MWOTO™

The Power of Fire!

Centre for Research in Energy and Energy Conservation
Kampala, Uganda

CREEC

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Executive summary

The Centre for Research in Energy and Energy Conservation at Makerere University, Kampala, Uganda implemented the project "Promotion of improved biomass Top-Lit UpDraft (TLUD) stoves in Uganda". Next to wood, this type of stove can use fuel sources that otherwise would have been considered as agricultural waste, such as maize cobs, bundles of grass, seeds or husks, thus replacing use charcoal or wood. Therefore, the TLUD can contribute to less deforestation and climate change. The project promoted the TLUD cookstove by creating awareness about its use and benefits, training tinsmiths in manufacturing, supporting entrepreneurs in sales, marketing and business development and creating other business opportunities.

The project started with the selection of one type of TLUD that was subjected to technical tests at CREEC's laboratory and user tests during a pilot phase, where end users were monitored regarding preferences, usability and acceptance. These tests resulted in a number of modifications in the stove design.

Tinsmiths from various parts of Uganda were observed and suitable ones selected were for training in stove production. The initial trainings took place at CREEC, but others were carried out in the field at tinsmith production areas. To monitor and evaluate, the project team visited trained tinsmith during follow-up some time after the training.

Awareness creation and promotion of the stove was done shortly after the training of tinsmiths in their district. Cooking demonstrations where water was boiled and/or food was cooked using a TLUD and another type of cookstove to compare the technologies and to provide a platform for tinsmiths to showcase and market the product.

The approaches and methodologies have significantly changed over the course of the project. The primary focus at the beginning of the project was on knowledge transfer and training of tinsmiths to manufacture stoves. After some time the project team noticed that tinsmiths had been trained but were not producing stoves in the anticipated numbers.

This observation was further supported by the visit of a World Bank team during which the project team was advised to leave the training aspect and focus on promotional activities in order to get more stoves onto the market.

A business assessment indicated that the trainings were to a very large extent adequate, but promotions so far had been inadequate. This created a lack of market in most of the areas which demoralized tinsmiths to take the technology up further. Another major constraint facing the majority of tinsmiths was scarcity and high cost of raw materials. It should be noted that this assessment started just before the more intensive promotions were implemented. The study ran parallel to the promotion activities. This allowed the team to get a clear picture of the actual situation before the increased promotions.

The project team decided to adjust the approach from training-centred to promotion-centred and from tinsmith-centred to distributor-centred in order to enhance market penetration of the stove. A marketing and promotion campaign was designed and implemented which included marketing coordinators, salesmen, exhibitions, fairs, media coverage and internet presence through a website, Facebook and Twitter. This created further awareness and increased demand for the stove

The business study further revealed inadequate business knowledge and weak business models with the tinsmiths and salesmen. A workshop on business development and sustainability was held to address these issues. During the workshop the tinsmiths and salesmen themselves initiated the formation of Ugandan MWOTO Stove Association to strengthen their position and focus on further technical training, after-sale services, quality monitoring, sourcing of cheaper materials and business/entrepreneurial training. This will enhance commercialization of the production and thus improve sustainability of the business.

Foreword

Three years ago CREEC started its journey in the cookstove world by attending the PCIA meeting in our very own Kampala. We rapidly progressed into our understanding of stove testing and design. With the BEIA project we stepped into the aspects of training, marketing and awareness creation of the gasifier stove.

One and a half years later we have many experiences, both good and bad, and believe that we are attaining recognition and an established name in the cookstove business. Four of the most important lessons we learned are:

Firstly, the gasifier stove makes sense to the majority of the audiences reached and is generally appreciated for its advantages in saving fuel, lowering emissions, cooking faster and making charcoal as compared to the traditional three-stone fire.

Secondly, the gasifier stove will not solve all the demands and challenges of cooking in urban and rural areas of Uganda. We envision that a household will obtain a variety of stoves that will be used for specific cooking and boiling tasks. The full range of the different functions of the stove will be discovered and identified by the users themselves, because of the principle that people learn and understand more if they discover on their own.

Thirdly, we have come to understand that even though certain solutions will make a lot of sense, it does not mean that the users will adopt the technology. There are a variety of human factors that influence the decision making, among which peer pressure and cooking habits are significant ones.

Fourthly, users are not convinced only by reasons such as saving the environment, impacting climate change or other 'large' beneficial implications of improved cookstoves. Saving money is usually the main argument for using advanced technologies. Also, talking about the stove many times does not result in purchases. Actual cooking demonstrations are vital in convincing people because they like to see before they act.

Training in stove manufacturing and business, awareness campaigns and demonstrations go hand in hand with market development.

Not only has this project resulted in capacity building of tinsmiths and salesmen, but also CREEC has highly benefited. Being a very young organization with very young staff, this has provided an extremely valuable learning process in project implementation skills such as planning, quality control and budgeting.

We are therefore grateful to be able to make a contribution to the lives of users, tinsmiths and salesmen in specific and the global cookstove sector in general, while at the same time building our own organization and staff members.

We hope that you will enjoy reading this report and trust that you will profit from this stove project. Being a centre based on open source and knowledge sharing, we encourage you to contact us in case you would like to receive more information.

Mary Suzan Abbo
Managing Director
Centre for Research in Energy and Energy Conservation

The CREEC project team

The CREEC project team consisted of:

Prof. Paul S. Anderson - Technical Advisor
Karsten Bechtel - Project Manager
Emmanuel Bukenya - Marketing Manager
Wim Getkate - Management Advisor
Dorothy Lsoto - Marketing Coordinator
Jed Musinguzi - Business Development
Joshua Mutebi - Marketing Coordinator
Rehema Namukose - Public Relations Assistant
Sheila Nantambi - Marketing Coordinator
Grace Nantonga - Events Coordinator
Ronald Simbwa - Project Manager
Mohamad Sadam Ssembatya - Master Tinsmith

Acknowledgements

We wish to thank Prof. Paul S. Anderson for contributing from his extensive expertise and experience with TLUD gasifiers, both in technical matters, such as stove operation and manufacturing, as well as on other levels, like customer preferences. We enjoyed working with this pleasant and friendly man and we were amazed by his energy and passion for the TLUD gasifiers.

