energy enterprises

The Process

The implementation of the DEEP programme has undergone many changes since its inception. An initial project design around community mobilisation and capacity building has evolved into a broader market development initiative. The emphasis also shifted part way through the programme to 'green' energy solutions. Many rural markets rely on charcoal or wood for cooking, and kerosene or paraffin for lighting, but it was decided in the second year of implementation that the programme will move away from dirty fuels and instead push for cleaner alternatives.

Since 2011, the programme has aimed to focus support on the entrepreneurs who have the real capacity to grow, and a methodology around key supply chain linkages has been developed. Direct funding of businesses is not an option within DEEP, but entrepreneurs are informed that viable businesses can be assisted in linkages to financial institutions to access finance.

Once the entrepreneurs are recruited into the programme, they are taken through a technical and business development training programme by business development staff. A basic business plan is finalised to help the entrepreneurs to access loans. After the training programmes, group networking and marketing activities are also held. These assist the entrepreneurs to share ideas, learn about new technologies and link in to new suppliers and to each other. In addition, both technical and business mentors provide support to each entrepreneur on a one to one basis.

Figure 6 below provides the key technology product areas that are taken up by a total of 975 DEEP entrepreneurs as per data collected at the end of June 2012. Many entrepreneurs have diversified into more than one business line with support from DEEP, for example selling solar lanterns alongside improved cookstoves. The major technology areas are: Improved Cookstoves (43%), Solar (27%), Briquettes (14%) and Biogas (10%).

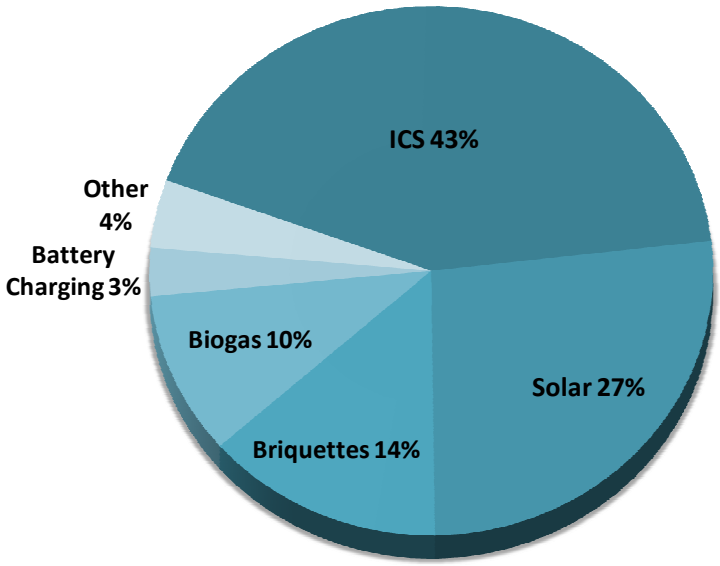


Figure 6: Key technology product areas taken up by DEEP entrepreneurs (as of June 2012)

4.2 Types of Improved Cook Stove Business

Within the DEEP programme the dominant technology is improved cookstoves making up 43% of the total businesses. The improved cookstove (ICS) sector is complex with many different business models in existence. In addition the types of stove made by entrepreneurs also vary between business and country. Both wood and charcoal stoves are made with the majority consisting of a clay ceramic liner encased in a metal cladding (such as the Kenyan Ceremic Jiko), although all clay stoves, gasifier stoves and institutional stoves are also produced. Within the DEEP programme ICS businesses are grouped into five main categories; ICS liner production, ICS assembling, ICS stocking and selling, ICS cladding and full ICS offering.

Production of Improved Cook Stove Liners

These businesses produce the ceramic liners that form part of the complete improved cook stove. The two main types of liner produced are those for charcoal burning stoves (e.g. Kenyan Ceramic Jiko liner) and those for wood burning stoves (either portable Kuni Mbili type or fixed Jiko Kisasa).

Figure 7: An entrepreneur making ICS liners by hand in Uganda

The process of liner production is labour intensive with several stages involved including mixing of the raw materials, moulding of the liners and firing. The complete process of producing liners from preparing the raw material to having a fired finished product can take around 45 days. As a result ICS liner producers often have several employees, be it casual or permanent. They may also work as a group and share tools and facilities. The quality of the liner can vary depending on the quality of the raw materials used, the production process followed and the finish of the stoves. Firing the liners in a kiln greatly improves on the durability. This step is followed by most ICS liner producers in Kenya but is less common in some areas of Uganda and Tanzania.

ICS liner producers normally have several regular wholesale customers that they will supply their liners to. These customers will usually buy in bulk and use the liners to either assemble completed cookstoves or they will act as middle men and sell the ICS liner on further - often to local artisans and shop owners. A vehicle is normally hired either by the customers to collect the liners or by the producer who will arrange for their deliver and include transportation costs in the purchasing price.

Production of Improved Cook Stove Cladding

Figure 8: Cook stove cladding outside a workshop in Central Kenya.

Most portable improved cook stoves are protected by a metal cladding in which the cook stove liner is fixed using insulating cement. Some businesses make only this metal cladding which they then sell on to businesses that use it to assemble the complete stove. These businesses employ local artisans who have metal work skills and will often make other metallic household items alongside stove cladding. They are usually located in commercial centres and close to local artisan markets.

Assembling of Improved Cookstoves

These businesses will source improved cookstove liners and use them to assemble complete cookstoves. They may make the cladding themselves or source it from elsewhere. The liners are insulated and held in place in the cladding using a mixture of vermiculite and cement (or other local materials such as mica, ash or lime). The completed stoves are then painted and occasionally branded ready for sale.

Assemblers will normally source ICS liners from a number of suppliers to be able to maintain production levels and ensure a constant supply. The quality of the completed stove is largely dependent on the liner which may be difficult to control especially when sourced from multiple locations. ICS assemblers may sell on to individual stockists and shops or maintain a network of dealers. They may also have a stall at a local market or sell to traders there.

Figure 9: An entrepreneur assembling improved cook stoves in Western Kenya.

Stocking Improved Cook Stoves

These businesses do not produce any components of the cookstove themselves but will instead buy the complete cookstoves and sell them on further, either directly to the end user or to other stove dealers. The amount of stock obtained will vary depending on the size of the business and the proportion of the business dedicated to cookstove sales. Many stockists of improved cookstoves will have shops and market stalls in the local area where they will sell from. These stalls may sell a variety of commodities, often household or hardware related. Community Based Organisations and women's groups may also distribute improved cookstoves as part of projects to promote environmental issues or create employment generating opportunities for members.

Stockists of improved cookstoves may also have a network of dealers based in other areas that they supply to or outlets in other towns to increase their customer reach. These dealers will make orders directly with the stockist every few months and arrange for the stoves to be transported, normally at the expense of the dealers who will mark up the price of the stove to reflect this and include their profit margin. Keeping a constant supply of stock may be a challenge especially when demand is driven by dealers who may not purchase at regular intervals. Financing may also be an issue that hinders stockists from making bulk orders and accessing discounted prices.

The Complete Improved Cook Stove Business

These businesses are involved in the complete production of improved cook stoves from making the liners and cladding to assembling the complete stove. Such businesses are normally the full time occupation of the owner since they are labour intensive with several different components involved. The business will employ several people who will be assigned specific roles such as liner production, cladding production, assemble, marketing and sales. The owner of the business will oversee each of these processes and also be involved in the accounting, marketing and sales. The different processes involved will usually take place at a central production site either a rented plot or often adjacent to the residential premises of the owner. Similar to businesses that produce liners, the complete process may be done in a group setting or by individuals working together closely to share equipment.

Figure 10: Complete cook stoves ready for transportation in Tanzania with ICS liners drying in the background.

A variety of customers exist for such businesses as described in the business models above. Stoves may be sold to wholesale buyers or middle men who will then sell the products on further. They may be bought by institutions or organisations such as CBO's or those promoting environmental conservation. In reality ICS producers may operate several of these business models in tandem, for example producing liners as well as complete stoves. Others may produce their own stoves and also buy stoves in from other producers, depending on the demand from customers. The type of business model adopted often depends on the skills and background of the entrepreneur.

Entrepreneurs may have a desire to change or expand their business model but find they are restricted either by resources or the skills they have – a barrier that DEEP tries to overcome through capacity building and linking of complementary businesses. Figures regarding the number of entrepreneurs operating each of these business models in DEEP are given in 4.4.

Businesses involved in ICS production may have received training on the skills and techniques involved either by an NGO (such as GVEP, Practical Action or GIZ), by family members or people they have worked with. Liner producers are often located in areas where quality clay can be sourced and pottery skills have been passed down through generations. Within Uganda and Tanzania businesses are more vertically integrated with the majority of businesses doing complete cookstove production. In Kenya the cookstove value chain is more fragmented and complex in which many layers may exist between the collecting of raw materials and the complete cook stove arriving in someone's home.

Business Arrangement

Most of the improved cookstove businesses within DEEP are classified as individually operated, although many are run by individuals who work very closely with others and a few are operated as group businesses. The group or individual business will then operate one of the business models described above. The section below describes the type of business arrangements that might be operated in the DEEP programme.

• Individual Business

These businesses are run by an individual entrepreneur or by a small group of partners on a commercial basis. The business may take on employees, who are often family members, to help in the different stages of production or with marketing and sales but has overall responsibility of the business and control over the business finances. The entrepreneur will be responsible for making business decisions, managing the business accounts and any loans taken out will be in the individual's name. In this way the entrepreneur has full control over the direction of the business and decisions can be made quickly. For individuals in liner production it is likely that this is their full time business and main source of income for their family. Other individuals may be shop keepers stocking cook stoves alongside other commodities.

• Group Business

These businesses are run as a group where members of the group each make their own cook stoves but marketing, sales and business management is conducted through the group. Members will contribute a proportion of their sales which will be used for group costs such as management of facilities and equipment. Members of the group normally share equipment such as moulds and a kiln for firing liners and the production facility which may be rented or owned by a group member.

Historically some of the prominent groups making improved cook stoves in East Africa had been brought together by NGO's who gathered local pottery makers and entrepreneurs together to provide them with the necessary skills and resources to start in business. Other groups have formed from community based organisations and women's groups often with the objective of environmental conservation, employment generation and support. However these groups are often run more as social enterprises with the business aspects and market penetration secondary to other objectives. Many groups in operation are well established and it is very difficult for new members to join which can leave the group with an aging membership and without younger entrepreneurs to pass their skills on to.

Operating as a group can also pose challenges in terms of dynamics between group members. There may be conflicts of interests or disagreements over the direction the business should take. Groups often elect a committee who are responsible for making business decisions but this can slow down the process and disagreements between members can hinder business growth.

Table 7: Advantages and disadvantages of different business arrangements

Business Model	Advantages	Disadvantages
Group	• Can utilize economies of scale • Sharing of equipment and facilities • Can call on other members of the group to service large orders • Can combine collateral to access financing • More funds available through group contributions • Can access larger network of contacts and marketing opportunities	• Conflict between group member can affect running of the business • Hard for new members to join the group, which may leave aging population • Some members may be less willing to contribute and hold the group back • Facilities must be shared equally between the group members and may not be available full time
Individual	• Owner has full control over how the business is run • Business decision can be made quickly • Owner receives business profits directly	• More vulnerable to changes in individuals social and economic circumstances • Difficult to raise funds and further resources through individual profits alone • Difficult to service large order at short notice

4.3 GVEP International's Work with the Improved Cookstove Sector

GVEP International's work with improved cookstove businesses started in East Africa in 2008 through the initiation of The Developing Energy Enterprise Programme East Africa (DEEP). GVEP has since built on this experience and extended its support to the sector through its loan guarantee program, distribution networks, technical and market development, studies and reports. Some of the key areas were GVEP has supported cookstove businesses and the broader sector, through DEEP and other initiatives, are describe in the sections below along with case studies of the involvement with individual businesses.

• Financial Management

DEEP works with micro and small businesses in East Africa, many of whom lack basic business skills, particularly in respect of financial management. When entrepreneurs are recruited into DEEP they are taken through business and technology training sessions. The modules taught are designed to cover the main business skills that entrepreneurs will need to be able to successfully run their business and expand their market reach. The topics covered include record keeping, costing and pricing and financial planning. These topics are further followed up through the one to one mentoring that entrepreneurs receive after the training, in which they are coached on putting into practice these skills for their individual business situations.

Through this training entrepreneurs are able to start realising and monitoring the number of sales they are making each month, which in turn allows them to track their expenditures and income and calculate whether they are making a profit or a loss - which previously many businesses did not appreciate.

Once entrepreneurs are able to calculate their profit they can then plan what money is set aside for family needs, reinvested into the business and savings, which will give the business more financial robustness. Many micro entrepreneurs cite lack of finance as a barrier to business growth and wish to access loans. With better financial management small businesses can utilise the income that they do have and save for items such as kilns and moulds which will help them increase production. Business records also allow financial institutes to assess loan applications and helps businesses understand what loan repayments would be affordable to them.

Entrepreneurs are able to understand the direct and indirect costs of producing the cookstoves and can hence price the products accordingly to make sure that they are taking a profit. The financial planning training allows entrepreneurs to better manage their cash flow to understand when they will receive income from cash sales and how they will use this to ensure production until the next sales are made.

Case Study – Janet Atieno Odeyo – Keyo Pottery Enterprise, Kisumu, Kenya

Janet Atieno Odeyo joined Keyo Pottery Enterprise, a women's group producing improved cookstoves, in 2006 after receiving training from her mother in law Florida Ogada, also a member of Keyo, on improved cookstove production. Coming from a humble background, Janet started her business using a 2000 KES (24 USD) capital obtained from a rotational savings and credit association where she was a member. Janet started off with just a few buckets of clay that she would transport on her head from the river bank to her production site and grew this to the point where she could order clay per Canter lorry.

Janet's small enterprise was however not without obstacles. For four years she ran it without proper business skills given that she never had any formal training. During this four-year period, Janet describes herself as a price taker rather than a price setter, meaning she always took the prices offered by customers with very little negotiation and without calculating whether the prices were profitable or not. She also did not keep any records to track her activities. Quite often Janet's ICS business could run short of working capital leading to very limited stock. This was because she did not understand the importance of separating business funds from family funds. Failing to differentiate between personal and business funds always resulted in Janet overspending without realising that she was de-capitalising her business.

It was not until April 2010 during a Technology and Business Development training organised by DEEP that Janet came to realise some critical business mistakes she had been making for years. "Two sessions were indeed very useful to me and forever became eye openers," states Janet. First was the costing and pricing session during which she learnt how to set prices for her products based on the direct and indirect costs incurred during the production process, making sure to incorporate a small mark-up. "I tell you, currently things have changed. My business now makes more profits than ever before," she testifies. Secondly was the cash management session during which she learnt how to channel her revenues into specific business and family needs.

Janet learnt that funds should first be allocated to working capital before anything else because future income flow depends on successful continuity of the business operations. Working capital should be followed by setting aside funds for loan repayment, family consumption and lastly savings. It was during the training that she learnt that savings are important for business expansion as well as a risk management strategy. Similarly the knowledge of maintaining a simple cash book for her business on a daily basis has contributed significantly to her success in business.

With the continuous support from Elly Odhiambo, Janet's DEEP assigned business mentor since July 2010, Janet has been able to perfect her skills of balancing her cash books, setting prices and above all keeping business records which are now key reference materials and inform her decision-making on a regular basis.

Janet now manages her finances much better and has recently obtained a loan of 100,000 KES (1204 USD) from the Kisumu branch of Kenya Women's Finance Trust (KWFT), which she has used to increase the production and sales of ICS. The profits accruing from the increased production have enabled her to construct her own production store and kiln. "I no longer experience delays in firing due to long queues at the group kiln," Janet comments. "This has increased my efficiency and sales thereby translating into increased profits from the business." Soon after, Janet received a second loan of 70,000 KES (843 USD) from Eclof Kenya, from which she has added part to the business profits and used it to construct a brick house for her family.

With improved business management skills arising from DEEP's intervention, Janet's enterprise has become more profitable. She is able to comfortably service her loans at 12,500 KES (150) and 7000 KES (84 USD) per month respectively. The business also pays her two permanent casual labourers besides paying for the education of her children, two of whom are in a day secondary school where she pays a total of 20,000 KES (240 USD) per year, and two in primary school where she pays 30,000 KES (361 USD) annually. The business also feeds the family and provides for other needs such as healthcare.

• Marketing

The business training given to entrepreneurs when they join DEEP includes a marketing module which introduces topics and techniques to entrepreneurs such as elements of the marketing mix, raising product awareness and customer care. Many entrepreneurs are not proactive in their marketing activities and rely heavily on local customers and passing trade. DEEP recognises that marketing is a key component in creating growth in micro and small energy businesses and encourages entrepreneurs to put more emphasis on this activity. Mentoring sessions continue to pursue the theme of marketing encouraging entrepreneurs to engage in promotional activities, advising on new marketing opportunities and demonstrating simple ways of branding products. DEEP has also supplied entrepreneurs with marketing materials such as flyers, posters and technology factsheets relating to cookstoves which can be used to advertise their products and business.

DEEP organises Market Development Activities in which entrepreneurs in the programme and other stakeholders are invited to a local marketplace to engage in promotional activities and selling products. These events not only allow entrepreneurs to increase their sales for that month but also provide useful linkages with new customers many of whom make repeat orders after the event. It also allows entrepreneurs to experience engaging first hand in marketing activities and realise the potential of marketing in expanding their customer base and increasing sales. Events employ different promotional techniques to market the energy products. At a recent marketing event in Kenya a local comedian was hired to engage the crowd and demonstrations were done to compare improved wood stoves next to an open fire.

Figure 11: A demonstration of an improved wood stove and an open fire conducted at a recent marketing event.

Stove Branding

DEEP conducted work with SCODE an improved cookstove retailer in Nakuru, Kenya to encourage the use of branding for their products. A series of labels, stickers and stencils were provided enabling SCODE to paint their logo onto multiple stoves and experiment with different colours and designs. Initial results showed that the branded SCODE stoves have sold quickly and at a premium price of 1000 KES compared to 720 KES for the non-branded model. Customers have also been prepared to wait for the next batch of branded stoves which SCODE intend to produce.

• Access to Finance

Access to finance for business expansion is often a challenge for micro and small business who lack collateral and credit history. The DEEP program does not offer any direct grants to entrepreneurs but instead facilitates them to access loans from financial institutes. GVEP's work in providing access to finance for such energy entrepreneurs started in 2010 with training for financial institutes and small enterprises, to sensitise them on the benefits of developing energy portfolios and explain the processes involved. Since then GVEP has been able to build on this work through its loan guarantee program, working with several of these financial institutes to negotiate suitable terms for loans to be disbursed to businesses in the DEEP programme.

Currently over 85 business in East Africa have received loans through the program, with 39 of these involved in the cookstove sector, receiving average loans between 200 – 1000 USD. Examples of how these loans have been utilised include buying of raw materials in bulk & purchasing of vehicles for transporting products.