We are also grateful to Chip Energy, USA, for providing co-funding and making Prof. Anderson's physical presence and contribution possible.

The team is grateful to our home, the College of Engineering, Design, Art and Technology in Makerere University for co-financing office space and utilities (water, electricity and internet) to provide an enabling environment to implement our projects and activities.

In the initial phase of stove observations and selection, David Oyagah, a CREEC intern from Kenya put in his knowledge and experience with regards to stove technical issues. Asante sana, rafiki David.

A thank you also goes to Christa Roth of Food and Fuel for her contributions to the BEF Camp and the Research & Development on the stove.

Walter Kipruto, an MSc Renewable Energy student at the University of Oldenburg did investigations on the potential for a CDM project which was appreciated very much by the project team.

The efforts and involvement of staff members of the Ugandan NGO and project partner, Joint Energy and Environment Projects, in the first phase of the project are highly appreciated. We enjoyed doing stove demonstrations with them and stove introduction would not be where it is now without them.

The project benefited very well from the creative and artistic talents of Emmanuel Bukenya. In the position of marketing manager he designed promotional materials and lifted the project above the technicalities of stove design towards a visual presentation enticing customers to show interest and even buy the stove. Thanks Emma.

We are very grateful for the input of Jed Musinguzi, who did the business assessment of the trained tinsmiths, revealed very important information regarding tinsmiths' businesses and skilfully conducted the business training workshop for tinsmiths, salesmen and distributors. His experience and ideas were very helpful in upgrading business skills and practices of the tinsmiths.

The project team is highly indebted to Josua Burkart, CREEC's former Management Advisor, and Assoc. Prof. Izael Pereira da Silva, the former Managing Director of CREEC. Together with Karsten Bechtel they wrote the winning project proposal, so without their contribution the project would not have been possible in the first place.

A word of thank goes to Mirella Brenke who prepared the updated marketing approach providing invaluable suggestions to propel the project to wider awareness among the public. Danke schön, Mirella.

Although he has been part of the project for half of the time, we are very thankful for the contributions of Ronald Ssimbwa Katerega. He has been the project manager from the project start and truly took hold of the concept, ideas and approaches. Getting the project from the paper into the implementation phase was his responsibility and he took that task very seriously: activities were implemented successfully and documented well. We thank you, Ronald, for leading the team in the first project phase.

We are greatly obliged to Mohamad Sadam Ssembatya, the master tinsmith of the project. He trained all tinsmiths in a very proficient way. Being a tinsmith himself made it easy to understand and relate to the tinsmiths to be trained. We learned a lot from his expertise. Sadam is responsible for the high quality level in training and optimizations in manufacturing which resulted in better performance and reduced production costs of stoves. Webale ku somesa. Tusiimye nnyo!

The project team wishes to express a thanks to Winrock International, especially Norah Muthike and TG Wangombe from the Kenya office and Elisa Derby from headquarters in the USA for all guidance provided regarding project implementation, administration and reporting.

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Lastly, we also thank all CREEC staff members, both in- and outside the project team, who contributed to the project. It is a pleasure working with you. You made this happen!

The CREEC project team
October 2012

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Abbreviations

AFREA	Africa Renewable Energy Access
AFTEG	Africa Energy Unit
BAI	Biomass Availability Index
BEIA	Biomass Energy Initiative for Africa
CDM	Clean Development Mechanism
CEDAT	College of Engineering, Design, Art and Technology
CREEC	Centre for Research in Energy and Energy Conservation
EEW	Energy Efficiency Week
EI	Education Index
ESMAP	Energy Sector Management Assistance Program
GACC	Global Alliance for Clean Cookstoves
GIZ	German International Development Cooperation Agency
HH	Household(s)
IAP	Indoor Air Pollution
JEEP	Joint Energy and Environment Projects
MEMD	Ministry of Energy and Mineral Development
PATS	Particle and Temperature Sensor
PCIA	Partnership for Clean Indoor Air
PEMS	Portable Emissions Monitoring System
PI	Population Index
PREEEP	Promotion of Renewable Energy and Efficiency Energy Programme
PV	Photo Voltaic
REA	Rural Electrification Agency
RDC	Resident District Commissioner
SACCO	Saving And Credit Cooperative
SI	Selection Index
TLUD	Top-Lit UpDraft
UACE	Uganda Advanced Certificate of Education
UBOS	Uganda Bureau Of Statistics
UGX	Uganda Shillings
UNEB	Uganda National Examinations Board
WI	Wealth Index
WWF	World Wide Fund for Nature

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1. CREEC

The Centre for Research in Energy and Energy Conservation (CREEC) is a not-for-profit organization for research, training and consultancy, located at the College of Engineering, Design, Art and Technology (CEDAT) within Makerere University, Kampala, Uganda.

CREEC's mission is to enhance access to modern types of energy through research, training and consultancy in East-Africa. The centre focuses on four areas: bioenergy, solar PV, pico-hydro and energy management. The clients of CREEC are very diverse: national and local government, donor organisations, NGOs, private sector and students.

The centre aims at application and adaptation of technologies to the specific Ugandan and local environment with an emphasis on systems with components that can be locally manufactured. For capacity building and knowledge transfer purposes, CREEC endeavours to include students in the centre's projects whenever possible.

1.1 Bioenergy

CREEC is currently active in four areas in bioenergy: improved cookstoves, biogas, gasification and fuels. For this the organization is equipped with the Bioenergy Research Centre, a laboratory for conducting practical tests, training and applied research, which was built in 2008 in cooperation with GIZ.

1.1.1 Improved cookstoves

CREEC is developing into an independent and internationally recognized stove testing service using globally accepted testing procedures for the East-African region as well as a knowledge centre providing stove design studies, recommendations and improvements.

The centre owns a variety of measuring equipment such as a Portable Emission Monitoring System (PEMS) from Aprovecho Research Center and Particle and Temperature Sensors (PATS) from Berkeley Air, both American worldwide leaders in cookstove technology, for conducting practical tests, training and applied research.

Picture 1: PEMS in Bioenergy Research Centre

With the equipment emissions from cookstoves can be measured and analyzed. CREEC has already been conducting several tests, such as the water boiling test and controlled cooking test, for a number of stove manufacturers from Uganda, Kenya, the Democratic Republic of Congo, Rwanda, Burundi, Malawi, Indonesia and the USA.

CREEC is an active implementing partner of the Global Alliance for Clean Cookstoves (GACC), a globally active, public-private initiative 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 centre is a core member of two work groups: "Technology and Fuels" and "Standards and Testing".

1.1.2 Biogas

Biogas is gas being generated under anaerobic (no oxygen) conditions from biological materials such as animal dung, human excrements and fish-, slaughter- or kitchen waste. The gas generated can be used for cooking, fuelling an engine or lighting purposes.

CREEC is designing a biogas research program and is developing into a service provider for inspection of digesters, trouble-shooting and consultancy. The centre is part of a group of international institutions doing research in biogas.

1.1.3 Gasification

In a gasifier, a process called pyrolysis takes place. This is basically an incomplete combustion due to the absence or limited availability of oxygen. The heat of the process drives out combustible gases which are routed to a separate combustion process. During the normal burning of biomass, expulsion and combustion of the combustible gases occur practically at the same location. Due to the controlled conditions of a gasification process, the emissions to the atmosphere are lower than compared to the normal burning process.

CREEC is involved in the basic design and installation of a number of gasifiers in Uganda. The equipment will be utilized to provide a showcase, to provide training programs to the private sector and to implement applied research for the Ugandan environment.

Together with international partners CREEC has held training workshops with regards to gasification. One of the goals is to implement a program for inspection of gasifiers, advice and problem solving with consultants from the centre.

The cookstove in the project described in this report is a micro-gasifier. The technology is able to use various agricultural by-products that are currently viewed as waste.

1.1.4 Fuels

Resources currently seen as waste can also be converted into briquettes, blocks of compressed material used as fuel. This can be done in either carbonized or un-carbonized form.

The waste materials turned into briquettes can be burned in normal cookstoves or may require a special stove design. CREEC has studied several types of briquettes and continues to implement further research programs in the production of briquettes and other biomass derived fuels (i.e. wood, charcoal, agricultural residues and biogas).

1.2 Solar PV

The department of solar PV (photo voltaic) designs programs to promote and implement projects using solar power, both at household and institutional level.

Picture 2: Solar PV testing laboratory

Together with the Ugandan umbrella organization for the private sector, CREEC is developing a training program for technicians of companies intending to roll-out their activities to rural areas.

Next to awareness building and training, CREEC is equipped with a solar PV laboratory furnished with state-of-art testing and analyzing equipment. Solar PV equipment including panels, converters and lamps are tested in this laboratory in accordance with internationally accepted standards. One of the objectives is to become an independent testing and certifying laboratory for the private sector that is importing, marketing and selling solar PV systems.

1.3 Pico-hydro

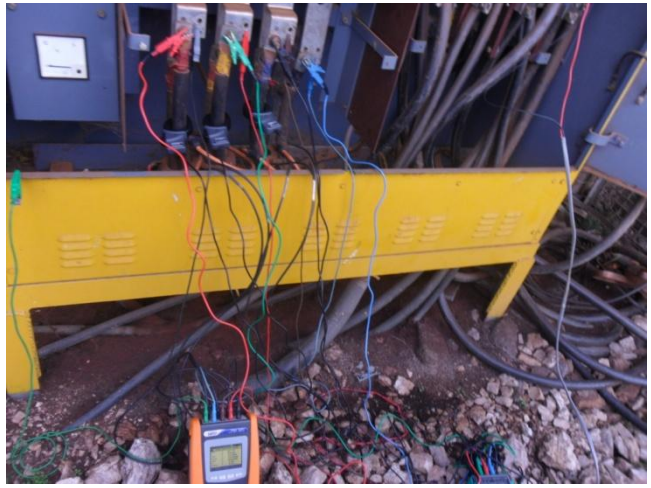
Specific areas in Uganda are blessed with enough water flow and height over which the water falls to install hydro power. CREEC is aiming at the lower end of the output scale for productive use by tourist facilities, agro-processing plants or other enterprises. CREEC aims to extend its demonstration unit into a full testing facility for applied research and training to enhance and extend the centre's facilities.

Picture 3: Taking measurements in a water stream

The main role of CREEC in hydro power is training, consultancy and project management. The centre is providing basic design and project management support for the installation of a number of pico- and micro-hydro power plants which also includes training of operating and maintenance personnel as well.

1.4 Energy management

CREEC has performed a number of energy audits and validations of energy efficiency equipment.



Picture 4: Energy efficiency verification measurements

Using CREEC experience and specific measurement and analysing tools, the centre has started verification of energy savings and guarantees.

1.5 Cross cutting

Apart from the research, training and consultancy services as mentioned above for the specific focal areas of CREEC, the centre is also engaged in cross-cutting projects.

CREEC has finalized several energy studies for international organizations with regard to the use of renewable energy for institutions and households. Field surveys, customer questionnaires, cost-benefit analysis and recommendations form part of these exercises for future implementation of energy saving technologies.

Another example of a cross-cutting project is one from a group of researchers of CEDAT. This project is financed with funds from the World Bank and the Government of Uganda. It involves a research program with three PhDs focusing on GIS mapping, appropriate energy conversion technologies and business models. It contains the implementation of four energy pilot plants (two bioenergy, one solar and one pico-hydro). CREEC is supporting the research team in technical design and implementation of the pilot plants and project management, such as budget control and reporting.

1.6 CREEC's approach

CREEC is a versatile organization with specific knowledge in bioenergy, solar PV, pico-hydro and energy management. The centre is increasingly recognized by a number of leading international organizations such as the World Bank, UNIDO, UNDP, GIZ, WWF and GACC leading to increased applied research and implementation of projects adapted to the Ugandan environment.