Case Study – Farooq Kiryowa – Energy Uganda Foundation, Kampala, Uganda

Farooq Kiryowa is clear about the direction he wants Energy Uganda Foundation, a business he co-owns, to take. "I want to be the major supplier of Improved Cookstoves in Uganda," he says. "As long as I have stoves, I believe I can sell them." Farooq's journey in the improved cookstove business began in 2006 with a start-up of 1.5 million UGX (603 USD) as a means to make a living for himself. Farooq and his co-founders, Sula Semuyaba and Abdul Busulwa, were introduced to GVEP in 2009 through a mobilisation drive. At the time, the team comprised of the founders and one employee. Based in Kawempe in the outskirts of Kampala, Energy Uganda Foundation now offers employment to seven permanent and four part-time staff. As well as accessing business and technology training and mentoring from DEEP Farooq has also been able to access a loan for his business through GVEP International's loan guarantee programme.

While Farooq's business has experienced positive outcomes as a result of GVEP's intervention, he says that getting access to funds to develop has been a real challenge. "The only thing disturbing Ugandans is access to working capital. I know people want to work but they don't have the means to finance their ideas," he explains. With an inflation rate of 25.7% in Uganda [as of January 2012] bank loans are simply out of the reach for the majority of MSEs.

In August 2011, Farooq was approved for a loan of 3.75 million UGX (1500 USD) with 393,000 UGX (160 USD) monthly repayments from FINCA, facilitated by GVEP's Loan Guarantee Fund. Though he initially applied for double that amount, Farooq says that they had to re-strategize on how to use the funds. The eight million would have purchased more materials and a vehicle to transport the cookstoves. Instead, they opted to buy a pickup truck and expand the current work shed to accommodate more stoves. Despite being approved for a smaller loan than he'd expected, Farooq feels the loan was worth getting. "Transport was previously eating largely into the profits." Before buying the pickup, transport costs alone were at 600,000 UGX (240 USD) per month, but now their transport cost stand at 300,000 UGX (120USD) – inclusive of the van's maintenance).

Outside of DEEP, GVEP International has also started working with Kartech a manufacturer of improved institutional cookstoves, based in Nairobi, Kenya. Kartech faced financing challenges due to the high upfront cost of their cookstoves for schools and other institutions. Most schools receive revenue from paying of school fees on a term by term basis which restricts their cash flow and limits orders for stoves to certain times of the year. To overcome some of these challenges GVEP International facilitated an agreement through its Loan Guarantee Program to link schools interested in purchasing Kartech's stoves with Unaitas SACCO. Under this agreement Unaitas provide credit in kind to the schools by facilitating them to receive an institutional stove. Kartech receive 40% of the stoves cost upfront from Unaitas and 60% on completion of the stove. The school repays the credit direct to Unaitas SACCO, in 6 instalments over a two year period, at an interest rate of 9.96% annually (standard interest rates in Kenya range from 19-25% annually). This agreement not only reduces the upfront cost of the stove to the customer but also gives the onus of credit collection to the SACCO who is better placed to do this. At the time of writing this agreement had recently come into effect and the impact on stove sales was unclear.

• Creating Market Linkages

Within the DEEP program business linkages are made between entrepreneurs operating in different sections of the value chain, for example liner producers are linked with cookstove assemblers who can in turn be linked with retailers. These linkages aim to increase the market reach of the entrepreneurs and increase their sales and orders. Linkages are formed through individual contacts or through group trainings and market development activities organised by the DEEP program as shown in the example below.

- At a recent DEEP marketing event, held in Karatina Kenya, Erastus Kimani a liner producer from Kiria sold the 100 liners he bought to the event within minutes of arriving, to a local stove assembler, who also put in a further order for 1000 liners per month. Erastus Kimani now visits Karatina market on a fortnightly basis since he was introduced to the market by GVEP. This has contributed to the growth of his business significantly over the period from 416 Euros October 2011 to 1294 Euros by March 2012.
- During the Mwea marketing event Patrick Marubu of Gakoigo got a deal to supply 4,500 KuniMbili liners to service an order for an NGO called German Agro Action based in Nairobi. Through the DEEP network several other entrepreneurs have also supplied stoves to help service the order.
- In Tanzania Jiko Bora,a producer of high quality improved cookstoves, have been signed on as an associate partner of the program. Through the program they have been linked to 45 new dealers through Market Development Events, DEEP mentors and joint recruitment activities. Jiko Bora has benefitted from this linkage by securing a reliable market for their products and as a result has experienced an increase in sales and revenue. The dealers linked to Jiko Bora have also experienced an increase in sales as customers are sure of the quality of the stoves and their durability. This linkage has also allowed the dealers to appreciate the importance of supplying good quality products.

• Technology Support

Within the DEEP program efforts to raise the quality of improved cookstoves have focused on the durability of the stove and streamlining the production process to increase efficiency and reduce breakages. Where country standards exist for biomass cookstoves, such as the KEBS standard in Kenya, these have been used as a benchmark for entrepreneurs to obtain, and to guide entrepreneurs on materials to be used in production and stove dimensions. The majority of the stoves produced under the program follow designs that have been promoted in East Africa for several years (such as the KCJ and Kuni Mbili stove) and for which standard production procedures exist and previous testing has been done. Until recently stove testing of individual stoves in the program has not been done and hence little consideration has been given to the effect of stove design in terms of fuel consumption and emissions.

As part of the DEEP technology and business training, entrepreneurs are given training on the energy products that they work with. This training is followed up by a visit from one of DEEP's technology mentors who performs a technical diagnosis of the business, identifies areas where further support is required and sets actions to address these issues. This support has primarily focused on the production of stove cladding and liners. Advice is given on the different production steps involved, for example the best ratios of raw materials for stove liners, stove dimensions, the gauge of steel to use in cladding, and the correct procedure for firing liners. For improved cookstove stockists they are linked with new suppliers of stoves, to help them source better quality products and ensure continuous supply.

For entrepreneurs already in the program growth & diversification training is organised to target a specific area to unlock business potential. For example, two Kenya based groups from the Coast (Mwaroko) and Central (Kiimani) have been producing Kuni Mbili liners but production had stagnated and sales were low. The groups were trained in KCJ liner production to help them unlock potential here, as the market for KCJ is still strong. The groups have now started producing KCJ liners and have been linked up to dealers who regularly buy from them. In addition businesses that produce improved stove liners have been supported to expand into assembly of complete stoves. Businesses have also been supported to expand into complementary products such as biomass briquettes or solar lanterns that could be sold alongside stoves.

Linkages between different entrepreneurs in the program are made to encourage the transfer of technical skills and ideas. For example Joseph Muriuki an ICS producer in Kiria, Kenya was contracted to build a kiln for another DEEP ICS group Keyo Pottery Enterprises in Kisumu, Kenya. Previously Keyo were using an open kiln and Joseph showed them how to build an improved down draft kiln. On a separate visit to Keyo Joseph was able to see the stoves made from Keyo and learnt about the Uhai stove (a new design based on the KCJ developed by Keyo). When Joseph returned to Kiria he started to produce the Uhai stove at his own production facility and also conducted a training facilitated by DEEP showing producers in Kiimani how to produce the stove as well. As a result the stoves are now available in the Kiria and Kiimani areas of Kenya.

In Tanzania, firing of cookstove liners is not common practice in the market; however the entrepreneurs in DEEP have been encouraged to start firing liners through growth trainings provided by the programme. These group exercises bring together those entrepreneurs who are not firing liners with those that are, so they can explain the importance of firing liners for the durability of the stove. This is followed up by support from the technical mentor. As a result several entrepreneurs have started to fire their liners and further assistance is being provided to help them to construct their own kilns.

DEEP has also supported the testing of stoves made by entrepreneurs under the program. A total of 12 stoves have been tested from the region of which the results are presented in Chapter 5. These results will further inform and influence the technology support given to entrepreneurs.

Case Study - Jane Tukuwa – ICS Liner Production, Uganda

For 20 years Jane Tukuwa has run a business producing ceramic liners for energy efficient cookstoves in the town of Namanve, near Kampala, Uganda. She was originally taught to create the liners 20 years ago by a group visiting Uganda from Kenya, and travelled to Kenya to get more training. Although she had some success selling liners, she became interested in improving the quality of her products, and expanding her business. In June 2010 she received training from the Developing Energy Enterprises Project (DEEP) which allowed her to diversify and expand her business.

Jane's technology mentor – also trained by DEEP - taught her in several sessions how to improve the quality of her liners, using methods such as drying them on a flat surface to prevent them from losing shape, mixing the materials in correct ratios and proper compaction of the mortar while molding to eliminate pockets which could create lines of weaknesses. He also taught her how to mix the clay and grog with insulative material such as sawdust and mica to improve on the liner insulation capacity and its ability to expand and contract during firing and to dry the liners under shade to reduce on cracking.

She was also shown how to load her kiln efficiently for uniform arrangement of the liners to avoid breakage during offloading, avoid direct contact of the burning fire with the liners and fill in gaps in the packed liners to avoid wastage of heat due to leaking. In addition to this Jane was also trained in briquette production to enable her to expand her product line.

The improved quality and diversification of her products has encouraged many permanent customers in the local area to buy from her in bulk, and has even attracted those outside the local area – some even travelling 10km to buy from her.

• Knowledge Sharing and Research

Within the DEEP program knowledge sharing takes place amongst different cookstove businesses during group trainings and marketing events. These events allow entrepreneurs to see the products that other businesses are making and to exchange ideas and advice. An example of such knowledge sharing can be seen with the Uhai stove – an improvement of the Kenyan Ceremic Jiko which has been developed by Keyo Women's group in Kisumu, Western Kenya. Through knowledge sharing in the DEEP program this stove is now being produced by several other businesses in Western Kenya and also in Central Kenya. Keyo were also sponsored by DEEP to attend an exhibition in Uganda where the Uhai stove was also demonstrated. Such knowledge sharing aims to increase the dissemination of these technologies across the region and expand the product line of entrepreneurs.

GVEP International has commissioned several studies relating to the clean cooking and biomass fuel sector and continues to develop its research capacity and share best practice. Notable studies conducted over the past year include '*Marketing Challenges and Strategies for Micro and Small Energy Enterprises in East Africa*' , '*Briquette Businesses in Uganda: The potential for briquette enterprises to address the sustainability of the Ugandan biomass fuel market*' and '*GVEP's experience with working with women entrepreneurs in East Africa*' which can be accessed through the GVEP International website.

Recently GVEP International partnered with the Global Alliance for Clean Cookstoves to conduct market assessments of the cookstove sector in Kenya, Uganda and Tanzania. These assessments provided an in depth analysis of the sector looking at several aspects such as the macro country environment, health and social impacts as well as the structure of the current industry, and inputted into The Alliance's regional stakeholder workshop held in Nairobi in April 2012.

4.4 Facts and Figure from the Developing Energy Enterprise Programme

As of the end of June 2012, the Developing Energy Enterprise Programme was supporting a total of 975 businesses across East Africa with most involved in the technologies of improved cookstoves, solar and briquettes. Specifically, 492 businesses in DEEP are involved in the cookstove sector. Out of these, 231 are male headed businesses, 257 are female headed and 4 are listed as groups. The tables below show the breakdown of entrepreneurs involved in the cookstove sector for each country and each business type, along with the total units sold in the period April to June 2012 (Quarter 17 of the programme). For ICS liner production a unit is one liner, for ICS cladding it is one clad whereas for the other business models one unit is a complete cookstove.

Table 8: Split of ICS businesses and units sold in Kenya

Kenya	Total No. Of Businesses	Male	Female	Group	Number of units sold
ICS liners production	72	12	60	0	69,828
ICS assembling	56	24	32	0	7,090
ICS stockists & Selling	42	21	20	1	12,742
ICS Cladding	6	5	1	0	3,517
Full ICS offering	53	12	41	0	14,040
Total	**229**	**74**	**154**	**1**	**107,217**

Table 9: Split of ICS businesses and units sold in Uganda

Uganda	Total No. Of Businesses	Male	Female	Group	Number of Units sold
ICS liners production	19	7	12	0	35,580
ICS assembling	3	1	2	0	4,011
ICS stockists & selling	51	24	27	0	10,003
ICS Cladding	0	0	0	0	0
Full ICS offering	40	25	15	0	59,250
Total	**113**	**57**	**56**	**0**	**108,844**

Table 10: Split of ICS businesses and units sold in Tanzania

Tanzania	Total No. Of Businesses	Male	Female	Group	Number of units sold
ICS liners production	8	3	5	0	3,115
ICS assembling	0	0	0	0	0
ICS stockists & Selling	59	29	29	1	30,010
ICS Cladding	0	0	0	0	0
Full ICS offering	83	68	13	2	63,897
Total	**150**	**100**	**47**	**3**	**97,022**

The figures show that within the DEEP program Kenya has the most cookstove businesses (229), followed by Tanzania (150) and Uganda (113) (for these countries technologies such as solar and briquettes have been more prominent). Within Kenya the most prevalent business model is ICS liner production followed by assembly and then full ICS offering whereas in Tanzania and Uganda the most prevalent business types is those offering full ICS and ICS stocking & selling.

In Tanzania the DEEP program works with only a few ICS liner producers and no assemblers or cladders. These numbers are reflective of the more complex cookstove sector that exists in Kenya, where individual components are often sourced separately and many different layers can exist in the cookstove value chain. Within Uganda and Tanzania it is more common for businesses to produce the whole cookstove themselves.

Making good stove liners is complex and is considered as a specialised skill in Kenya. In Tanzania the quality of liners is generally lower and many are un-fired, and hence the production process can be completed by less skilled artisans and combined easily with the complete stove. The availability of materials may also influence differences in the value chain. In Kenya good clay is available in pockets of the country where liner producers operate from and steel is available in commercial centres where cladding is made. In Mwanza Tanzania where DEEP operates from, both clay and metal are readily available, providing sufficient resources for complete stove production. In the Ugandan market all clay cookstoves are common and hence there is less need to split up the production process.

Within the program there are more female than male entrepreneurs involved in ICS. Women seem to dominate in the production of ICS liners and are prevalent in ICS stocking, selling and assembly. Men are more dominant in ICS cladding and also, for Uganda and Tanzania, complete production of cookstoves. Metal work for cladding is a labour intensive job and seems to be a male dominated areas, whereas liners production and stove assembly can be completed by women who often employee young men to perform the labour intensive parts such as preparing the raw materials. Kenya has the most ICS liner producers, although based on the number of units sold during Quarter 17, Ugandan businesses made more liner sales per business.

In the first 6 months of 2012 (Jan – June 2012) a total of 220,369 cookstove liners were sold, 4,357 stove clads, 268,726 complete stoves (complete ICS and assemble) and 124,869 stoves further sold on through retail. This is an impressive figure and not only demonstrates the production capacity of locally manufactured stoves in East Africa but also that people are buying them. It also demonstrates how DEEP is supporting the complete value chain from making the liner, to assembling the stove to it being sold through a retail outlet to the end user. If these sales volumes are to be continued through the second half of the year, over half a million complete stoves will be sold through the DEEP program in 2012 (accounting for complete ICS and assemble sales alone).This figure is set to significantly exceed the 275,842 complete stoves sold through the program in 2011, illustrating the growth that DEEP is prompting in some of these cookstove businesses.

In reality the sales made by ICS businesses under the program vary, with some businesses much more active than others. Figure 12 below shows the distribution of average units sold per quarter for 92 stove liner producers in Kenya that reported sales data between July 2011 and June 2012.

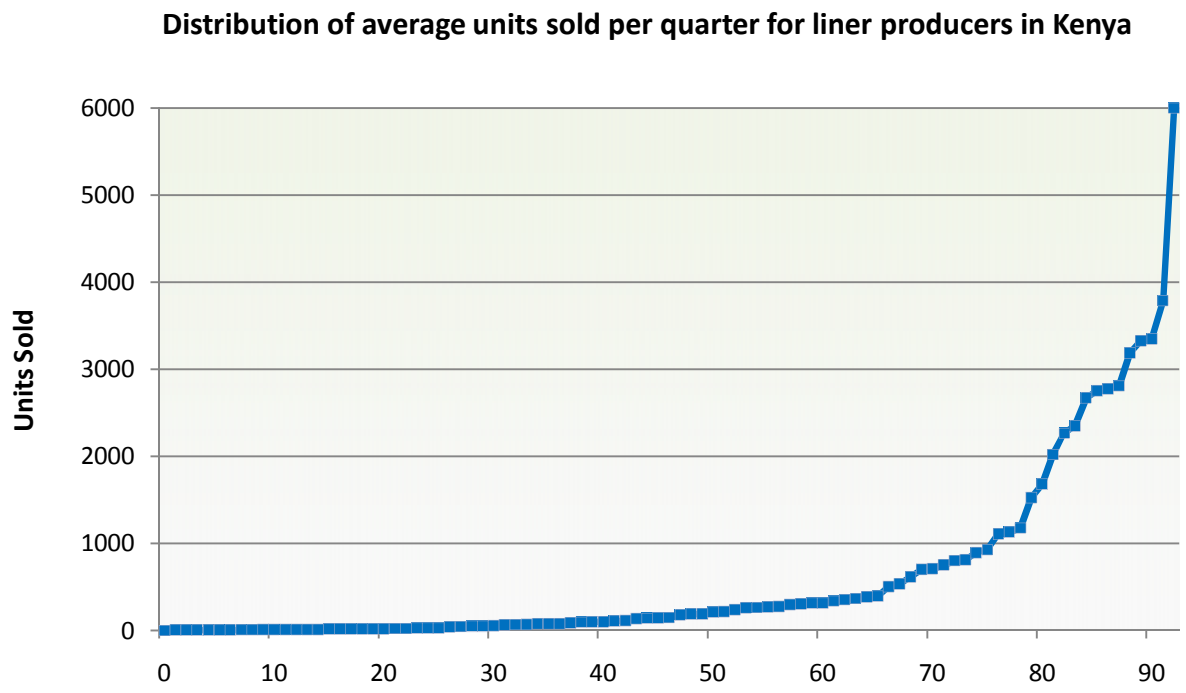


Figure 12: Distribution of average units sold per quarter for liner producers in Kenya from July 2011 to June 2012

The figure shows that the majority of DEEP liner producers in Kenya make low sales of ICS and only 29% of the liner producers that reported had average units sold above 500liners per quarter.

Based on this observation the revised strategy implemented in year 3 of the program looked to categorise entrepreneurs in the programme depending on their performance and potential. Entrepreneurs in each country were divided into three categories, with category one the highest performing and category three the lowest. Different support is then tailored to each of these categories with more support going to the highest performing businesses which have displayed high potential, responsiveness and ability to scale up. Businesses in category three that have been inactive and unresponsive to the program so far are given more general training. These categories are reviewed by business and technical staff every quarter with the option of entrepreneurs graduating to the next category.