CREEC approaches projects and activities based as follows:

FTAH = demand

In the core there has to be a certain demand to implement a certain project in a proper way. Four components need to be addressed:

F = Fuel - What fuel is available and suitable for the project?
T = Technology - Which technology is most appropriate for that specific situation and location?
A = Application - What does the user need? Shaft power, heat or electricity?
H = Human factor - What cultural, local or personal preferences, wishes or customs influence the project?

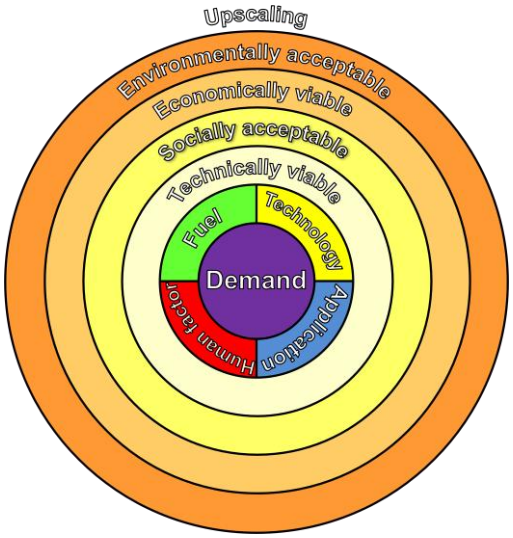


Figure 1: CREEC's FTAH = demand approach

This forms the core, the pilot project, from which data collection is obtained. After that, technical viability, social acceptability, economic viability, environmental acceptability and lastly up-scaling of the technology can be evaluated. Many times the latter viabilities and acceptabilities are discussed without looking at the core of demand, fuel, technology, application and human factor, leading to poor project results. CREEC wants to break the 'cosmetic' addressing of the outer layers and implement projects based on solid foundation and data collection.

2. Ugandan energy and cooking situation

The Ugandan energy sector is dominated by biomass, accounting for 92% of the energy use, followed by petroleum (6%) and electricity (2%) [1]. The biomass consumption comes from firewood, charcoal and crop residues. Biomass provides all the basic needs for cooking and water heating in rural areas and for most urban households (HH). It is also the main source of energy for rural small and medium-sized enterprises and contributes significantly to the rural economy. The high usage of biomass in these sectors has been attributed to high prices of petroleum products, limited, inadequate and inefficient power supply systems arising from stunted generation capacity growth and a poor transmission and distribution infrastructure. Petroleum products are mainly used for vehicles and thermal power plants [2].

Picture 5: Traditional three-stone fire using fuel wood

Until 2002 almost all of Uganda's electricity came from hydropower but by 2009 this had dropped to 48% while 47% came from thermal power plants and 5% from biomass (two sugar works co-generation schemes) [3].

The access to electricity in 2010 was still very low with 10% at the national level and only 3% in rural areas [2]. The Rural Electrification Agency (REA) recently reported that the electrification rate has increased to 15% but did not specify urban and rural rates.

Energy generation in Uganda is very centralized: large hydropower plants around Jinja and thermal power plants around Kampala. This, together with the dispersed housing patterns of Ugandan households, mainly in rural areas, results in high distribution costs and in turn explains the low electrification rates in rural areas.

Wood fuels (wood and charcoal) are still used as main sources of energy for cooking by the majority of households (95%). Use of electricity for cooking is still very low (0.6%) which could be due to the low electrification rate and high tariffs charged per unit. About 5% of households use alternative fuel sources such as kerosene, LPG and biogas for cooking.

The table below gives an overview of cooking fuels per region [4].

Residence	Fuel wood	Charcoal	Electricity	Alternative
Rural / urban				
Rural	86.3	10.4	0.3	3.0
Urban	15.4	69.8	1.6	13.1
Region				
Kampala	2.4	74.5	3.4	19.7
Central	57.8	36.4	0.4	5.4
Eastern	85.2	11.3	0.4	3.1
Northern	87.6	10.5	0.2	1.8
Western	84.2	10.8	0.4	4.6
Uganda	73.0	21.5	0.6	4.9

Table 1: Distribution (%) of HH by residence and cooking fuel

Biomass is traditionally harvested from natural forests and this has led to extensive destruction of the country's forest cover. Annual loss rates are about 2%. Most harvesting technologies are wasteful and even the use of biomass is inefficient. For example, about 9% of the population uses improved cookstoves, while 69% uses the three-stone fire and almost 19% uses traditional (inefficient) stoves. The table below gives an overview of cooking technology per region [4].

Residence	Three-stone fire	Open charcoal stove	Improved cookstove	Other (paraffin, gas or electric)
Kampala	3.5	63.5	12.2	20.8
Central	53.7	33.5	7.6	5.2
Eastern	83.1	10.2	4.8	1.9
Northern	76.8	4.8	16.5	2.0
Western	82.1	10.1	6.2	1.7
Uganda	69.1	18.5	8.5	2.8

Table 2: Distribution (%) of cooking technology by residence

This unsustainable situation has already resulted in desertification, soil erosion and even landslides. The increasing vulnerability of the ecosystem leads to uncertainty about the delivery of sufficient energy resources to households in the future. Unfortunately, very little is being done to establish sustainable (and commercial) biomass production or energy crop production systems for the future.

The majority of the Ugandan population depends on agriculture but most of it remains subsistence. This leaves various waste streams which are currently utilized as either fodder or just left to rot in the fields. This could provide another source of fuel for cooking.

Picture 6: Cooking on an open charcoal stove

3. The BEIA project

Since 2002 the Partnership on Clean Indoor Air (PCIA) brought together household energy and health practitioners, decision makers and experts from all around the world, focusing on clean and efficient cooking technologies and fuels. Between 2002 and 2012, almost 600 partner organizations joined together through the PCIA to contribute their resources and expertise to reduce smoke exposure from cooking and heating practices in households around the world.

In March 2009 the 4th Biennial Partnership on Clean Indoor Air Forum took place in Kampala, Uganda. CREEC participated for the first time at this event. During the forum staff of the centre met Prof. Paul S. Anderson and learned about the Top-Lit UpDraft (TLUD) gasifier. This was the genesis of the project.

3.1 Call for proposals

In mid 2009, the World Bank was requesting proposals for innovative pilot projects that demonstrate new approaches to modernizing biomass energy in Sub-Saharan Africa. The request for proposals was part of an initiative called the Biomass Energy Initiative for Africa (BEIA) which is administered by the World Bank Africa Energy Unit (AFTEG) and financed by the Energy Sector Management Assistance Program (ESMAP) Africa Renewable Energy Access (AFREA) Trust Fund, provided by the Government of the Netherlands. The following text is copied from the call for proposals.

The rationale for the pilot projects is that biomass is and will continue to be for many decades a predominant local source of energy in Sub-Saharan Africa since it is used for home cooking, heating and also commercial and industrial applications such as for bakeries, charcoaling, lime production, bricks and tile production, tobacco drying and other uses. Modernization of this sector with a view to obtaining a sustainable supply, efficient usage and new modern and cleaner applications of biomass energy is necessary and can be justified based on health, energy security, socio-economic, and global and local environmental reasons.

The Biomass Energy Initiative for Africa co-finances promising pilots of innovative biomass energy projects throughout the Sub-Saharan Africa region that could advance the biomass agenda, in terms of learning how to apply new knowledge/experience, and/or increased institutional capacity and understanding of biomass energy. These pilots are intended to present knowledge of building blocks for World Bank operations.

One of the themes for which proposals could be submitted was “Enabling market conditions for high quality and high performance modern cookstoves”. In order to increase access to cleaner cookstoves many conditions need to exist for improving the cookstove marketplace. To list the most important conditions, higher quality of biomass stoves can provide better performance in terms of cleaner combustion and lower indoor emissions, higher energy efficiency, improved safety and longer durability. Also such stoves ideally should be affordable and manufacturers should achieve scale economies in order to reduce costs. Micro-credit for households could facilitate uptake. Environmental benefits of stoves such as carbon emission reductions could generate important credits benefiting end users. Furthermore, public campaigns to raise awareness of the dangers of indoor air pollution, the advantages of quality cookstoves and other preventive actions could be promoted. Additionally government policies should attract investments to promote higher quality and cleaner cookstoves for the benefit of the poor with elimination or reduction of import tariffs, lowering sales tax and less paperwork while introducing better cooking technologies into the country. Setting up standards for minimum stove quality and providing knowhow to the local stove industry should improve stove performance, acceptability and usage of stoves. Initiatives addressing some or all of the above issues are expected to produce results toward better market conditions and enlarge markets for cleaner and quality cookstoves.

3.2 The proposal

The text in this section if largely copied from the original proposal from CREEC.

The project aims to produce and market the best cookstove models in order to ensure efficiency, clean emissions, user-friendliness and affordable technology in Uganda.

Prof. Paul S. Anderson and other researchers have developed different models of air-controlled TLUDs, proven to be highly efficient with very low emissions compared to other technologies. In order to identify the best-suited TLUD cookstoves for Uganda, further testing will be done on the existing stoves, which have already been proven to work very well.

With the Biomass Research Centre, which was built in 2009 in a joint venture with GIZ, CREEC is the only African institution which has direct access to state of the art stove testing technology through Aprovecho's PEMS. When stove models are modified and improved, CREEC can thus do all the tests to make sure that stove models which are marketed comply with standards for stove energy efficiency and emissions.

3.2.1 Methodology

The idea of the project is to market the previously described TLUD stoves in Uganda. The systemic project approach includes different courses of action, which are described below:

(A) Awareness building and promotion

This is necessary so that a large part of the population realizes the disadvantages of the traditional stoves compared to modern TLUD stoves.

Many rural Ugandans feel in their everyday life that their way of using firewood is no longer sustainable, since it becomes more and more difficult to collect a sufficient amount of wood every day due to deforestation.

The marketing campaign will centre especially in regions that are affected by deforestation and scarcity of firewood and where suitable fuels, like agro by-products from maize cobs, are readily available. In a first stage, the project activities will be targeted on a few model villages and institutional kitchens, with which relationships already exist. As more experience is gained, more and more villages, towns and institutions will be included. The selection of villages and regions will also depend on where the project can find able tinsmiths, who are willing to go into TLUD stove production.

Picture 7: Smoky kitchens are more of the rule than the exception

Especially, but not only, in the early periods of the project, the production and usage of the TLUD stoves will be closely monitored and evaluated in order to formulate lessons learnt for further stove production and promotion.

Public demonstrations will be done regularly in different places, so that people in the respective areas can actually see the new stoves in operation. Since the capacity of the project team is limited, it is not envisioned to introduce the TLUD stoves all over Uganda at once, but to concentrate activities on certain regions. Different concepts will be tested and the successful ones will be copied in other places. This way the project hopes to 'conquer' village after village and region after region.

(B) Quality improvement, monitoring and development

Since there are several TLUD stove technologies, CREEC must collect those stoves, test them and discover which models are the best suited for Uganda. After the initial inventory and testing, a maximum of two or three stove models will be promoted. As the project team gains more experience with the stoves and as feedback from the market come in, the chosen stove models will be continuously improved through applications of Kaizen principals.

The quality of the stoves produced by local tinsmiths will be continuously monitored and a CREEC Quality Label will be awarded to the producers who comply with certain quality standards.

Furthermore, TLUD stoves produce a valuable by-product in the form of small charcoal chunks. Research is still required to determine the best use for this product. One option is to use them as a soil amendment to boost productivity of farming activities. Another option is to press the small charcoal chunks into larger and denser charcoal briquettes, which can be used in (modern) charcoal stoves but the method and side effects of this process must still be analyzed.

(C) Training and production

The technology behind TLUD stoves is relatively simple and they are not difficult to produce. Within a few days and with only limited coaching, a tinsmith in Kampala learned how to produce Anderson's Champion 2008 stove with good quality.