Many of the ICS businesses also experience fluctuations in sales from quarter to quarter depending on orders they have and the focus they have given their business during that time. For example, many small entrepreneurs also engage in farming activities and during planting and harvesting season will take time away from their ICS business to concentrate on this – hence having an effect on their production and sales.

As well as providing a livelihood to the entrepreneur themselves, cookstove businesses often take on several employees to help in the production process and running of the business, hence providing income generation for addition people. As of June 2012, 1305 people were employed in ICS businesses through the DEEP program with 48% of these employed on a temporary basis and the remaining as permanent employees.

Table 11 below shows the total employees (both casual and permanent) for each business type in the three DEEP countries as well as the average number of employees per business.

Table 11: Number of employees involved in ICS businesses in DEEP

	Kenya		Uganda		Tanzania	
Technology	**Total Employees**	**Av.employees per business**	**Total Employees**	**Av. employees per business**	**Total Employees**	**Av.employees per business**
ICS liners production	165	2.29	71	3.74	11	1.38
ICS assembling	153	2.73	10	3.33	0	0.00
ICS stockists & Selling	82	1.95	126	2.47	106	1.80
ICS Cladding	12	2.00	0	0.00	0	0.00
Full ICS offering	128	2.42	196	4.90	245	2.95
Total	540	n/a	403	n/a	362	n/a

The table shows that in total businesses in Kenya have the most employees reflecting the higher number of ICS businesses in the country under the program. In Kenya, on average, ICS assembling businesses take on the most employees followed by full ICS offering and then ICS liner production. In Uganda and Tanzania complete ICS businesses have the most employees per business on average. This is not surprising considering this is a labour intensive activity with many production stages involved. The figures show that businesses in Uganda tend to have more employees per business. This could be down to differences in costs, availability and regulation of labour.

Through the GVEP loan guarantee fund, as of Sept 2012, 39 cookstove entrepreneurs in the DEEP programme have been able to access loans ranging from 111 USD to 5556 USD from financial institutes. These entrepreneurs consist of 19 females, 19 males and 1 group who have collectively received 27,108 USD through loans to invest into their businesses. The average loan size received is 645 USD with repayments made over a 6 – 12 month period.

In addition to the common ceramic and metal improved cookstove, the DEEP program is also working with entrepreneurs in biogas, solar and fireless cookers and LPG refilling business, although in smaller numbers. As of June2012, the program worked with 115 biogas entrepreneurs 113 in Uganda, 2 in Tanzania), 19 entrepreneurs in Kenya producing fireless or solar cookers and 8 entrepreneurs involved in refilling and selling LPG (3 in Kenya, 5 in Tanzania).

DEEP Facts and Figures at a Glance (as of June 2012)

- The programme works with **975** businesses in Kenya, Uganda and Tanzania with most involve in improved cookstoves, solar (phone charging, installation and lanterns) and briquettes.
- The programme works with **492** businesses involved in the ICS sector with **231** male headed businesses, **221** female headed and 4 groups.
- During the period January to June 2012, DEEP businesses sold a total of **220,369** cookstove liners, **4,357** stove clads, **268,726** complete stoves (complete ICS and assemble) and **124,869** stoves were further sold on through retail.
- Total revenue generated by ICS businesses in DEEP during January to June 2012 was **693,506 USD.**
- As of June 2012, **1305** people were employed in improved cookstove businesses through DEEP.
- In addition DEEP works with **115** biogas entrepreneurs, **19** entrepreneurs producing fireless or solar cookers and **8** entrepreneurs involved in refilling and selling LPG.
- Through the GVEP International loan guarantee fund **39** ICS entrepreneurs in the DEEP programme have received loans from financial institutes to invest into their businesses resulting in total disbursed funds of **27,108 USD**.

4.5. Main Challenges faced by Improved Cookstove Businesses in DEEP

Cookstove businesses in the Developing Energy Enterprise Programme face a range of challenges, which often depend on the individual circumstances of the enterprise. However there are key challenges that are experienced by cookstove businesses across the region as are described in the section below.

1. Marketing

Although many cookstove entrepreneurs in DEEP have the necessary skills and experience to produce quality cookstoves, they often lack appropriate marketing skills to promote their products. Entrepreneurs also struggle to recognise different market segments so as to customise their products in light of different market needs. Some cookstove entrepreneurs within East Africa are located in remote rural areas which are not serviced by adequate road infrastructure, making access to markets difficult. Such entrepreneurs are often reliant on wholesale buyers and middlemen coming to them to transport their products to market and are missing out on the profit margins that could be gained by accessing the market directly. As a result many entrepreneurs rely on a limited local market and passing trade.

There are few entrepreneurs in the market that make use of branding of stoves and as a result it is difficult to distinguish stoves made by different manufacturers, although the quality of them may vary greatly. Entrepreneurs often perceive lack of finance as a hindrance to marketing and rely on support from other organisations, yet there is much that can be done with existing business resources. Simple branding and marketing techniques such as use of colours, product demonstrations, business cards and free trials are not fully utilized by entrepreneurs. Many do not realize the potential impact of marketing on their business which often falls second to efforts in business expansion and product diversification.

2. Consumer Awareness

Within East Africa consumer awareness around the benefits of improved cookstoves can be low, especially in rural areas where reliance on wood fuel is at its highest. Even where cookstoves are readily available and people are aware of them they may not be aware of the difference between quality stoves and those of substandard quality. As a result consumers are often unwilling to pay a higher price for better quality stoves instead seeing stoves as a disposable, consumer item and favouring cheaper options, since they will most likely be replaced within a few months. Many consumers, even within rural and low income segments, will spend reasonable amounts on household items. However, due to this low awareness, cookstoves are rarely a priority and instead consumers aspire to purchase radios, televisions and furniture. This, combined with a lack of branding by quality stove manufacturers and a lack of broader marketing campaigns around the benefits of clean cookstoves, creates a difficult environment for entrepreneurs to sell their products into.

3. Bottle necks in the value chain

Many cookstove businesses within DEEP form part of a larger value chain that contributes to the production and distribution of cookstoves. They may not make the complete stoves themselves but instead make one component and source the other externally. For example, a business may produce cookstove liners, source the cladding from elsewhere and assemble the complete stove. This leaves them reliant on other businesses – if the cladding is not available they cannot assemble the complete stove, which delays their own order. Similarly a cookstove retailer may source from a few businesses and if these businesses cannot deliver enough stock the retailer will potentially lose business and customers. This reliance on contributions from other businesses can leave them vulnerable to delays in production when suppliers cannot deliver.

Distribution can also present a bottleneck to entrepreneurs. Many businesses do not own transport and are either reliant on customers collecting products from them, hiring a vehicle or using public transport. This can leave them open to delays and limit the number of stoves that they can transport in one go. When relying on others to transport goods, they can often be handled poorly resulting in breakages before the stoves reach the customer. Poor infrastructure in many areas also leads to delays with some roads becoming impassable to trucks during the rainy seasons. The entrepreneur may have a large stock of stoves but due to delays in distribution channels they cannot reach the customers.

4. Maintaining quality products

The standard of stoves being produced by entrepreneurs in the DEEP program varies. Although they have been trained on the correct procedures and materials to use to produce a quality stove many fail to maintain this quality within their products. Many businesses feel the market demands low cost stoves and these are what customers will buy. As a result, they will concentrate on keeping the price down and cutting costs, which often means compromising on the quality. This can be heightened by increases in the price of raw materials such as steel. Some entrepreneurs fear that if they increase the price to the consumer they will no longer purchase from them, so instead they will favour cheaper, lower grades of materials or cut corners in production. In some areas entrepreneurs can collect clay for free making it difficult for those entrepreneurs that pay for their clay to compete with the stove price they can offer. This relates to the lack of consumer awareness for quality products, meaning that price rather than quality is often the main market driver.

The fragmented nature of the cookstove industry means that quality control is difficult. Quality stove liners may be sold on to artisans who place them in poorly assembled stoves. Stove assemblers that source from different suppliers may also struggle to maintain consistence quality in components.

5. Access to capital

Access to capital is often cited as a barrier to micro and small business expansion in East Africa. This lack of capital may restrict both the working capital of the business and investment capital for business expansion. For some small cookstove businesses once raw materials are purchased and production commences, they must sell the stoves that have been made before the next batch of raw materials can be purchased. Due to lack of working capital to purchase materials and pay labour it is difficult for them to maintain continuous production and businesses are left vulnerable to economic and social change.

Small entrepreneurs often find it hard to break through to the next level, due to lack of capital to invest in business expansion. For an entrepreneur to increase production they may need to invest in a new kiln, more drying space, vehicles, marketing material and additional labour. This represents a significant investment, from which the returns through increased cookstove sales may take some time to achieve. It is often difficult for these small businesses to obtain loans from financial institutes since they lack credit history and collateral.

6. Realising the business potential

A good number of entrepreneurs still hold on to the mentality that energy products and services cannot be provided on a commercial basis hence a need for grant support from development organisations. Many do not realise the full potential of their enterprise or see it as a substantial means to provide for their family. In light of this many entrepreneurs may be involved in the cookstove sector as a side business and not fully concentrate on the venture, hence limiting its profitability.

As a result they struggle to see the bigger picture and are reluctant to invest in the business significantly or take on extra employees since they do not appreciate the returns on these investments. For cookstove businesses formed through women's groups and community based organisations, social rather than business objectives may predominate which limits the sales that they make. Businesses branching from NGO's are often run as a project rather than a business with a lack of responsiveness to demand.

7. Business Attractiveness

Cookstove businesses generate low profit margins in what is an already crowded sector. It is hence an unattractive sector for business people to enter who are looking to make an easy profit. For entrepreneurs that are already involved in the sector there is often a lack of training and product development available to them to further advance their skills and business.

4.6. Key Lessons Learnt for ICS from the Developing Energy Enterprise Programme

Through its four years of operation, offering support to cookstove businesses throughout East Africa, the Developing Energy Enterprise Programme has learnt many lessons and continuously refined its approach to enhance the services it provides. Some of the key lessons learnt from the programme relating to cookstove businesses are summarised in the section below.

- **Micro entrepreneurs choose shorter life span energy technologies:** If an entrepreneur sells a product with a long lifetime, it will take a few years for the customer to make a repeat purchase. Most micro-businesses in the ICS sector operate within a very limited geographical area relying heavily on passing trade for their sales. Some cookstove producers will compromise on quality and favour shorter life span stoves, expecting customers to come back frequently. Their perception is that customers prefer cheaper products, and that supplying cheaper, less durable products, is better for their business. The prices they would have to charge for a durable stove to make the same profit would, they fear, price their products out of the market. Diversification and accessing new markets are both ways entrepreneurs can maintain profits while raising quality. However, most micro-enterprises do not have the motivation to do this and/or lack the skills and experience to develop their businesses in this way.
- **Consumer awareness of clean cooking technologies is low:**Consumer awareness of quality cookstoves and their benefits is low and needs to be incorporated into cookstove programs. Consumers need to know how long quality cookstoves can last and what kind of fuel savings they should offer. Customers need to know what an efficient stove looks like if they are to start demanding better quality from the market. Where sensitisation around cookstove is done and consumers appreciate the benefits, evidence suggests that demand is switching to better quality stoves; however sensitization can be a resource intensive activity. Consumer research consistently shows that customers are primarily concerned with usability and 'value for money'. Practical demonstrations and giving customers the opportunity to try out improved stoves can be effective in stimulating interest.

- **Locally available stoves have gained some user acceptability: Poor** user acceptability of a particular cookstove can lead to low uptake of the technology. Within some regions of East Africa local artisan made improved cookstoves have been promoted for many years, resulting in user acceptability and some commercial sustainability, particularly the Kenya Ceremic Jiko and fixed wood stoves in Kenya. It is possible to make modifications to locally available stoves through branding and design change to further improve on their performance and appearance without changing the complete design of the stove. While these modifications may not achieve the efficiencies of a highly engineered stove made in a factory, they can improve performance and reduce emissions.

  Given the volume of stoves produced by local artisans improving local design standards can have impact at scale. This is most easily achieved where a limited number of larger scale producers dominate the market and can be incentivised to adopt higher quality standards. Business owners need to be persuaded that stoves capable of performing to a higher standard are economic to make and will sell. They need to be supported through a process of trialling and testing new designs to the point where they are confident a market exists for the new product.

- **Entrepreneurs are able to sustain and generate incomes through cookstove businesses**: The DEEP program has demonstrated that where entrepreneurs have put their training into practice and demonstrated commitment and entrepreneurship within their business it has the ability to sustain and generate an income for them. The income generated through cookstove businesses has the ability to improve the lives of entrepreneurs, many of whom are women. DEEP supported businesses achieve this without any subsidy from carbon revenues.

- **Changing attitudes towards business can take time:** Getting small cookstove enterprises to think in a more business mind-set is key, but this does not happen instantly; it takes time and continued support to get them to change attitudes and behaviour. Many entrepreneurs have been running their own business for many years before DEEP intervention and do not instantly realise the benefits of changing their approach. However as the programme has continued to provide support, attitudes towards business have gradually changed and the entrepreneurs are appreciating the impact on their business. It may be necessary for entrepreneurs to first see the growth in their business before they will engage with issues of quality improvement.

- **Mentoring maintains motivation and learning for cookstove businesses:** Providing businesses with a mentor to give one to one support can help entrepreneurs put their training into practice, maintain their motivation and continue the learning process. When entrepreneurs expect a mentor visit they are more inclined to keep their records up to date and follow through with actions that have been set. Entrepreneurs also find it supportive and motivational to have someone take a regular interest in their business activities. Initially the programme took on local volunteers, with some business experience who mentored the entrepreneurs on a part time basis.

However this approached has since changed to employing full time qualified regional mentors who provide support to businesses within individual clusters. This approach has proved more successful with the mentors more committed and accountable to the role.

- **The GVEP loan guarantee fund has stimulated access to finance:** Many micro and small businesses struggle to access finance from traditional sources whilst financial institutes view them as a high risk investment. Through training of financial institutes and the GVEP loan guarantee fund, small cookstove businesses have been able to access loans previously viewed as out of reach. In some cases access to a loan is important and has allowed the business to buy raw materials in bulk or purchase equipment for production, contributing to increased sales. Credit facilities can play an important role for customers of institutional stove producers, where the upfront cost of the stove is high. In these cases customers have been able to pay for the stove in instalments and the burden of chasing finance is taken away from the supplier.

Chapter 5: Performance of Cookstoves in the Developing Energy Enterprise Programme

5.1. Introduction

The quality and performance of improved cookstoves can vary greatly between producers depending on the materials used, design and production process followed. For improved cookstoves, quality refers to the durability of the product, particularly the ceramic part of the stove, the grade of materials used and the stove finishing. Performance refers to operational characteristics of the stove, such as the fuel consumption, thermal efficiency and time to boil as well as carbon monoxide and particulate matter emitted during operation.

Locally produced ceramic lined cookstoves are often quoted as having thermal efficiencies of 25 – 40%, whereas traditional cooking methods such as the three stone fires have a thermal efficiency of around 10-15% and a traditional metal charcoal stove around 20%. This translates into fuel savings of around 40-50% for improved stoves compared to traditional methods such as the three stone fire and open metal jiko. Highly engineered and tested imported stoves are a recent addition to the cookstove market in East Africa and boast impressive performance statistics. However many local producers, such as those in the DEEP programme, have never tested their stoves and don't actually know the performance of their product.

Sub-standard products on the market are a major challenge within East Africa. Such stoves are marketed as 'improved' yet often do not reduce fuel consumption or emissions compared to traditional cooking methods. They are also of poor quality often breaking within a few months, requiring replacement by the user and confusing the market as to what is 'improved' about an 'improved cook stoves'. By engaging in product testing stove producers are able to ascertain the performance characteristics of their products. This will help them in improving the design of their cookstoves and also when marketing their product.

Recently the international cookstove community has been discussing standardising procedures for cookstove tests and developing guidelines for minimum stove standards. An International Workshop Agreement (IWA) was signed in February 2012 which provides guidelines for rating cookstoves on key performance indicators (fuel use/efficiency, total emissions, indoor emissions, and safety), a process that has been led by The Partnership for Clean Indoor Air (PCIA) and the Global Alliance for Clean Cookstoves[20]. The introduction of carbon credit programs targeting cookstoves has also required producers to quantify their carbon saving potential through testing.

[20] http://www.pciaonline.org/news/cookstoves-iwa-unanimously-approved

Standard testing protocols have been under development for the past two decades with organisations such as VITA, Aprovecho, Shell Foundation and the University of California Berkley leading the way. There are three standard tests which are widely in use:

- **The Water Boiling Test (WBT)**[21] - a laboratory test that compares stove performance while completing a standard task in a controlled environment to investigate the heat transfer and combustion efficiency of the stove.
- **The Controlled Cooking Test (CCT)**[22] - a field test that measures stove performance in comparison to traditional methods when a cook prepares a local meal to investigate stove performance using local fuels, pots, and practice.
- **The Kitchen Performance Test (KPT)**[23] – a community field test that measures fuel use in homes after stoves have been distributed to ensure real-world savings and use.

While testing is becoming more widespread significant challenges still exist in making testing facilities accessible to local cookstove producers, with the costs of testing often several hundred dollars and out of reach to micro entrepreneurs. The availability of testing facilities is also a challenge in East Africa where centres with the appropriate equipment and expertise can be scarce and often located far from cookstove producers.

The Global Alliance for Clean Cookstoves is trying to address this issue through its Standards and Testing activities, releasing a request for proposals in July 2012 to enhance capacity of regional testing and knowledge centres[24]. Under this proposal The Alliance will be supporting the development of a network of "Regional Testing and Knowledge Centres" (RTKCs) that can provide testing, stove development, and capacity building services.

To ascertain the performance characteristics of the stoves being produced under the Developing Energy Enterprise Programme (DEEP), GVEP International engaged in stove testing for a sample of high potential cookstove entrepreneurs in its program. The water boiling test was conducted on 12 stoves from entrepreneurs in Kenya, Uganda and Tanzania at testing facilities at The Centre for Research in Energy and Energy Conservation (CREEC) in Kampala, Uganda and The University of Nairobi in Nairobi, Kenya. In addition, exposure to emissions was also monitored throughout the tests and the stove liners were subjected to thermal shock testing. The tests and results are explained in more detail in the following sections.

[21] http://www.pciaonline.org/node/1048
[22] http://www.pciaonline.org/node/1050
[23] http://www.pciaonline.org/node/1049
[24] http://www.cleancookstoves.org/funding-opportunities/testing-rfp-pdf-file-1.pdf

5.2. Stoves Tested

A sample of stoves was selected from high potential entrepreneurs in each of the three countries. These entrepreneurs were selected based on a criterion including business turnover, commitment to the business, quality and growth potential. The selection included 4 wood stoves, 7 charcoal stoves and 1 multi-purpose stove that can use both wood and charcoal as shown in the pictures below.