The project team has chosen a decentralized stove production scheme for different reasons:

i. The technology to produce TLUD stoves is simple and can be learned with minimal training by any skilled tinsmith. It also allows pre-cutting of metal sheets and assembly at different locations.
ii. Due to bad road conditions in many parts of Uganda, transportation costs for bulky stoves would be too high if they were produced centrally.
iii. The local production and distribution of the TLUD stoves offers an additional income opportunity for small business entrepreneurs in rural areas. Keeping the wealth at community level contributes to the eradication of poverty and hunger.

Not only do the local producers require training in stove manufacturing, but the resellers must also be trained in basic business skills.

Finally, the correct operation of the TLUD differs substantially from the operation of traditional stoves or three-stone fires. Thus, the tinsmiths and resellers have to be trained in the correct operation of the stoves and in the preparation of the fuels, so that they can pass on this knowledge to their customers. Furthermore, a graphic operation manual for each stove type will be produced, which can be understood even by illiterate people. Community mobilization and trainings in rural areas will play a major role in this aspect of the project.

(D) Business modelling and microfinance

The business model is relatively simple. CREEC provides the technology and training to local entrepreneurs free of charge and they operate on their own costs and profits. The process is accompanied by local promotions.

Nevertheless, the local entrepreneurs will probably need access to microfinance services. The project team seeks a loose partnership with Ugandan microfinance companies and will establish the contacts, so that the microfinance activities are coordinated with the ones of the project team.

Since charcoal is produced in the TLUD stoves as a valuable by-product, its use should be considered as an extra incentive to adoption of the TLUD stove. For example, shows that the grinded charcoal can be used as a valuable soil amendment. In addition, extra income could be provided for the household if the small charcoal could be easily transformed into high-quality charcoal briquettes. Before the project team promotes such additional income generating activities, a business case must be calculated in order to find out whether such a commercial undertaking would be viable.

Due to the TLUD stoves' low emissions, there is a potential for a Clean Development Mechanism (CDM) carbon emission reduction project. The potential for carbon credits will be evaluated by an external organization specialized in this subject. In case such a project can be viable, a mechanism must be developed for the local producers and consumers to actually profit from such a project.

The four courses of action as described above are not separate activities but are all closely linked and influence each other. The systemic approach of this project is strengthened by many specialists working together under a single project management for the common goal of penetrating the Ugandan cookstove market with modern TLUD stoves.

3.2.2 Innovation

With the TLUD technology, the project is promoting an excellent technology available for biomass stoves, which is also affordable for many citizens in rural Uganda. Not only is state-of-the-art technology promoted and disseminated, but the whole value chain is also addressed. This includes the stove promotion, development, production, dissemination and operation, as well as fuel preparation and productive utilization of the by-product as charcoal briquettes or soil amendments.

The project will lead to the development and enhancement of environmentally friendly renewable fuel supply chains with the possibility of using locally available by-products from agro-processing, such as rice husk, coffee husks and maize cobs that have previously been neglected before.

On the financial side, access to microfinance services will be facilitated and the potential for the realization of carbon credits under a CDM scheme will be evaluated and, if economically viable, implemented.

The project also has a strong emphasis on income generation for the population in rural communities. These people are not seen only as consumers, but also as stove producers, fuel producers, traders and by-product processors.

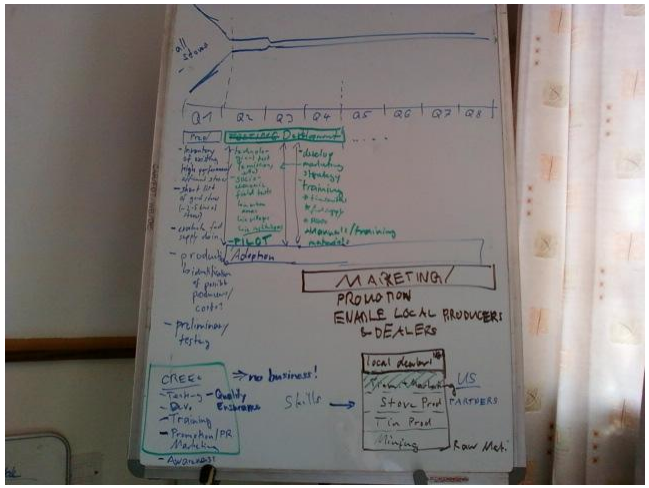
3.2.3 Sustainability

The proposed TLUD stoves use less biomass and emit fewer pollutants compared to other biomass cookstoves. This will go far in protecting the forests, enabling cleaner air and making the environment sustainable for future generations.

Capacity building through training of stove producers and resellers is one of the key activities in this project. Thus, these people will learn skills that help them to generate income for themselves. The fact that local producers and resellers will be earning money while delivering good products and services to consumers, will create a market complete with supply and demand dynamics that will last sustainably.

Apart from the initial field tests, subsidies will not be provided to the producers, resellers or end-users of the stoves. In order to keep market distortions at a minimum, the involved parties will only receive knowhow and advice and will profit from the general awareness building and promotion campaign.

CREEC also monitors the quality of the produced stoves in regular tests and intervenes if necessary. Only producers that fully comply with the defined CREEC benchmarks will receive a quality label. CREEC will maintain its quality assurance role well after the project days, to monitor the stoves' progress in the field and to ensure that the quality of the stoves is not compromised after some time.



Picture 8: Project proposal writing

The local entrepreneurs must produce and operate profitably from the very beginning. This market-oriented approach ensures that the business is run in a sustainable manner, which is crucial for the long-term success of the project. Support in marketing, sales and business development is part of the project.

In addition to stove producers and resellers, students from Makerere University will also profit from capacity building in the project. Students from various faculties will be involved in specific tasks in the project and will gain hands-on experience about project management, stove development, marketing and promotion, quality control etc. Well-trained local researchers, business men and women and project leaders are key factors of success for any (future) project.

3.2.4 Replicability and scalability

Several TLUD technologies are 'open source technologies' meaning that anyone is allowed to copy and modify the technology free of charge. Thus, any skilled artisan can start producing those stoves if he/she chooses to do so. It is even possible for a company to produce the stove industrially.

During the project, different production methods will be developed and tested. One option is to produce the TLUD in a semi-industrial way. In order to make it easier for the local tinsmiths and to attain a uniform high quality, different pieces of the stove can be cut industrially and then sent to the local tinsmiths in flat packages (to reduce transportation costs). The local tinsmiths' task would be reduced to assembling the different pieces. This production method must be evaluated in greater detail during the project by the engineers and the business development specialist.

If the chosen approach proves to work well in Uganda, the project can quite easily be reproduced in other places. The project team is willing to share all information and experiences acquired in the course of this project.

3.2.5 Risks

The local population may refuse to accept the TLUDs due to the stoves' price and lack of reputation and the population's unfamiliarity with the operation of the technology. The challenge is that the main competitor of the TLUD stove in rural Uganda, the three-stone fire, is freely available, so it is important to convince people to spend money on a modern cookstove.

The following factors will contribute to the success of TLUD stoves in Uganda:

- Deforestation in Uganda has reached alarming proportions and people realize that they must spend more and more time collecting fuels. The labour and financial costs of traditional fuel are increasing constantly. The fuel used in TLUD stoves is in the form of agricultural by-products (such as maize cobs) and carpentry waste.
- Women and children in Uganda suffer from serious Indoor Air Pollution (IAP). It is the project team's task to demonstrate TLUD stoves can easily solve this problem and significantly increase quality of life.
- The production and operating costs of TLUD stoves are low and can be further reduced through carbon compensation in a CDM project and productive utilization of charcoal as a by product.

Another risk is that the end-users will not use the TLUD technology correctly. If it is not operated in a certain way, there is no clean combustion process and the TLUD stove loses its comparative advantage of low emissions and high fuel efficiency. There is a strong focus on capacity building in this project, so that local producers and resellers can instruct the end-users correctly. Public demonstrations will be conducted and simple documentation of stove use will be provided.

When local producers are not monitored regularly, a uniform high stove quality cannot be guaranteed. CREEC will continuously monitor the local producers and provide additional training where necessary. Only producers who fully comply with the defined quality standards will receive the CREEC Quality Label.

3.2.6 Partners and roles

The core team of this project includes experts from Uganda and abroad with specialized but complementary competencies.

Prof. Paul S. Anderson is the inventor of the Champion 2008 TLUD and is a retired professor of Illinois University (USA). He works as Biomass Research Consultant, is the co-founder and vice-president of Chip Energy Ltd. and is a specialist in small gasification cookstoves and furnaces using chip-type biomass. He also has excellent contacts with other stove producers around the world and will be present in Uganda for about three months per year to support the project team.

CREEC is a research, training and consultancy organization with regards to bioenergy, solar PV, pico-hydro and energy management. The centre is actively involved in the cookstove sector and will provide leadership, project management and field staff for this project.

Joint Energy and Environment Projects (JEEP) is a local Ugandan NGO that will be involved in community mobilization, promotion and demonstrations of the TLUD.

Jed Musinguzi is an expert in entrepreneurship and small business development and will be in charge of all activities regarding business modelling, promotion and marketing.

Mohamed Sadam Ssembatya is a Ugandan tinsmith based in Kampala who already has experience in producing Paul Anderson's stove Champion 2008. His workshop will be producing the first TLUDs to be used in the project and he will be training other Ugandan tinsmiths in stove production.

3.2.7 Co-financing

The total project value is USD 260,080 of which USD 150,000 is funded by the World Bank. The remaining USD 110,080 is funded by the following co-financing partners (match funding):

- Chip Energy from the USA co-financing USD 13,000 towards time and services of Prof. Paul S. Anderson
- CEDAT from Uganda co-financing USD 12,000 towards MSc students, who will be involved in project activities
- CEDAT from Uganda co-financing USD 17,680 towards:
  - Office space
  - Electricity
  - Water
  - GIS specialist
- CREEC from Uganda co-financing USD 67,400 towards:
  - salary support of Karsten Bechtel, who will be involved in project management
  - salary support of Wim Getkate, who will be involved in project administration
  - salary support of Emmanuel Bukenya, who will be involved in the marketing campaign
  - salary support of Jed Musinguzi, who will be involved in the business development
  - Kick-off and wrap-up meeting
  - Airfare kick-off and wrap-up meeting
  - Other various testing equipment

4. Initial project phase

After finalization of the grant agreement in September 2010, a delegation of Winrock International visited CREEC to discuss the project, its implementation and monitoring, the relationship between CREEC and project partners, World Bank guidelines for procurement, the grant agreement, reporting requirements and CREEC's accounting and financial system.

At the end of 2010, kick-off meetings, both CREEC internal and with other BEIA grantees in Kenya, marked the start of the project. However, it took until April 2011 for funds to be released and the actual project implementation to start. The project team utilized the extra time to start research and development of the TLUD stove.

Anderson's Champion 2008 stove was selected for this project for two primary reasons: (a) the technology is open source and thus did not have any legal implications, such as royalties, and (b) due to Prof. Anderson's involvement in the BEIA project, the team would have direct and fairly unlimited access to the stove inventor with regards to anything pertaining to the stove. Both factors would significantly reduce the start-up time of the project since there was no need to go through any legal process and the team could utilize short, direct communication lines.

4.1 Stove observations

The project team carefully inspected the selected stove to determine if any modification would be required for the Ugandan environment.

Some technical observations were first made by testing the stove at CREEC laboratory facilities and in the field.

Chapters 6 and 7 provide technical details with regards to the TLUD technology, the selected stove and its modifications within the project.

4.2 Pilot study

In addition to technical tests at CREEC, the stove was also tested in a pilot study by a group of users. At the end of the pilot, the team hoped to have good insight into the acceptability, usability, adaptability and the price for the stove. For these purposes, twenty stoves were made, distributed and monitored.

It was important that the opinion of actual or potential users be considered before introducing the stove to the general public. Field tests provided further details away from ideal laboratory conditions to allow a better understanding of the stove's strengths for promotion purposes and the stove's weaknesses for correction and refinement purposes. Any problem that arose during the pilot was addressed before the actual field work commenced to enhance the cookstove's acceptance and adaptability in the market place.