Each stove is given a code as shown below which will be used to identify it in the presentation of results.

• Kenya

Stove Producers Sampled: Keyo Pottery Enterprise, Sustainable Community Development Services (SCODE), Ludia Dede

Multipurpose Stove Wood/ Charcoal – KWC1

KuniMbili – Wood – KW2

Kenya Ceramic Jiko – Charcoal – KC1

Uhai Stove – Charcoal – KC2

Traditional Metal Stove – Charcoal - KTMS

Kenya Ceramic Jiko Small – Charcoal – KC3

• Uganda

Stove Producers Sampled: Herbert Bogezi, Clay Mix, Energy Uganda Foundation

Wood Stove – Wood – UW1

Charcoal Stove 1 – Charcoal – UC1

Charcoal Stove 2 – Charcoal – UC2

Traditional Metal Stove – Charcoal - UTMS

Rocket Stove – Wood UW2

• Tanzania

Stove Producers Sampled: Mama Shigella, Damado Victoria Works

Clay Wood Stove – Wood - TW1

Clay Charcoal Stove – Charcoal – TC1

Metal Charcoal Stove – Charcoal – TC2

5.3. Tests Conducted

The stoves from Kenya were tested at the University of Nairobi (UON) whilst the stoves from Uganda and Tanzania were tested at The Centre for Research in Energy and Energy Conservation (CREEC) in Kampala. It was decided to transport the Tanzanian stoves to Kampala for testing since no suitable testing facility could be located in the vicinity of Mwanza, where the stoves were produced.

A water boiling test (WBT) was performed on each of the stove samples in a basic laboratory set up as shown in Figure 13. Although this is not the best representation of how the stove would perform under real life conditions, as used in a local kitchen, the WBT was chosen based on its ease of replication, the budget for the testing and to give a series of parameters that could be compared between the stoves. During the WBT carbon monoxide (CO) emissions and particulate matter (PM) were monitored to give a measure of the exposure that a cook in the kitchen might experience. The procedures followed for each of the tests are given in Annex E.

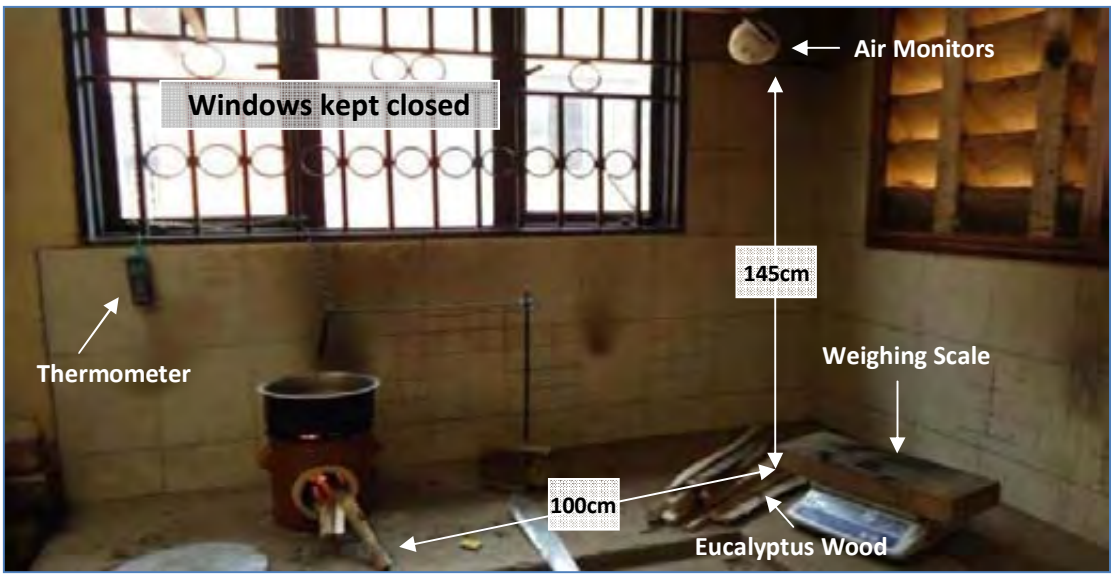


Figure 13: Experimental Set up for stove testing at CREEC

In most cases the tests were performed on three samples of each stove. For each sample three water boiling tests were performed giving a total of 9 tests per stove type, which was used to give an average result. For some of the stoves from Uganda and Tanzania 3 samples could not be obtained due to availability and logistical issues, however the results are still presented to give an idea of potential stove performance, but should be treated with more caution. The table in Annex F shows the number of samples tested for each stove.

In each location a three stone fire and traditional metal charcoal stove was also tested to benchmark the results against. In Kenya the KC3 stove was not suitable for use with the standard pot size, as used on the larger stoves, so a smaller traditional metal stove was also tested for comparison purposes both using 2.5 litres of water.

Although the tests in Nairobi and Kampala were replicated as closely as possible a number of variables still exist which make the results difficult to directly compare, for example the quality of fuel used, ventilation in the lab, how the fire was tended, size of the room etc. There was also a significant difference in the performance of the three stone fires and the traditional charcoal stoves used to benchmark performance of the stoves. In the presentation of results the Nairobi and Kampala tests are presented separately and caution should be exercised when comparing directly between the two sets of results.

a. Results of Stove Testing

i. Water Boiling Tests and Emissions Monitoring

Key: *Tested in Kenya* *Tested in Uganda*

The following sections present some of the main results from the water boiling tests and emissions monitoring conducted on the stoves and provides some comparison between the different stoves and analysis on their performance. Wood stoves and charcoal stoves are presented in separate charts. A full table of results for quick comparisons is available in Annex G.

Price Of Stove

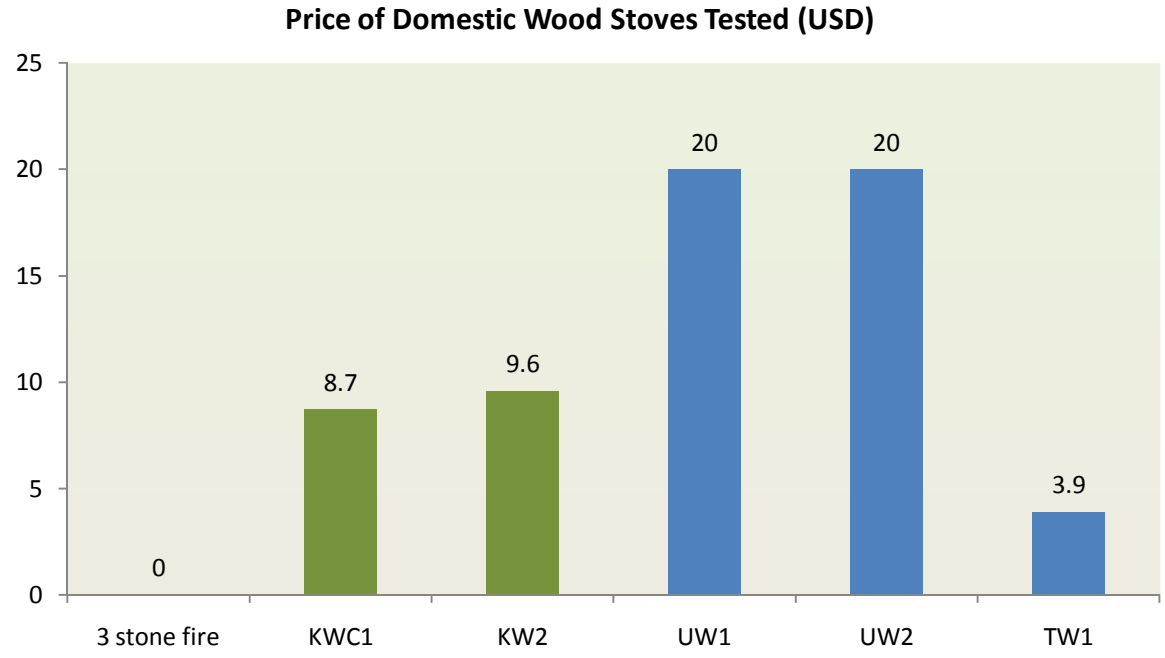


Figure 14: Price of Domestic Wood Stoves Tested

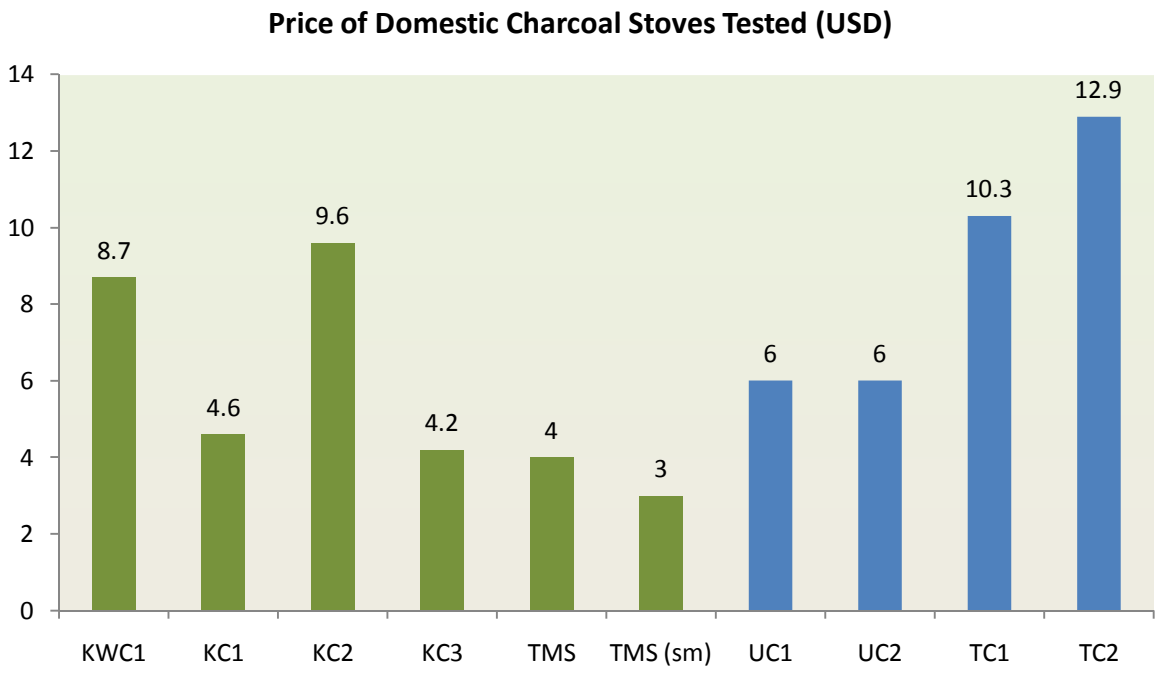


Figure 15: Price of Domestic Charcoal Stove Tested

From the wood stoves the TW1 stove from Tanzania is the cheapest, having a basic clay body with no metal parts. The two stoves from Uganda are the most expensive at 20 USD each.

For the charcoal stoves the traditional metal stoves (used as a benchmark) are the cheapest, they are often made from scrape metal and constructed by local metal workers. The Kenya Ceremic Jiko type stoves (KC1 & KC3) cost only slightly more than the traditional metal stoves and are still under 5 USD. The most expensive charcoal stoves are those from Tanzania, TC2 in particular which has a clay liner fully enclosed by metal. These stoves are not commonly available in the wider market in Tanzania and are unique to the individual producer, which is reflected in the higher price.

Thermal Efficiency

This is the most commonly used metric for reporting stove performance. As discussed later in this section, there are limitations to using thermal efficiency alone as a measure of performance. However, it is important for understanding performance.

Thermal efficiency reveals how well the energy is transferred from the fuel to the products being cooked. Thermal efficiency is the percentage of the fuel's heat energy that goes to the water in a pot placed on the stove. It caters for both the combustion efficiency (how well the fuel burns to give off energy) and the heat transfer efficiency (how well the stove transfers energy to the pot).

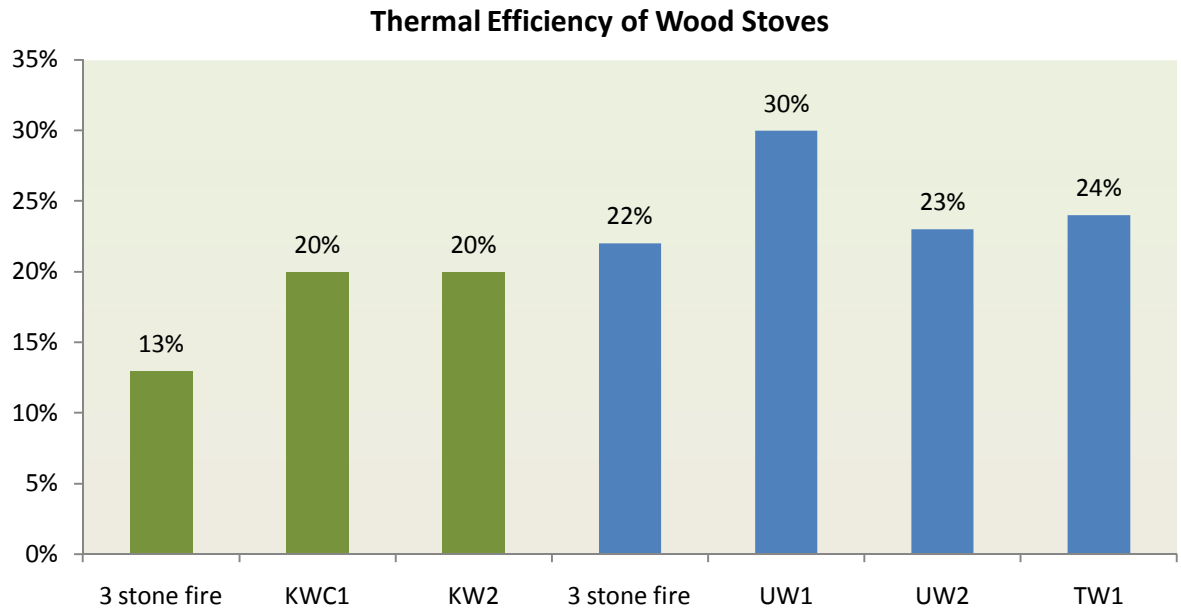


Figure 17: Thermal Efficiency of Wood Stoves Tested

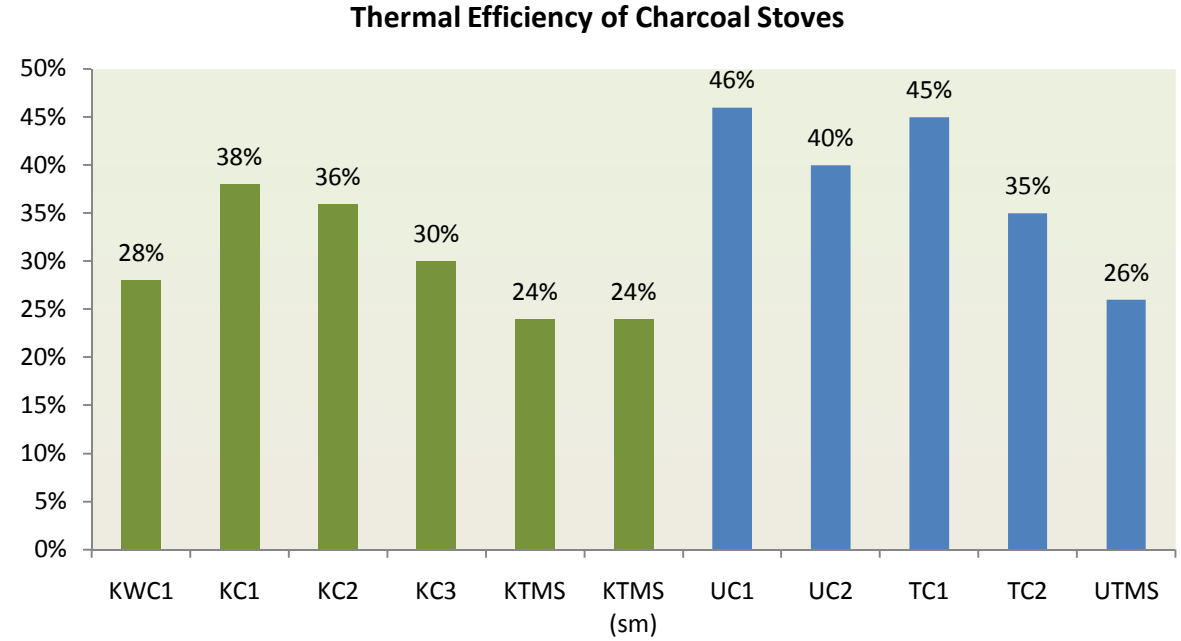


Figure 16: Thermal Efficiency of Charcoal Stoves Tested

In general the charcoal stoves had a higher thermal efficiency than the wood stoves. All of the improved cook stoves had higher thermal efficiencies compared to the respective traditional method (open fire for wood or traditional metal stove for charcoal), although in some cases such as the UW2 stove in Uganda the difference was small. The improved thermal efficiency is due to less heat being lost to the surroundings and more heat being transferred to the cooking pot mainly due to the use of insulating ceramic material in the improved stove. Depending on the materials used in this liner its efficiency at transferring the heat will vary giving rise to differences between the improved stoves (24).

As expected the charcoal stoves in Kenya displayed thermal efficiency of 25-40%. However most of the charcoal stoves tested in Uganda had higher thermal efficiencies, with the UC1 stove having a 46% thermal efficiency. The traditional metal stoves in each country displayed similar thermal efficiencies, however the thermal efficiency of the three stone fires tested in each location was quite different, highlighting how user operation and other variables can significantly affect it performance.

Stove manufacturers often quote thermal efficiency results when talking about their stoves performance. However during boiling a lot of energy can be used to vaporize the water which will give the stove a higher thermal efficiency but in most cases does not contribute to cooking the food. Instead thermal efficiency should be considered alongside other factors such as power output and specific fuel consumption (25).

Specific Fuel Consumption

Specific fuel consumption is defined as the average amount of fuel consumed to produce a unit output. For this case, it is the amount of fuel consumed per litre of water boiled. The specific fuel consumption of each stove can be compared to that of the respective traditional method to determine the fuel saving between the two. The specific fuel consumption of the stoves tested are shown below.

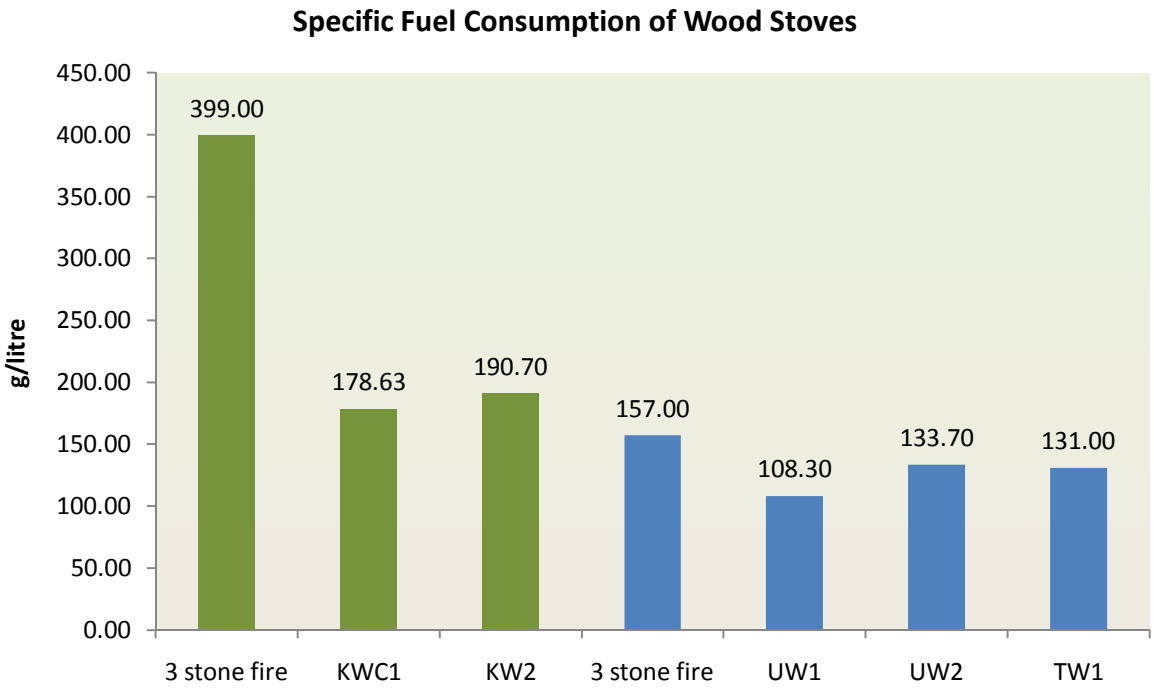


Figure 18: Specific Fuel Consumption of Wood Stoves Tested

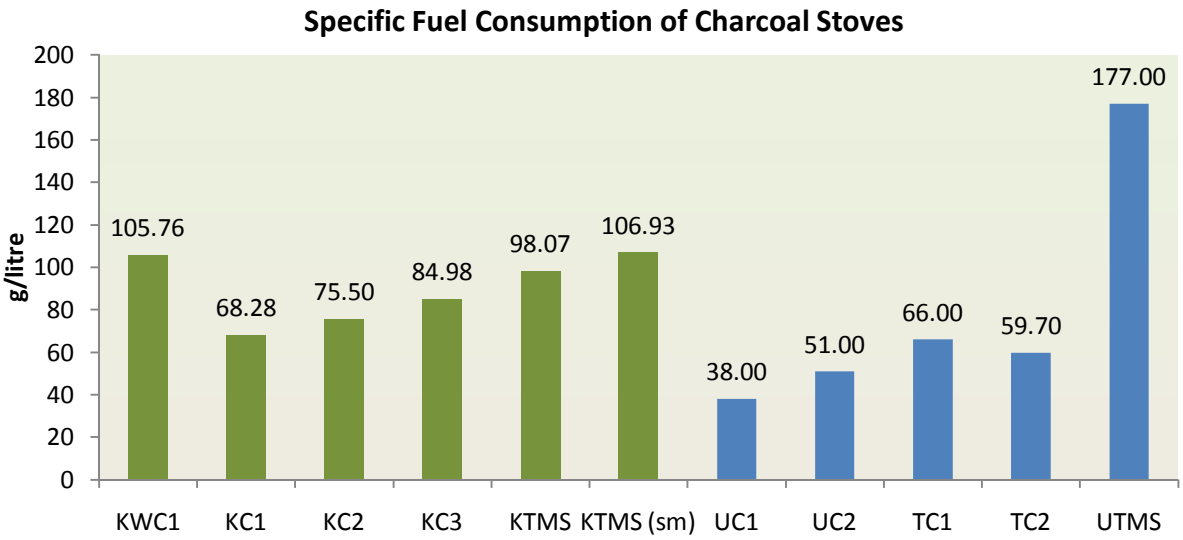


Figure 19: Specific Fuel Consumption of Charcoal Stoves Tested

In general, the wood stoves have a higher specific fuel consumption compared to the charcoal stoves. In Kenya the wood stoves offered fuel savings of 50-55% whereas in Uganda the wood stoves offered smaller fuel savings in the range of 15-31% compared to the open fire tested at each location. However the fuel consumption of the three stone fire used as a benchmark in each location differed significantly.

For the charcoal stoves, the KWC1 is the only stove that used more fuel than the traditional metal stove (although it offered significant savings using wood). This stove is primarily designed as a wood burning stove, with the charcoal grate added in more for user convenience than performance potential. For stoves tested in Uganda the charcoal stoves offered significant fuel savings in the range of 60-80% compared to the traditional metal stove which had relatively high specific fuel consumption. Again the UC1 stove that had the highest thermal efficiency also had the lowest specific fuel consumption.

The higher fuel savings of the charcoal stoves in Uganda are likely to reflect the poor performance of the traditional metal stove there, which had a fuel consumption of 177 g/litre compared to the traditional metal stove used in Kenya which had a fuel consumption of 98 g/litre. As can be seen in the pictures the traditional stoves tested in each country are of different design, which in the Kenyan case had lower fuel consumption. Improved stoves may not achieve major fuel efficiencies when compared to a well-made ‘traditional stove’ but can achieve significant fuel savings when compared to the more open type of charcoal stove.

The same is true for the three stone fires in each country. In Kenya the three stove fire had a specific fuel consumption of 399 g/litre, compared to 157 g/litre in Uganda, a significant difference. Operation of the stove, better fuel, and perhaps the arrangement and size of stones, could potentially lead to some of these differences.

The difference in performance of these 'benchmark' stove' makes it difficult to compare fuel savings between the two countries, hence why specific fuel consumption is shown here instead. Fuel savings normally translate into reduced expenditure for households and are an importance factor for households operating on limited budgets. Certain stoves appear to offer much better value for money than others. For example the TW1 stove from Tanzania only cost $3.9 and offers the user around 17% fuel savings compared to the three stone fire, whereas the UW2 stove which costs $20 had higher fuel consumption. The UC1 charcoal stove in Uganda is also good value for money costing $6 and having the lowest specific fuel consumption and offering greater fuel savings than the more expensive Tanzanian charcoal stoves (TC1 & TC2).

For the stoves tested, performance varies a lot and the price of the stove doesn't correlate with performance - aesthetics and workmanship may be more of an influencing factor in this. The results suggest that there is considerable scope for some stoves to improve on fuel efficiency, without increasing (and potentially even decreasing) the price of the stove. These results are symptomatic of a market where the producers have very little technical training and have no access to testing and prototyping facilities. In a developed market you would find more expensive products generally offering higher levels of performance (being more expensive to manufacture). This may also explain why consumers are unwilling to pay higher prices for improved cookstoves, when an increase in price does not necessarily correlate to improved performance or quality.

Carbon Monoxide Exposure

The carbon monoxide (CO) data was collected using Easy Log CO monitors at a time interval of one minute. The CO present during the boiling and simmering phase (approximately a one hour period) was monitored at each time interval and an average taken. The charts below show the average CO emissions given off by each stove. These are compared to the WHO indoor Air Pollution Guideline for carbon monoxide, which is a maximum of 30.6ppm for 1 hour (26).

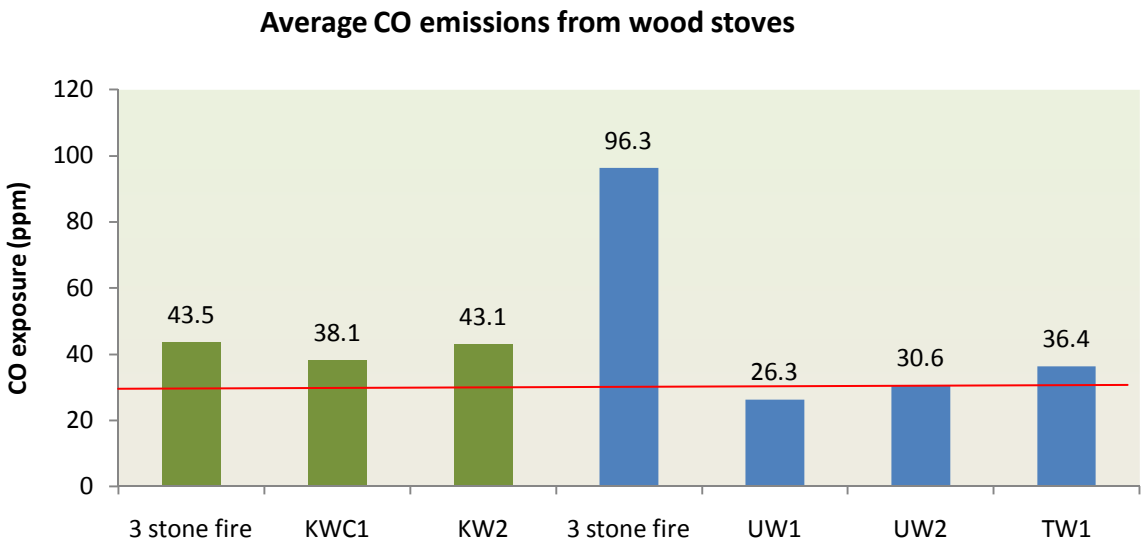


Figure 20: Average Carbon Monoxide Emissions from Wood Stoves Tested

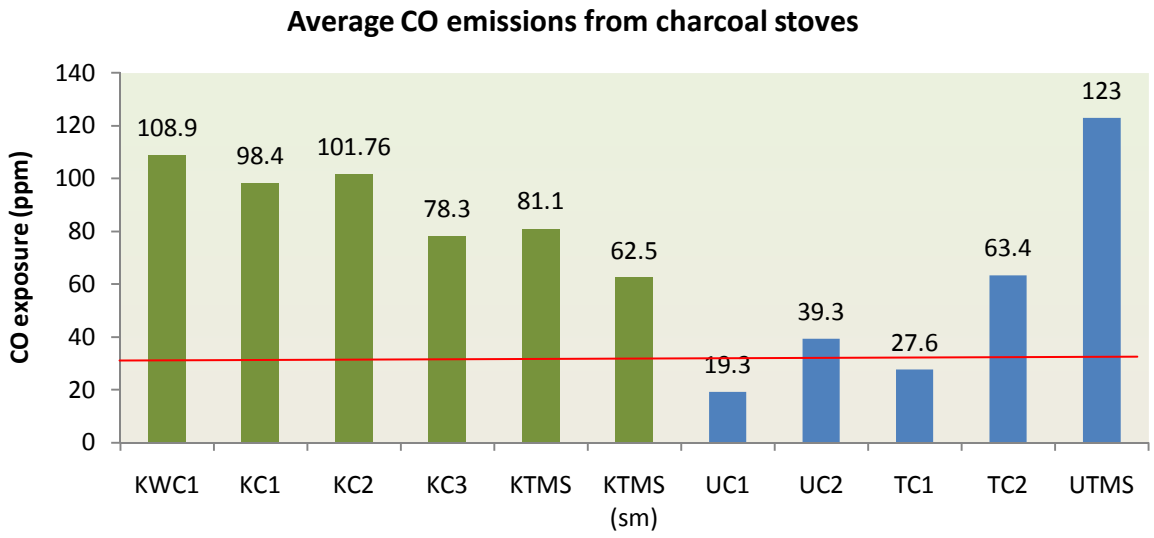


Figure 21: Average Carbon Monoxide Emissions from Charcoal Stoves Tested

The wood stoves released less carbon monoxide than the charcoal stoves due to the nature of the fuel they burn. Again there was significant variation between the three stone fire and traditional metal stove used in each location as a benchmark.

The charts show that none of the stoves tested in Kenya fall within the WHO guideline for CO exposure. In fact all of the charcoal stoves increased exposure to carbon monoxide compared to the traditional metal stove. The smaller charcoal stoves released the least CO. Contrary to the results from Kenya, several of the stoves tested in Uganda fall within the WHO guideline for CO exposure (UW1, UC1 & TC1). In all cases CO exposure was reduced by the improved stoves compared to the respective traditional method.

The level of exposure to CO and PM varies significantly between the stoves tested and between the two testing centres. CO exposure will be affected by a range of variables, notably the ventilation in the room, which could vary between testing centres and even on a daily basis. The position of the monitors varied slightly between the two labs and the size & shape of the rooms where also different.

Particulate Matter Exposure

The particulate matter (PM) data was collected using UCB-PATS at a time interval set by the tester. The PM present during the boiling and simmering phase (approximately a one hour period) was monitored at each time interval and an average taken. The charts below show the average PM emissions given off by each stove. These are compared to the WHO Guideline for Indoor Air Pollution, which is 25µg/m^3 (24 hours) for PM2.5 (27)[25].

[25] Assume that for 1 hour, the limit is 25/24 ≈1µg/m^3

As expected the charcoal stoves give off less PM than the wood stoves due to the nature of the fuel they burn and hence several of the charcoal stoves tested fall within the WHO guideline (one of them the small traditional metal stove). In Kenya there is no significant difference in PM exposure between the improved and traditional charcoal stove, with the KC1 stove giving off high levels off PM. In Uganda all of the improved charcoal stoves reduced emissions compared to the traditional methods and fell within the WHO PM guidelines. None of the improved wood stoves were within the WHO guidelines but they all reduce exposure compared to the three stone fire.

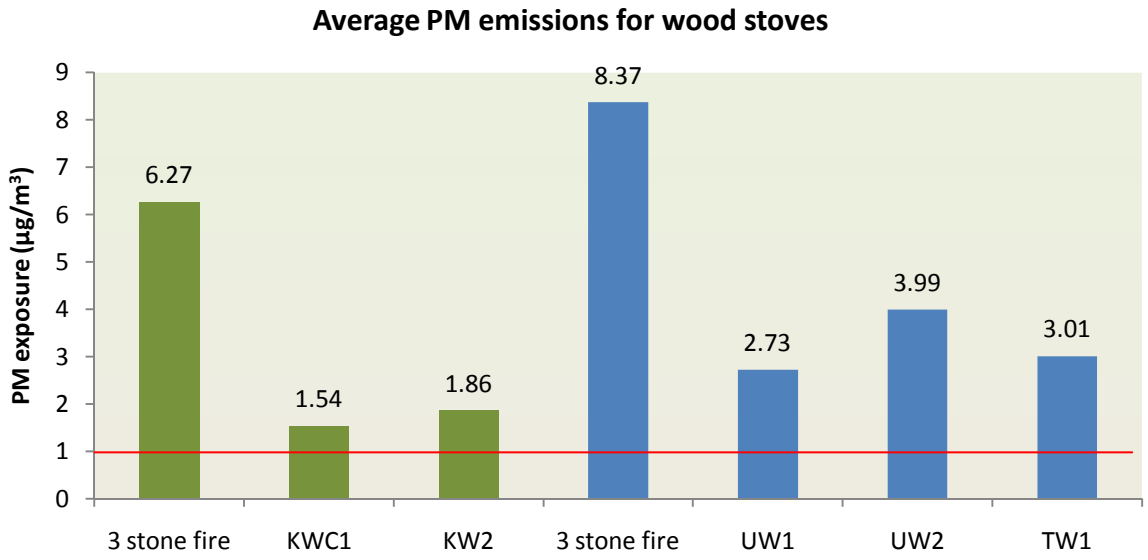


Figure 22: Average Particulate Matter Emissions from Wood Stoves Tested

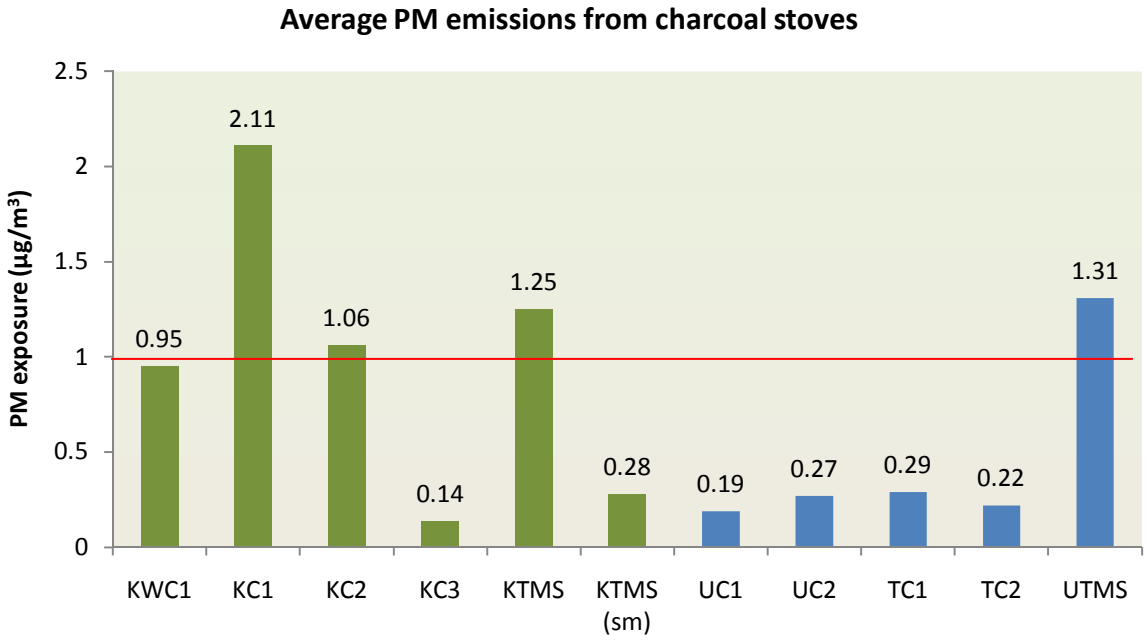


Figure 23: Average Particulate Matter Emissions from Charcoal Stoves Tested

ii. Materials Testing

In addition to the water boiling test with emissions monitoring, the ceramic liners of the stoves were tested to get an indication of their durability and material properties. This involved subjecting the liner to thermal shock testing in which the liner is heated to temperatures ranging from 800℃ - 900℃ and then immersed in cold water at room temperature. Since the heating and cooling cycle is extreme a liner which can withstand 5 cycles is considered to be made from a clay mix that is thermally shock resistant. This test is based on the Kenya Bureau of Standards (KEBS) standard for biomass stoves. In addition the density of the liners was also measured.

The liners from five stoves from Kenya and three stoves from Uganda were tested. Due to logistical issues and breakage of liners during transport no stoves from Tanzania were subjected to material testing. The liners in Kenya were tested at the University of Nairobi whilst in Uganda testing was done by the Centre for Integrated Research and Community Development Uganda (CIRCODU) at The University of Makerere. Only one sample of each liner was tested.

Results

Table 12: Results from thermal shock and density testing on ceramic stove liners

Stove	Thermal Shock	Density (g/cm^3)
KWC1	No breakage after 5 cycles	1.639
KW2	No breakage after 5 cycles	1.638
KC1	No breakage after 5 cycles	1.639
KC2	No breakage after 5 cycles	1.647
KC3	No breakage after 5 cycles	1.637
UC1	No breakage after 5 cycles	1.94
UC2	No breakage after 5 cycles	1.795
UW1	Cracks after 1 cycle	1.717

Apart from one liner (UW1) all of the stoves survived 5 cycles of extreme heating and cooling, indicating that they are thermally resistant. The UW1 liner that developed cracks after one heating cycle was heated in a different oven that the UC1 & UC2 due to its larger size. This oven had a slower rate of heating, so the liner was heated for longer which may have resulted in more thermal stress.

The liners tested had densities between 1.637 g/cm^3 and 1.94 g/cm^3. Liners are used in improved cookstoves to retain heat that would be otherwise lost to the surroundings. In East Africa clay is most often used for ceramic liners since it is cheap and locally available. Unlike metal, clay is longer lasting and can withstand the high temperatures of the combustion chamber. However, high thermal mass materials such as clay can also absorb heat that would otherwise be directed to the pot.

A compromise needs to be made between the durability and thermal mass of the material. Fillers made from organic material such as sawdust, charcoal or vermiculite can be mixed with the clay to improve its insulating properties. During firing of the liners the organic material burns away leaving insulative air spaces in the clay liner. The filler will make the liner lighter but it will also make it weaker, hence a compromise exists.

Testing conducted by organisations such as Aprovecho Research Centre has suggested that ceramic liners with a density of between 0.8 g/cm^3 to 0.4 g/cm^3 offer a good compromise (24). As can be seen from Table 12 the liners tested had higher densities that this recommended figure. Although some of this may be due to the procedure used to take the measurement (for example only one sample of each liner was tested), there appears to be scope to further improve on the mixtures used in liner production. The exact recipe for each liner was not recorded but the use of organic material such as sawdust or charcoal could be potentially used to make the liner more lightweight. The availability of these materials would have to be considered and the cost implications on production, however, materials such as sawdust and charcoal dust are commonly available in many parts of East Africa and could potentially be utilised further.

5.4. Further Discussion

Throughout the testing, differences can be seen in the results from the testing conducted at The University of Nairobi in Kenya and The Centre for Research in Energy and Energy Conservation (CREEC) in Uganda and it is difficult to compare directly between the two sets of results. Even where standard testing procedures are used, they cannot account for all variables in the testing set up, differences in user operation and user error. For example, the following observations where made which could account for variation in testing conditions;

- During the WBT the University of Nairobi used a 6 litre capacity pot with 4 litres of water, whilst CREEC used a 7 litre capacity pot with 5 litres of water. This variation would affect the time to boil and also thermal efficiency.
- The moisture content of the wood used at The University of Nairobi averaged between 8-11% compared to 15-17% at CREEC. Drier wood tends to give off less smoke and would affect the measurements of PM exposure.
- The University of Nairobi used a pot of 6 litre capacity weighing 450g whereas CREEC used a 7 litre capacity pot weighing 360g. This suggests that the pot at UON was of thicker material which would slow down heat transfer and could affect the time to boil and thermal efficiency.

The traditional metal stoves used in each location are of varying designs which will also affect the comparison for the charcoal stoves. In each location only one sample of a traditional stove and three stone fire was tested which does not take into account variations in design and use. In Kenya the traditional metal stove performed relatively well in terms of fuel consumption and emissions.

These traditional methods can be effective cooking devices when used properly and new 'improved' stoves entering the market need to offer tangible benefits against what is already available.

In hindsight, a meeting should have been arranged between the two testing institutes before testing commenced to allow them to discuss the procedures to be carried out and the testing set up to plan for replication. A control stove could also have been used, so that the same stove was tested at each lab to act as a benchmark, which other results could be normalised against. For further testing it is recommended that all stove are tested at the same facility to allow for easy comparison.

During the writing of this report, GVEP consulted several professionals in the field of stove testing about the results, an option unavailable to most local producers. For a manufacturer testing stoves for the first time it is challenging to locate a testing facility, understand the tests to be done and interpret the results without any external support. Although standard procedures exists for stove tests, it is impossible to replicate all of the variables, such as ventilation, stove operation and lab size, that can influence performance measurements, between different labs.

Stove performance cannot be judged on one characteristic alone. Within the above section we have presented some of the main findings from the testing conducted, with a more complete table given in Annex G. Other factors such as time to boil and ability to control the stoves firepower are also important considerations. There are also important factors outside of the scope of this testing such as ease of use, safety of the stove and aesthetic appeal which will affect a consumers decision to purchase a stove. The specific task to be done or objective of promoting the stove will often determine the most suitable stove to use.

The stoves tested here are artisan made and variations may exist from one stove to the other due to lack of standardisation on the production process. Without uniformity the performance of the stove cannot be guaranteed across the product line - further highlighting the need for businesses to incorporate quality control and unsure uniformity.

Carbon monoxide and particulate matter emissions contribute to Indoor Air Pollution (IAP) which has been linked to serious short and long term health problems. The carbon monoxide results should be treated cautiously. It is likely they represent a snap shot of the stoves performance for that particular task, setting & laboratory conditions and cannot be used to determine any particular health impact of the stove.

Carbon monoxide and particulate matter are formed when fuel and air do not completely mix, which results in incomplete combustion (28). Complete mixing does not occur in stoves with natural draft, as tested here, resulting in exposure to PM and CO. Many stove programs have concentrated on reducing fuel use and have not fully considered the stoves impact on exposure to emissions. The results presented here show cases of improved stoves that increase and decrease exposure to emissions as compared to traditional methods they aim to replace.

This suggests that there is scope to work with local artisans to develop improved versions of stoves with lower emissions. There will inevitably be trade-offs between emissions levels and other performance characteristics but stove performance could be better optimised.

5.5. Conclusions from Stove Testing for the DEEP Programme

Completing this testing provided a valuable learning experience on some of the challenges associated with stove testing and also on the importance of stove testing for any business producing and selling stoves. Questions may still remain around the interpretation of the test results and how representative they are of the wider market and the performance of the stoves in a user's home. However, it is importance to share the findings of stove testing to inform others in the stove sector and continue the debate around stove design and testing.

The following conclusions can be drawn from the results of the stove testing and fed back into the support offered to local stove artisans through programs such as DEEP:

- Significant variations exist between the performances of locally manufactured stoves. The results have shown that local artisan produced stoves can save the end user fuel and in some cases potentially reduce emissions exposure (although further testing is required to draw firm conclusions). Technology transfer between entrepreneurs producing high performing stoves and those of poorer quality could be beneficial in improving on stove design.
- A better understanding of stove performance is required not only from a technology perspective but also considering the effects it has on the users experience and how it might influence their purchasing decisions. Controlled Cooking Tests (CCT) and Kitchen Performance Tests (KPT) should be conducted in addition to the WBT to understand the stoves performance in real kitchens performing common cooking tasks.
- Changes to existing stove designs are sometimes made by producers for aesthetic purposes and ease of use (such as the multipurpose stove). These changes often do not improve on the performance of the stoves and in some cases can reduce it. However it is also important to consider the consumers' needs from the stoves and what is appealing to them and try to incorporate that without compromising on performance.
- There is a need for further investment and capacity building of local testing centres, to ensure the equipment and expertise, to provide accurate results that can be confidently presented, are available. Testing facilities also need to be made affordable to local stove manufacturers to promote a better understanding and awareness of stove performance. Further work needs to be done in adopting standard testing procedures and systems for comparing results cross border and making this information available to local stakeholders.

- Local entrepreneurs need to be on board and committed to improving the performance of their stoves, to make the necessary design and production changes required to shift the market. Incentives need to be provided to producers, such as providing product development or facilitating access to loans, to encourage them to improve on their stoves performance. Raising consumer awareness around the benefits of stoves will help producers realise the demand for better performing stoves.

Stove manufacturers often produce a range of stove designs and sizes using both wood and charcoal. Each stove design and size will perform differently and require separate analysis to make improvements. In this respect, fewer changes are involved if manufacturers concentrate on one design of stove. This will reduce the work involved to improve on stove design, conduct quality control and link to carbon finance.

Chapter 6: GVEP Strategy For Improved Stoves

6.1. Introduction

Energy for cooking is once again on the agenda of the international development community. Fuel prices are rising, alongside the general cost of living, putting pressure on consumer's limited household budgets. Forest cover in East Africa is reducing as land is cleared and wood resources are harvest at alarming rates for settlements, agriculture, fuel and industry - having serious environmental and economic effects. Depletion of forest cover in East Arica has been linked to fatal mudslides, loss of economic activities and heightened tensions between communities as well as affecting local eco systems, biodiversity and habitats (11)(13) (12). The health impacts of using biomass for cooking in enclosed spaces includes pneumonia, cardiovascular disease and mental impairment as well as short term effects such as coughing and sore eyes. Exposure to high levels of indoor air pollution for pregnant women also results in low birth weight infants (1).

Improved cookstoves have been promoted in East Africa for over two decades. However many of these stoves do not reduce emissions to a level low enough to reduce long term health risks, although short term impacts and safety issues can be addressed. Reducing long term health impacts from cooking with biomass is difficult and further research and detailed household studies are required. Health impacts can be reduced by moving people away from cooking with biomass to cleaner fuels such as LPG, biogas and alcohol fuels, but this is not going to happen quickly. Fundamental issues around infrastructure, supply and governance for LPG need to be addressed as well as overcoming user perceptions and upfront hardware costs. In reality availability and affordability of fuel are key market drivers determining the type of stove used. Potential health benefits are not a factor in current consumer purchase decisions.

In the past many programs have focused on training entrepreneurs in the production of local artisan stoves and assisting them in marketing activities, for example, covering transport of goods and taking products to exhibitions. However many of these approaches have failed to sustain commercialisation when the program ends and indirect subsidies are taken away. As a result many entrepreneurs have adopted the mind-set that energy products cannot be sold on a commercial basis without subsidies and donor support. Over the past few years some programs have shifted their focus to promote business development skills alongside training on production and have attempted to open up new distribution channels to reach end users. For example organisations such as Solar Sister in Uganda, are selling stoves through women's sales networks and East Africa Energy in Kenya has linked up with Unilever to sell a Royco branded cook stove both direct to the consumer and through Royco product stockists.

6.2 GVEP International's Experience

GVEP International started implementing the Developing Energy Enterprise Programme in March 2008. From the outset DEEP aimed to be technology neutral and build on the existing businesses in the target regions. As a result the programme has been enterprise led with businesses approaching DEEP for support, as well as being identified through local partners. DEEP never set out to be a cookstove programme but came to work with local cookstove businesses as a result of the existing market.

The programme initially set out as a provider of business development services and technology training for energy businesses. The programme aimed to take a facilitating role without being directly involved in the buying and selling of stoves. Since then the programme has built on lessons learned. After year 3 of the programme a new strategy was introduced to address issues in the wider value chain. Creating market linkages within the value chain, facilitating access to finance and developing entrepreneurs marketing skills, were given a larger focus in the programme. Businesses were also categorised on their performance and potential. Tailored training based on individual business' needs has been targeted at high performing businesses with potential to scale up.

Local artisans are playing an important role in the cookstove market in East Africa and will continue to do so in the medium term especially around urban and peri urban areas where charcoal use is high and consumers are paying for their fuel. Within the DEEP program alone 268,726complete stoves were sold in the first 6 months of 2012. This is a much greater volume than sales reported for imported models. Within the programme artisan producers are operating on a commercial basis, without receiving carbon subsidies.

Although current research suggests that there is little scope to modify the design of improved cookstoves enough to have long term health benefits, these stoves can reduce emissions to a level that can alleviate some of the short term impacts such as coughs and sore eyes and also protect families against safety issues and burns. These stoves also offer fuel savings to households that are operating on limited budgets, hence saving money for the end user and reducing some of the pressure on forest resources.

6.2. Moving Forward

There is no one solution to unlocking the potential of the improved cookstove sector. A range of interventions are needed at different levels of the value chain and within the larger enabling environment. The sections below describe some of the interventions that are needed based on the experience of the DEEP program.

Consumers

The consumer should be the ultimate driver of the cookstove market as the person who will buy and in most cases use the stove. The consumer can sometimes get forgotten and in the past programs have often tried to 'educate' the consumer on a particular type of technology instead of listening and responding to consumer needs. Dialogue between the consumer and producers/retailers should be two way - whilst consumers need to understand the issues around cookstoves and be able to use their stove to maximum effect, stove producers need to seek feedback from the consumer on how they can improve their stoves. Examples of this have already been seen with modifications adding stove legs to lift it off the ground & clay pot rests for example. Innovations such as the multipurpose stove in Kenya have been designed to respond to consumers who don't want to buy two stoves for different fuels. These design changes should be made in a way that does not compromise on stove performance.

Overall awareness around improved cookstove in East Africa is low. Many consumers are not aware of quality products on the market and see cookstoves as cheap items which need frequent replacement. They are often willing to spend money on household items but do not see cookstoves as a priority when deciding where to spend their limited budgets. This is particularly true in Tanzania and Uganda, where outside of urban centres the availability of improved stoves is very low. Consumers need to be aware that quality products are able to last for several years and provide the user with significant economic and in some cases health benefits. However, as the results of stove testing have shown, higher price does not necessarily result in higher performance and durability making it difficult for consumers to know which products to trust. Business models incorporating features such as guarantees on durability or 'try before you buy' trial periods could help to demonstrate these benefits and build consumer confidence. It is expected that this will result in the demand for quality products increasing, giving producers more incentive to meet this demand rather than producing low quality stoves.

Raising awareness can be done on several levels from large scale media campaigns to local efforts by stove entrepreneurs. However raising awareness of cookstoves and increasing the demand for quality products must go hand in hand with increasing the availability of quality stoves. To stimulate the market without having the products available could have negative effects on future demand. It is therefore recommended that raising awareness is initially done on a gradual scale in parallel with increasing the quality and availability of stoves, starting with local efforts in a focused area. Further research also needs to be done to understand consumer purchasing habits so that marketing approaches can be developed that are effective in communicating the selling points of stoves to the consumer.

Retailers

Retailers represent an important distribution channel for cookstoves and are often the ones that make the final sale to the end user. Cookstoves are sold alongside many other consumer commodities and the percentage of sales that a retailer makes from stoves will vary. Retailers often perform limited marketing activities and rely on customers to hear about them through word of mouth or take advantage of passing trade. Marketing support should be offered to retailers in advertising their stoves. Techniques such as simple signboards and banners, and distributing posters in the local area, may attract customers to their outlets. Retailers should also be encouraged to engage in promotional activities such as attending local markets and community meetings and perhaps employing mobile sales people to promote products in new areas.

For high potential cookstove manufacturers new retailers and innovative distribution channels should be identified to help increase their sales and reach. For example, many stove producers in Uganda manufacture in the Kampala region and would benefit from linking with retailers in Northern regions where the availability of stoves is much lower. Innovative distribution channels could be developed through linking with retail channels of existing products & companies, similar to the pilots carried out by Unilever with the Wonderbag and Envirofit products. In Kenya, for example, improved stoves could be marketed to employees of flower farms and tea estates where a large number of employees live within the vicinity & financing options such as salary deductions could be explored. Linking up the retail of stoves and alternative fuel such as biomass briquettes could help to address the fuel supply chain and encourage sales of each product.

Retailers also need to identify quality products and reliable suppliers that can ensure a continuous supply of stock. In return cookstove producers should better understand the needs of retailers including the level of quality they expect from the stoves, what products they sell fastest & how often they require new stock.

Middlemen

Middlemen are involved in the value chain mainly through buying liners or complete cookstoves direct from the producer, transporting them and selling them on to other retailers or assemblers, often in another part of the country. Within Kenya the value chain is more fragmented and middlemen are more common, whereas in Uganda and Tanzania manufacturers tend to sell direct to retailers or end users and middlemen don't play as big a part. Although they are not directly involved in any part of the production process and rarely sell direct to the end user they play a vital role in facilitating the flow of products.

Such intermediary brokers are often operating a low margin business, having to hire vehicles to transport the products across the country and sell them at a small mark up. To make the business worthwhile they need to be able to buy upfront in large quantity and support is needed to provide credit facilities to such businesses. Linkages to reliable suppliers of quality liners and stoves and interested retailers need to be made, enabling these products to be further sold down the value chain.

Middlemen can provide the market linkages missing between cookstove producers and retailers and may be beneficial in the Uganda and Tanzanian market where producers struggle to transport goods and reach the market.

Quality and Large Scale Producers

Within the East African market there are enterprises that are endeavouring to produce quality cookstoves and those that have managed to reach a significant scale of production. For such businesses, further tailored technical support should be offered in product design to maximise the performance characteristics of the stove. This could include research into design changes that can further improve on the stove without introducing a complete new design. Further technical training on the different production steps should also be provided to ensure efficiency and quality control is maintained throughout. Access to testing facilities should be facilitated to aid the design process and allow producers to fully understand their stove's performance in terms of fuel efficiency and emissions. These businesses should aspire to obtain quality standards through local standards bodies, such as KEBS in Kenya, to give their products a distinguishing quality mark and open up potential new outlets such as supermarkets.

Businesses that have already shown entrepreneurial acumen and are producing a good quality product should be further supported to scale up production and increase market reach. This includes improving access to finance for such businesses, so they are able to invest in expansion activities such as building a second kiln, buying raw materials in bulk, taking on more employees or purchasing a vehicle. This access to finance could be through loans from financial institutes, such as those facilitated through the GVEP Loan Guarantee Fund, or linking producers to carbon developers where appropriate. In addition support should be provided through business training such as developing business plans to help them plan business growth and understand how their businesses fit into the larger value chain. Financial planning also needs addressing so entrepreneurs can access additional loans required and understand how these will be repaid.

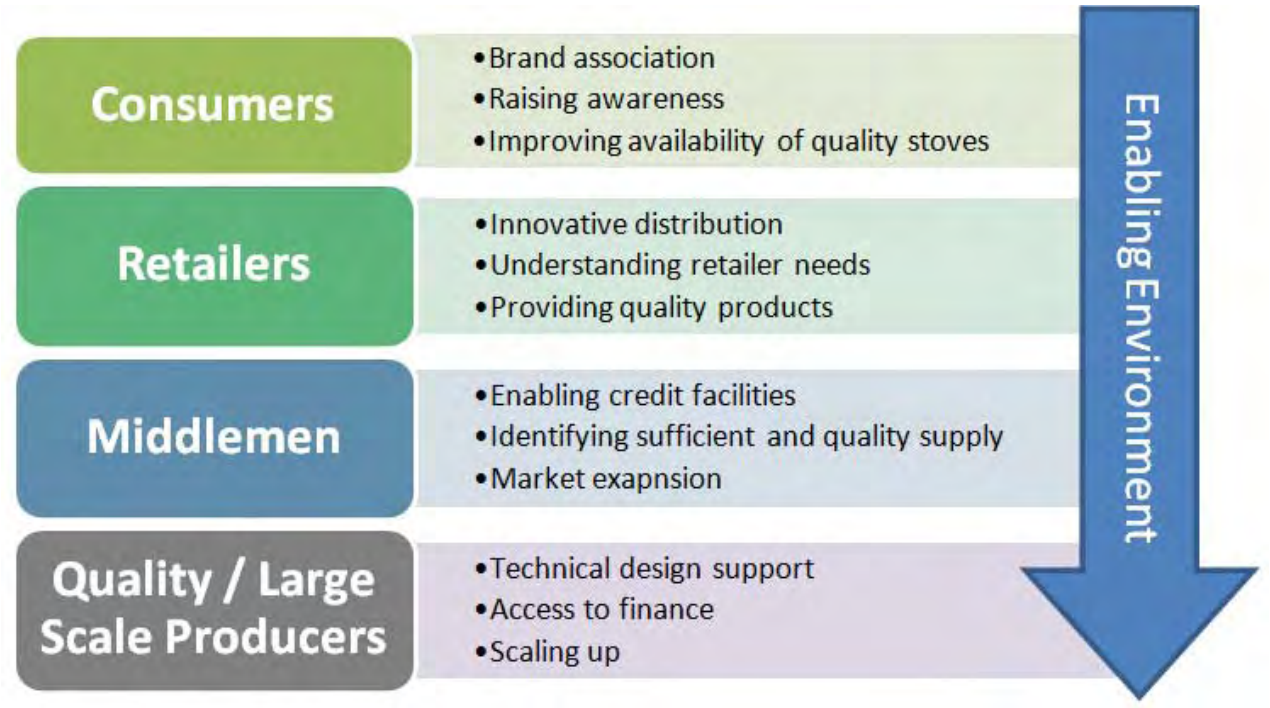
For larger producers, introducing mechanisation into the production process and focusing on lean manufacturing techniques may be a way of further increasing production and lowering costs. New market linkages should also be created to help producers expand their market and further infiltrate quality products into the market as discussed in the sections above. Quality producers that are at a smaller scale may benefit from grouping with similar businesses in the area to take advantage of economies of scale through sharing facilities, purchasing of raw materials and group marketing.

Enabling Environment

Work being done to establish global and local standards should be supported through organisations such as PCIA, GACC and national standards bodies and put into action through activities on the ground, for example working with producers to obtain local KEBS standard in Kenya and using international standards to compare test results from stoves between countries.

GVEP's experience conducting stove testing for this report has highlighted the need to increase the availability and capacity of local testing centres, so that producers have access to quality testing facilities that follow recognised procedures. In many cases grants would need to be given to testing facilities to subsidise the cost of testing for local artisans. The regional testing and knowledge centres being planned by the GACC should help to address some of these issues and should be utilised once services are available.

It is recommended that initiatives such as the GVEP loan guarantee fund is further built on with training of more financial institutes to sensitise them on energy products and the potential of lending to businesses in the cookstove sector.



Interventions would take account of differences between the structures of the market in each country. For example in Kenya where the market is more fragmented and components are made by different businesses more focus would be given to linking up the manufacturers of components to ensure quality is carried through the value chain. In Tanzania where complete stove production is dominant, quality control would be introduced to maintain standards at individual production steps.

It is recommended that the focus should be on a small number of high performing entrepreneurs who have the scope to scale up with tailored support. However other businesses with growth potential should be identified and invested in to increase their performance level. Although the focus would be given to a smaller number of entrepreneurs, it is expected that entrepreneurs improving the quality of stoves in the market and attaining standards will encourage other players in the market to follow. Support provided to the larger enabling environment such as educating financial institutes on lending in the energy sector and developing the capacity of testing centres will also benefit the market as whole.

GVEP International also supports entrepreneurs in the production of improved biomass briquettes which can help to address the complete fuel supply chain, and move uses to alternative fuel sources. It is recommended that such initiatives are continued in the future to complement efforts in the improved cookstove sector and provided further linkages between sustainable fuel supply and cooking devices. Further details of GVEP International's work with briquettes and sustainable fuel supply can be found on our website (www.gvepinternational.org) but have not been covered in the scope of this report.

6.3. Creating a Package of Support for Entrepreneurs

As outlined in the previous section there are several areas within the value chain where interventions are needed to enhance the cookstove sector. Whilst offering individual interventions may address some needs, it is recommended that support is offered as part of a larger holistic package which will enable growth throughout the value chain and the larger market system.

For many of the interventions recommended the effect can be maximised by embedding it as part of a larger process. For example improving the quality of a cookstove is an individual intervention but for it to have maximum effect it needs to be followed by scaling up the production of the stove which may require access to finance and business planning. It should also be complemented with marketing activities and raising consumer awareness to increase the demand for the stove.

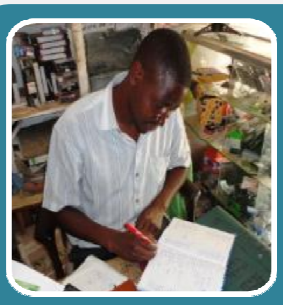
Through a holistic approach to supporting stove businesses the following can be achieved:

- Strengthened linkages between different stakeholders in the value chain.
- Broaden the perspectives of individuals to envisage the complete market system and how their activities fit into this.
- Equip value chain players with the skills and knowledge required at each part of the value chain to reduce bottlenecks and encourage long term sustainability

Below is a summary of what a package of support for local artisan stove entrepreneurs may entail. Overlap will occur between the different activities, for example a stove business may need to acquire standard moulds to improve on the stove quality, which will require financial planning or access to a loan to purchase the moulds.

Raising Quality and Improving on Product Design

- Facilitating access to testing facilities for producers to understand stoves performance
- Incorporating consumer feedback on stove design through focus groups and field testing
- Working with technology experts to use design principles to improve on stoves current design in terms of performance and emissions
- Advising on materials and production processes to be used to ensure quality manufacturing and steps to be put in place to achieve this



Business Support for Scaling Up

- Putting in place fundamental business procedures such as record keeping, costing and pricing and financial management
- Develop business plans to map out goals for business growth based on the entrepreneur's current level

Appropriate Access to Finance

- Facilitating access to loans for business expansion activities
- Linking producer to carbon finance where appropriate
- Improving access to working capital through revolving funds or overdraft facilties
- Developing financial agreements to facilitate credit to retailers and dealers

Expanding Market Reach

- Supporting entrepreneurs in marketing activities
- Creating brands for cookstoves to distinguish quality products in the market
- Creating new market linkages in the value chain
- Exploring innovative distribution channels

Empowering the Consumer

- Raising consumer awareness around stove related issues
- Consumer research into buying habits and needs and marketing methods and communication that impacts consumer choices
- Ensuring service and maintenance are available at a local level

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Annex A: Examples of improved cookstoves in the East Africa Market

Kenya	**Kenyan Ceramic Jiko**		**Uhai Stove**		**Mulit-purpose stove**	
Cost Range	$4-$10		$10 - $18		$9	
Thermal Efficiency	30-40%		36%		20% Wood, 30% Charcoal	
Manufacturer	Various		Keyo Pottery Enterprise, various		SCODE, around Kiria, various	
Key Features	Ceramic liner with metal cladding. Production has been sustained on commercial basis		Improvement on the KCJ with clay rim to retain and direct heat.		Ceramic liner and metal cladding with removable charcoal grate so it can be used with both wood and charcoal	
Production Capacity	Demand driven. Collectively large but individual producers make a few hundred a month. Liner producers may have higher capacity.		Not extensively produced- demand driven. Most production in the hundreds per month.		Not extensively produced- demand driven. Most production in the hundreds per month.	
Distribution Channels	Complete stoves sold through middlemen, retailers, markets & small vendors.		Sold through retailers, middlemen and markets.		Sold through retailers, middlemen and markets.	
Availability and Use	Use ◑ Availability ◕		Use ◔ Availability ◔		Use ◔ Availability ◔	

Kenya

	 Fixed Brick Rocket Stove	 Co2Balance	 JikoPoa	 Envirofit Wood Stove
Manufacturer	Various, GIZ trained	Made in Mombasa, distributed by Co2Balance	Fine Engineering, Nairobi	Envirofit (Imported)
Cost Range	Starting at $15	Free (subsidised), installation $2	$14 (subsidised)	$23.5 (subsidised)
Thermal Efficiency	24%-32%	Around 35%	22%	33%
Key Features	Fixed wood stove made from fired clay bricks held together with mortar	Wood stove made entirely from ceramics based on rocket stove principle	Ceramic liner inside metal cladding with pot skirt	Highly engineered wood stove manufactured in China
Production Capacity	Demand driven, end user gathers material and pays for installation.	GS projects will install 20,000 stoves each	Can produce 80 pieces a day.	Demand Driven
Distribution Channels	Direct sales	Stove distributed within vulnerable communities free of charge	Distributed through Paradigm Project	New to the market, still setting up distribution networks
Availability and Use	Use ◔ Availability ◔	Use ◔ Availability ◔	Use ◔ Availability ◔	Use ◔ Availability ◔

Uganda	**Improved Charcoal Stove**		**OkeloKuc Stove**		**Rocket Mud Stove**	
Manufacturer	Ugastove, Kampala		ILF, LIRA		GIZ trained producers, various	
Cost Range	$6.5 - $15		$8 - $11		$5-$20	
Efficiency	36%		34%		25-32%	
Key Features	Ceramic liner with metal cladding. First Gold Standard registered cookstove project		Ceramic part made from 6 bricks with outer metal cladding		Made from bricks and stones held together with insulating mud. Has two pot burners and a chimney	
Production Capacity	Currently around 4000 a month and looking to increase		Currently around 1500 a month, increasing with new facility		Demand driven	
Distribution Channels	Sell through branches and retailers		Sell through network of stove vendors		Trained installers travel to communities to promote and install. Raw materials available locally	
Availability and Use	Use Availability		Use Availability		Use Availability	

Uganda

	 Envirofit Wood Stove	 Local portable wood stoves	 Local charcoal stove (other)	 Basic charcoal stoves
Manufacturer	Envirofit (Imported)	Ugastove, petsd, various	Many grouped under BEETA network, Various	Various – mainly informal sector
Cost Range	$17	Various	$4 - $20	$1-$2
Efficiency	33%	Various	Various	Unknown
Key Features	Highly engineered wood stove manufactured in China.	Main designs follow rocket stove principles, can be metal cladded or made from mud and clay.	Improved charcoal stoves of varying type, Main design have a ceramic liner and metal cladding.	Basic ceramic stoves with short lifespan.
Production Capacity	Demand Driven	Demand driven, most producers make less than 100 a month.	Demand driven, some enterprises produce a few hundred per month.	Demand driven
Distribution Channels	New to the market, still setting up distribution networks	Mainly direct sales	Through direct sales, retailers and middlemen	Through retailers and local markets
Availability and Use	Use ○ Availability ○	Use ◔ Availability ◔	Use ◔ Availability ◔	Use ◔ Availability ◑

Tanzania

	 Improved Charcoal Stove	 Improved Charcoal Stove	 Envirofit Imported Stove
Manufacturer	SECCO, Dar-es-Salaam	CAMARTEC, Arusha	Envirofit (Distributor L's Solution)
Cost Range	$6.25 - $7.5(subsidised)	~$40 medium	$12 (subsidised)
Thermal Efficiency	35%	25%	33%
Key Features	Ceramic liner with metal cladding. SECCO make complete stove. Subsidised by about $3, will generate carbon revenue through VCM.	Ceramic liner made from bricks with outer metal cladding and metal charcoal grate. Metallic parts sourced elsewhere.	Highly engineered wood stove manufactured in China.
Production Capacity	Currently around 700 stoves a month. Sold over 6000 stoves so far.	Sold over 500 so far but capacity to make more	Demand Driven. 16,000 sold to date through L's Solution
Distribution Channels	Sell through network of 48 agents around Dar-es-Salaam	Sell through agricultural fairs and contacts	Through roadshows and network of distributors
Availability and Use	Use ◔ Availability ◔	Use ○ Availability ○	Use ◔ Availability ◔

Tanzania

	 Portable rocket wood stoves	 Fixed rocket wood stoves	 Fixed Maasai Wood Stove
Manufacturer	M&R Appropriate Technology Engineering	Various (Many ProBEC trained)	ICSEE (manufactured locally)
Cost Range	$20	$20 -$70 (depending on size/material)	$45 (subsidised)
Thermal Efficiency	30-35%	Around 25%	24%
Key Features	Liner made from clay and sawdust, with metal cladding and insulation material	Made by fabricating mild steel sheets, galvanised sheets and inserting insulative bricks inside the combustion chamber.	Stove brings hot gases around the pot before escaping through chimney.
Production Capacity	M&R sell 500 – 800 annually. Currently seeking investment for expansion.	Demand driven. On average producers make 20-30 per month.	300 installed so far by ICSEE. Factory capacity currently 150 / month
Distribution Channels	Mainly direct sales and exhibitions	Mainly direct sales and exhibitions	Sold within Maasai community, installed through local women
Use and Availability	Use ◔ Availability ◔	Use ◔ Availability ◔	Use ○ Availability ○

Annex B: Example Cookstove Initiatives in East Africa

- **Kenya - NGO**

	The Improved Cook Stoves for Households and Institutions Project (2011-2015)	Developing Energy Enterprises Program (DEEP) – (2008-2013)	Improved Cookstove for East Africa
Who	The project is run by HIVOS, working with SCODE - a local NGO and assembler of improved cookstoves.	Implemented by GVEP International with technical support from IT Power.	Collaboration between Uganda Carbon Bureau, Care International and the Nordic Climate Facility
What	The program aims to build the capacity of SCODE a local NGO and stove assembler so that they can go on to further support small scale producers, end users and institutions with the aim of scaling up the commercialisation of the technology. SCODE will open up 5 new branches under the project.	The program provides business and technical support to existing micro energy enterprises through training, mentoring, and market linkages. It also links entrepreneurs to financing through its loan guarantee program to enable them to expand their businesses. The program has trained over 300 entrepreneurs in Kenya.	The project aims to provide sustainable access to affordable and efficient cook stoves. Improving affordability of these cook stoves is achieved by the setting up of a CDM Program of Activities (registered 2011) that will provide stove suppliers with access to revenue from the CDM carbon market.
Challenges	Maintaining consistent quality of the cookstoves when parts are sourced from different suppliers.	Changing mindset of entrepreneurs to realise market potential of energy business.	Delays in registering project in country. Identification of suitable stove producers to work with.
Partners	HIVOS, SCODE, EU, ETC	IT Power, Practical Action, Coastal Rural Support Program Kenya	Uganda Carbon Bureau, CARE International, Nordic Climate Facility.

Kenya – NGO (continued)

	Improved Stoves and Portable Solar Lighting Program	Kenyan Stoves Project (Energizing Development, EnDev) (2005 – 2012)	East Africa Energy
Who	SNV provide capacity building and advisory services in renewable energy.	Implemented by German based NGO GIZ (formerly under the PSDA program).	East Africa Energy are an NGO focusing on reducing carbon emissions through market based approaches.
What	Since 2011 SNV have expanded their activities into the cookstove sector working on a model for commercialisation. They are working with various partners including GIZ and ISAK and Envirofit distributors to build capacity, create market linkages, strengthen distribution and improve access to finance.	The project supports access to modern cooking energy by promoting the sustainable production, marketing, installation and use of improved cooking stoves. These stoves include the portable or installed JikoKisasa stove and the built–in mud or fired brick stove, the Rocket.	East Africa Energy are distributing the Envirofit imported charcoal stove in urban areas of Kenya through development of a network of vendors. They are also linking with existing networks to distribute products through. The project will be linked to carbon finance to provide the stove at a subsidised price.
Challenges	Raising consumer awareness on improved cookstoves. Developing standards for the sector.	Maintaining quality standards amongst producers. Educating end user on proper use & maintenance of the stoves.	Delays in registration of the carbon project. Monitoring of the stoves for tracking purposes.
Partners	GIZ, ISAK	Ministry of Energy, Ministry of Agriculture, Ministry of Education	Envirofit, AdvanceAid

Kenya - Carbon Developers

	The Paradigm Kenya Efficient Stoves for Livelihoods and the Environment Project	Improved Cookstove Project – CO2Balance	Stoves for Life – Eco2librium
Who	Paradigm Project are a carbon project developer focusing on sustainable change.	CO2Balance are a UK based carbon project developer.	Eco2librium develops and implements carbon projects to foster sustainable energy and natural resource use.
What	Paradigm project aims to distribute approximately 250,000 improved household cooking devices in 7 years. It is selling the Envirofit wood stove and jikopoa stove through a network of stove vendors on a commercial basis and through NGO's.	CO2Balance have several projects in Kenya including Kisumu, The Abadares and Shimba Hills. Projects focus on communities with high biomass use and distribute stoves virtually free of charge subsidised by carbon revenue. Communities are also educated on stove use .	Eco2librium works with local groups to build their capacity to produce the ceramic Upesi stoves and provides mechanisms to distribute and sell stoves to communities. The project works around Kakamega forest and provides the stove at 80-90% subsidy.
Challenges	Setting up effective distribution networks. Monitoring requirements for carbon credits restrict distribution methods.	Creating continuous funding for projects.	Unknown
Partners	Food for The Hungry, World Vision, World Food Program		My Climate

Uganda – Manufacturers and Distributors

	Ugastove – Uganda Efficient Stoves Project	International Lifeline Fund (ILF)	Up Energy
Who	Private company making stoves since 1994. Have been supported by Impact Carbon and Climate Care to access carbon credits to increase production.	US based NGO involved in Fuel Efficient Stove and Clean Water and Sanitation initiatives.	Commercial company created by Impact Carbon to accelerate uptake of stoves in the market.
What	Aims to increase stove uptake and usage in Uganda. Ugastove manufacture complete charcoal stoves at Kampala factory. Distribute through branches and retailers. Carbon revenue generated through stove sales subsidies stove price and reinvested into business. Over 50,000 stoves sold to date.	ILF have established a stove production facility in Lira producing the Okello Kuc charcoal stove. Stoves are sold through a network of 30 stove vendors. Current capacity is around 1600 stove per month which they are planning to double through a new production facility in Kampala. Registering to access carbon revenue.	Up Energy import and sell Envirofit and Jiko Poa stoves on a commercial basis. Have sold 4500 stoves in first two months through roadshows, dealers and linking with existing distribution networks. Registering to access carbon revenue.
Challenges	Monitoring requirements for carbon credits restrict distribution methods. Further expansion limited by factory space,	Marketing of stoves and raising consumer awareness. Opening up new markets through distribution network.	Still establishing effective distribution models. Stove is expensive for many households.
Partners	Impact Carbon, JP Morgan Climate Care, GIZ	Uganda Carbon Bureau	Impact Carbon, Barefoot, WWF, Premier Green, GVEP International, Pearl Microfinance, Paradigm Project, Envirofit

Uganda – NGO

	Promotion of Renewable Energy and Energy Efficiency Programme PREEP - (2007-2014)	Developing Energy Enterprises Program (DEEP) – (2008-2013)	Improved Cookstove for East Africa
Who	Implemented by GIZ working closely with the Ministry of Energy and Minerals and local NGOs.	Implemented by GVEP International with technical support from IT Power.	Collaboration between Uganda Carbon Bureau, Care International and the Nordic Climate Facility
What	The program aims to increase access to modern biomass energy technologies. It works closely with local NGO's to disseminate household mud stoves, provides capacity building to private stove companies and promotes the use of institutional stoves and sustainable charcoal production.	The program provides business and technical support to existing micro energy enterprises through training, mentoring, and market linkages. It also links entrepreneurs to financing through its loan guarantee program to enable them to expand their businesses. The program has trained over 300 entrepreneurs in Uganda.	The project aims to provide sustainable access to affordable and efficient cookstoves. Improving affordability of these cookstoves is achieved by the setting up of a CDM Program of Activities (registered 2011) that will provide stove suppliers with access to revenue from the CDM carbon market.
Challenges	Difficulty in finding markets in rural areas where many households find stove too expensive.	Changing mindset of entrepreneurs to realise market potential of energy business.	Delays in registering project in country. Identification of suitable stove producers to work with.
Partners	Ministry of Energy and Minerals, Local NGO's and stove producers.	IT Power, EAETDN	Uganda Carbon Bureau, CARE International, Nordic Climate Facility.

Uganda – Other

	Translating Research into Action (TRACTION)	Biomass Energy Initiative Africa (BEIA)
Who	Funded by USAID and implemented by local partners Impact Carbon, CIRCODU & GVEP with support from UCB.	Funded by the World Bank, BEIA is being supported by PATH under the TRACTION project.
What	Research project which will test behavior change communication strategies to increase the purchase and use of improved, clean-burning wood stoves in rural regions of Uganda where wood is the primary fuel. Will also conduct baseline survey and test innovative sales & peer marketing strategies.	BEIA looked at several themes including establishing local production and dissemination of (TLUD) gasifier stove. The study with PATH will involve baseline assessments to measure fuel consumption, indoor air quality, and stove usage, followed by formative research on current attitudes and practices related to cookstoves.
Partners	Impact Carbon, CIRCODU, University of California Berkley. GVEP International	Berkley Air, CREEC, JEEP

Tanzania – Manufacturers and Distributors

	Sustainable Energy Enterprise Company	Introduction of Envirofit Stove
Who	TaTEDO is an NGO with over 20 years experience in the ICS sector. In 2000 it started SECCO a private company based in Dar-es-Salaam	E+Co is an NGO that invests services and capital in small and growing clean energy businesses in developing countries.
What	TaTEDO set up SECCO to promote the commercial dissemination of quality improved stoves, SECCO make a range of cookstoves and improved ovens. Their best selling product is the charcoal domestic stove and they are currently working with E+Co to link the project with carbon finance. So far they have sold over 6000 charcoal stoves under the project.	In 2010 E+Co started coordinating the introduction of the Envirofit stove through local distributors Zara Solar, L's Solutions and Alternative Energy Tanzania. L's Solutions have continue the distribution in large numbers distribution 16,000 stoves in the past year, targeting rural areas through road shows and retailers.
Challenges	Creating awareness and demand for the stoves particularly outside of Dar-es-Salaam	Marketing is very resource intensive with several visits to an areas required to realize sales potential.
Partners	TaTEDO, SECCO, E+Co	E+Co, Envirofit, L's Solution.

Tanzania – NGO

	Program for Basic Energy and Conservation (ProBEC) (2005-2010)	Developing Energy Enterprises Program (DEEP) – (2008-2013)	Improved Cookstove for East Africa
Who	A SADC program implemented by GIZ. Since the program ended activities have been taken over by the Rural Energy Agency.	Implemented by GVEP International with technical support from IT Power.	Collaboration between Uganda Carbon Bureau, Care International and the Nordic Climate Facility.
What	Aim to assist low income groups in access to sustainable and affordable energy. Promote improved cookstoves through training on stove construction (rocket, clay & charcoal stoves), and assisting in marketing activities. Offered indirect subsidies through raw materials, kiln access and transport.	The program provides business and technical support to existing micro energy enterprises through training, mentoring, and market linkages. It also links entrepreneurs to financing through its loan guarantee program to enable them to expand their businesses. The program has trained over 300 entrepreneurs in the Mwanza region.	The project aims to provide sustainable access to affordable and efficient cook stoves. Improving affordability of these cookstoves is achieved by the setting up of a CDM Program of Activities (registered 2011) that will provide stove suppliers with access to revenue from the CDM carbon market.
Challenges	Many artisans stopped production after the project ended, although REA have taken over the marketing activities their limited resources are spread across several sectors.	Changing mindset of entrepreneurs to realise market potential of energy business.	Delays in registering project in country. Identification of suitable stove producers to work with.
Partners	Ministry of Energy and Minerals, GIZ	IT Power, EAETDN	Uganda Carbon Bureau, CARE International, Nordic Climate Facility.

Tanzania – NGO (continued)

	Biomass Pellet Stove	Maasai Stove Project
Who	Partners for Development are a US based NGO aiming to improve the quality of life for vulnerable people in underserved communities.	ICSEE is a NGO working on projects around environmental conservation and community development
What	Working with local stove manufacturer Kiwia and Lausten they have developed an energy efficient gasifier stove that cooks using biomass pellets. PFD are also producing the biomass pellets from agricultural residues and aim to distribute them through network of vendors. Aiming to register the project under CDM.	Working with local Maasai women the project has developed a fixed wood stove that greatly reduces exposure to smoke within the household. The stove is locally manufactured and installed by trained local women. On purchasing a stove women get access to a buyers club and other home improvement items.
Partners	Partner for Development, Kiwia and Lausten	ICSEE

Annex C: Stakeholders in the ICS Sector

Kenya

Stakeholder Category	Stakeholders Present in the Sector
Government Departments	Ministry of Energy, Ministry of Agriculture, Ministry of Health, Ministry of Environment and Natural Resources, National Environment Management Authority (NEMA), National Economic and Social Council, Kenya Bureau of Standards (KEBS), Kenya Industrial Research Development Institute (KIRDE), Energy Regulatory Commission (ERC), Community Development Trust Fund (CDTF)
Donors	European Union (EU), DGIS, World Bank, DFID, USAID, Shell Foundation, HIVOS, German Government, Global Environment Facility (GEF)
International NGO's	Practical Action, GIZ, CARE International, GVEP International, SNV, East Africa Energy, UNCHR, Millennium Village Projects, International Lifeline Fund, World Vision, Food for the Hungry, Energy Sector Management Assistance Program (ESMAP), UNDP, RETAP, AFREPREN/FWD, Winrock International
National & Regional NGO's	Solar Cookers International, SCODE, Kakamega Environment Education Programme (KEEP), The International Small Group Tree Planting Program (TIST), African Christians Organisation Network (ACON)
Private Sector	Paradigm Project, Musaki Enterprises, Improved Stove Association of Kenya, Premier Gas Company Limited, Keyo Pottery Enterprise, Kartech, Envirofit, Unilever, Ekero, Riumbaini Energy Saving Stoves, Lakenet Energy Solutions, Chujio Ceramics, Rural Technology Enterprise, Fine Engineering
Carbon projects / Developers	CO2Balance, Uganda Carbon Bureau, Carbon Manna, Eco2librium, Impact Carbon, My Climate
Finance	Faulu Advisory, Muramati SACCO, Acumen Fund
Research	University of Nairobi, African Centre for Technology Studies (ACTS), Berkeley Air Monitoring Group

Uganda

Stakeholder Category	Stakeholders Present in the Sector
Government Departments	Ministry of Energy and Mineral Development, Ministry of Water and Environment, Ministry of Agriculture, Ministry of Health, National Environment Management Authority (NEMA), National Forestry Authority, Uganda Industrial Research Institute (UIRI), Uganda National Bureau of Standards (UNBS)
Donors	European Union (EU), DGIS, World Bank, DFID, USAID, Shell Foundation, HIVOS, German Government, Global Environment Facility (GEF), REEEP, NORAD, USEPA
International NGO's	Practical Action, GIZ, CARE International, GVEP International, SNV, UNCHR, Millennium Village Projects, International Lifeline Fund, World Vision, UNDP, Winrock International, Aktion Africa Hilfa (AAH), Impact Carbon, Living Goods, Mercy Corps, World Food Program (WFP), BRAC
National & Regional NGO's	Joint Energy and Environment Projects (JEEP), Jinga Empowerment Organisation, Integrated Rural Development Initiatives (IRDI), EAETDN, CIRCODU, Alternative Basic Education for Karamoja (ABEK), African Alliance for Clean Cookstoves, PRIED, Rural Agency for Sustainable Development, Ecotrust, Appropriate Technology Centre, YWCA
Private Sector	Ugastove, Friends of Wealthy Environment (FOWE), Envirofit, Ecozoom, Paradigm Project, BEETA Network, The Private Sector Foundation of Uganda, Uganda Energy Foundation, Up Energy, Wana Energy Solutions, PEES, PETSD, AEESS, Prime Equipment & Co, KEAN Development Enterprises, Black Power Company, Usika Crafts Ltd., Rwashana& Associates
Carbon projects / Developers	CO2Balance, Uganda Carbon Bureau, JP Morgan Climate Care, Impact Carbon
Finance	FINCA
Research	CREEC, Aprovecho, Berkeley Air Monitoring Group

Tanzania

Stakeholder Category	Stakeholders Present in the Sector
Government Departments	Ministry of Energy and Minerals, Ministry of Natural Resources - Division of Forestry and Beekeeping, Ministry of Community Development, Gender and Children, Ministry of Industry and Trade, Vice President's Office – Division of Environment, Prime Minister's Office – Regional Administration and Local Government
Parastatal Organisations	Rural Energy Agency (REA), Small Industries Development Organisation (SIDO), Centre for Agricultural Mechanisation and Rural Technology (CAMARTEC), Tanzanian Commission for Science and Technology (COSTECH), Tanzanian Industrial Development and Research Organisation (TIRDO), Tanzanian Bureau of Standards(TBS), Tanzania Engineering and Manufacturing Design Organisation (TEMDO)
Donors	European Union (EU), DGIS, World Bank, DFID, Southern African Development Community (SADC), HIVOS, German Government, Global Environment Facility (GEF), NORAD, USEPA, Shell Foundation
International NGO's	GIZ, CARE International, GVEP International, SNV, UNCHR, Millennium Village Projects, World Vision, UNDP, World Food Program (WFP), Partners for Development, ICSEE, TaTEDO, ARTI Tanzania, Canadian Physicians for Aid and Relief (CPAR), E+Co
National & Regional NGO's	The Family Alliance for Development and Cooperation, Karatu Development Association, Sunseed Tanzania Trust, Women Development for Science and Technology (WODSTA)
Private Sector	Envirofit, Ecozoom, L's Solution, Zara Solar, Alternative Energy Tanzania Ltd, Kiwia&Lausten, SECCO, Envotech, Greenstar, Morogore metal clusters, M&R Appropriate Technology Engineering
Carbon projects / Developers	CO2Balance, Uganda Carbon Bureau, E+Carbon
Others	Tanzania Renewable Energy Association (TAREA), Camco, Round Table Africa
Research	University of Dar esSallam, Berkeley Air Monitoring Group

Annex D: Pima Gas – Example LPG Initiative Kenya

Pima Gas

Pima Gas is trialingan initiative in the LPG sector to target low income households by reducing the upfront cost of LPG hardware and refilling costs.

- Many low income households cannot afford the upfront cost of LPG hardware and the bulk purchasing of large cylinders.
- Pima Gas promoted by Premier Gas aims to overcome these issues by offering a 1kg gas cylinder and refills of as little as 50 KES ($0.6)
- The scheme started rolling out in Nairobi in February 2012 with dispensers located in low income areas around the city.
- 1500 users in the first one month.

- **Cost of complete unit: 2000 KES / $23**
- **Cost of 1kg refill: 300 KES / $3.5**
- **Minimum Refill amount: 50 KES / $0.6**

Annex E: Test Procedures for Stove Testing

Water Boiling Test

The water boiling test version 4.1.2 was used. The procedure can be found at the following link: http://www.pciaonline.org/files/WBT4.1.2_0_0.pdf

Monitoring Emissions

Particulate and Carbon monoxide:

UCB particulate (mg/m3) monitor and CO monitors (ppm) are held at equal-distances from the fire place at the height of sitting position of the cook and monitors the parameters on real time for each three of the three phases.

The data is downloaded at the end of the three phases and average emissions calculated. Comparisons of emissions are from ICS are made with those of obtained using a 3 stone fire and a traditional metal stove.

	Phase 1		Phase 2		Phase 3		Average	
ICS	**Particulate**	**CO**	**Particulate**	**CO**	**Particulate**	**CO**	**Particulate**	**CO**
Round 1								
Round 2								
Round 3								
3-stone fire								
Round 1								
Round 2								
Round 3								

Determining thermal shock resistance

(Based on procedure from Kenyan Standard for Biomass Stoves)

To test whether ceramic liners made from a particular clay mix are thermally shock resistant, the liners shall be heated to temperatures ranging from 800℃ - 900℃ and then immersed in cold water at room temperature. These temperatures are attained in fireboxes when in use. This is repeated several times until the liner cracks. The number of cycles that the liner withstands before cracking shall be noted. The heating can be done using a gas flame or electric kiln.

As the test is extremely severe, a liner which can withstand 5 cycles shall be considered to be made from a clay mix that is thermally shock resistant.

Annex F: Number of Samples Tested for each Stove Type

Stove	Number of Samples Tested
KWC1	3
KW2	3
KC1	3
KC2	3
KC3	2
KTMS	1
Traditional Open Fire	1
UW1	2
UW2	1
UC1	3
UC2	3
UTMS	1
TW1	2
TC1	2
TC2	3

6.4. Annex G: Stove testing results – Comparison Table

Code	*Fuel Used*	*Country of Origin*	*Stove Price (USD)*	*Thermal Efficiency*	*Time to Boil (min)*	*Specific Fuel Consumption (g/litre)*	*Fuel Saving (compared to traditional methods)*	*Average CO emissions (ppm)*	*CO Reduction (compared to traditional method)*	*Average PM emissions ($\mu g/m^3$)*	*PM Reduction (compared to traditional method)*	*Density (g/cm^3)*	*Liner Testing (Thermal shock cycles withstood)*
KWC1	Wood	Kenya	8.7	20%	20.90	178.63	55%	38.1	12.41%	1.54	75.44%	1.639	No breakage after 5 shocks
KW2	Wood	Kenya	9.6	20%	20.20	190.70	52%	43.1	0.92%	1.86	70.33%	1.638	No breakage after 5 shocks
3 stone fire	Wood	Kenya	0	13%	15.00	399.00	n/a	43.5	n/a	6.27	n/a		n/a
KWC1	Charcoal	Kenya	8.7	28%	29.3	105.76	-8%	108.9	-34.28%	0.95	24.00%	1.639	No breakage after 5 shocks
KC2	Charcoal	Kenya	9.6	36%	54.62	75.50	23%	101.76	-25.47%	1.06	15.20%	1.647	No breakage after 5 shocks
KC1	Charcoal	Kenya	4.6	38%	30.02	68.28	30%	98.4	-21.33%	2.11	-68.80%	1.639	No breakage after 5 shocks
KC3	Charcoal	Kenya	4.2	30%	28.1 (2.5 L)	84.98	21%	78.3	-25.28%	0.14	50.00%	1.637	No breakage after 5 shocks
KTMS	Charcoal	Kenya	4	24%	2915%	98.07	n/a	81.1	n/a	1.25	n/a		n/a
KTMS (sm)	Charcoal	Kenya	3	24%	16.5 (2.5 L)	106.93	n/a	62.5	n/a	0.28	n/a		n/a

Code	*Fuel Used*	*Country of Origin*	*Stove Price (USD)*	*Thermal Efficiency*	*Time to Boil (min)*	*Specific Fuel Consumption (g/litre)*	*Fuel Saving (compared to traditional methods)*	*Average CO emissions (ppm)*	*CO Reduction (compared to traditional method)*	*Average PM emissions (µg/m3)*	*PM Reduction (compared to traditional method)*	*Density (g/cm3)*	*Liner Testing (Thermal shock cycles withstood)*
UW1	Wood	Uganda	20	30%	21.50	108.30	31.02%	26.3	72.69%	2.73	67.38%	1.717	Cracks after one shock
TW1	Wood	Tanzania	3.9	24%	26.00	131.00	16.56%	36.4	62.20%	3.01	64.04%	n/a	n/a
UW2	Wood	Uganda	20	23%	43.50	133.70	14.84%	30.6	68.22%	3.99	52.33%	n/a	n/a
3stone fire	Wood	Uganda	0	22%	14.00	157.00	n/a	96.3	n/a	8.37	n/a	n/a	n/a
TC2	Charcoal	Tanzania	12.9	35%	27.00	59.70	66.27%	63.4	48.46%	0.22	83.21%	n/a	n/a
UC1	Charcoal	Uganda	6	46%	39.50	38.00	78.53%	19.3	84.31%	0.19	85.50%	1.94	No breakage after 5 shocks
TC1	Charcoal	Tanzania	10.3	45%	30.5 (2.5 L)	66.00	62.71%	27.6	77.56%	0.29	77.86%	n/a	n/a
UC2	Charcoal	Uganda	6	40%	31.50	51.00	71.19%	39.3	68.05%	0.27	79.39%	1.795	No breakage after 5 shocks
UTMS	Charcoal	Uganda	4	26%	12.00	177.00	n/a	123	n/a	1.31	n/a	n/a	n/a

The Improved Cookstove Sector in East Africa: Experience from the Developing Energy Enterprise Programme (DEEP)

The task of cooking is an essential part of life for people around the globe, yet in East Africa it is a task that can consume many hours of the day and have far reaching consequences on health and the environment as well as social and economic impacts. Improved cookstoves have been promoted in East Africa for many years and can help to reduce household fuel consumption, time spent on fuel wood collection and exposure to harmful emissions.

This report aims to analyse and document GVEP International's experience working with improved cookstove businesses in East Africa through its Developing Energy Enterprise Programme (DEEP). It describes the context of improved cookstoves in East Africa and provides an overview of the cookstove markets in each of the three countries before going on to describe how the DEEP programme has supported cookstove enterprises and the challenges and lessons learnt from the programme. In addition it examines results from stove testing done on cookstoves produced under the DEEP programme. Based on this experience the report finally goes on to present a strategy for GVEP International to take its cookstove work forward in the future.

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