The pilot ran for three weeks in two different districts and involved twenty cookstoves, ten enumerators and twenty respondents. Each of the two districts had ten respondents.

Picture 9: Enumerators training at JEEP

The enumerators consisted of CREEC and JEEP staff who had previously been trained for three days on administering questionnaires and stove demonstrations.

A questionnaire was prepared by focusing on each question through group discussions. Inadequate questions were modified in content and emphasis was placed on meeting pilot objectives. This resulted in: (a) simple and precise questions, (b) concise and objective replies and (c) questions and answers that met the pilot goals. The questionnaire was tested by applying it to five different, randomly selected households within Kyanja, Nakawa division of Kampala district. Any inadequacies were adjusted and a final questionnaire was designed to be used in the actual pilot study.

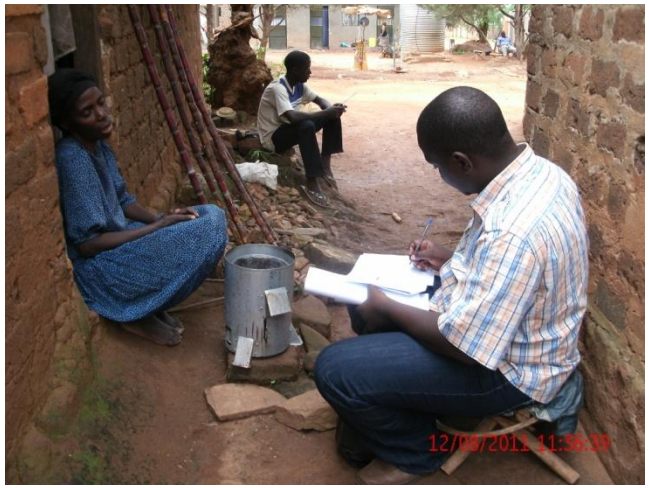
Picture 10: Lighting a stove at the Kyanja demonstration

The training also focused on the ability of the enumerators to light and operate the stove with different fuels, since each one of them would be required to independently demonstrate the stove. Teams of two were tasked to cook one kilogram of beans. As a result, all enumerators acquired the knowledge to demonstrate and operate the stove.

The actual pilot study was conducted in three villages in the Wakiso district: Kisenyi, Koona and Budalazizi and in two villages of the Nakawa division of the Kampala District: Komamboga and Kyanja.

The pilot consisted of three stages, each with its own part of the questionnaire:

1. The pilot was introduced to the local leaders, who in turn introduced it to the communities. The project team then made the public aware of the stove's benefits and demonstrated the operation of the stove by specifying the stove's parts and explaining the role of each part in the stove's operations. The stove was lit and 2.5 kilograms of beans were cooked. Respondents for the pilot study were selected following the demonstration, with the criteria that they resided within the parish or village. The enumerators were led to the homes of the selected respondents and all homes were allocated a cookstove to be tested and monitored during the pilot. Further stove demonstrations were performed at the respondents' homes. Lastly, the first part of the questionnaire was administered to establish baseline data. The respondents were asked to keep using the stove to familiarize themselves with it and for further monitoring.
2. A first follow-up visit was conducted three days after the initial demonstrations, with other follow-ups weekly after that. During these visits another part of the questionnaire was administered by the enumerator.
3. At the last field visits the final part of the questionnaire was administered.



Picture 11: Administering a questionnaire in Budalazizi

The respondents were given the stove to keep at the conclusion of the pilot study as a sign of appreciation for their cooperation and for further research on long-term factors such as the lifespan of the stove.

The pilot study gave the following positive responses:

Positive findings	Households that agree
The stove cooks much faster than other stoves (indicative: 25 to 50% less time)	100%
The Stove has limited smoke	100%
The stove uses less fuel than other stoves (indicative: 50-60%)	100%
The stove saves household fuel costs (indicative: 60-80%)	100%
The stove generates good quality and quantity of charcoal	100%
The stove is suitable for intensive cooking of meals such as beans, matooke* and cassava	100%
The stove can use different types of biomass fuel	95%
The stove is in high demand (10+ people expressed the desire to buy one)	90%

Table 3: Positive findings of the pilot

* matooke is a plantain that is eaten steamed or cooked

Also some negative responses were recorded:

Negative findings	Households that agree
The stove is too hot	100%
Removing the charcoal from the fuel chamber is cumbersome	55%
Preparing the fuel for the stove is new and more cumbersome than other stoves	35%
Cannot cook certain foods that require more simmering (e.g. rice and g-nut* sauce)	60%

Table 4: Negative findings of the pilot

* g-nut means ground nut or peanut

After discussing the results, the positive findings were upheld and solutions were sought for the negative findings. Recommendations for the latter are shown below.

Negative findings	Recommendation / solution
The stove is too hot	Caution remarks to be placed on stove marketing material and stove itself
Removing the charcoal from the fuel chamber is cumbersome	The technical team has devised a safer hot-charcoal retrieving technique
Preparing the fuel for the stove is new and more cumbersome than other stoves	100% of the households had prepared and stocked their own fuel by the second week
Cannot cook certain foods that require more simmering (e.g. rice and g-nut sauce	A diffuser to effectively power-down the stove has been tested and approved; this will be recommended for simmering

Table 5: Recommendations / solutions to negative findings of pilot

None of the families in the pilot study rejected the cookstove and other community members expressed interest in buying of their own, indicating that the respondents and the community have accepted the cookstove because of its many positive attributes.

It is interesting that about one-third of the people complained about the new way of preparing the fuels, but that they went ahead and started preparing a fuel stock anyway.

The possibility of using other fuels (expressed by almost all respondents) demonstrated a willingness to adapt to the stove.

The fact that every respondent replied that the stove produced good quality charcoal, implied that the stove would be adopted as a complementary stove.

Picture 12: Interactive demonstration in Kisenyi

With regards to the price, people reported that they were willing to pay for the stove and indicated rates between Uganda Shillings (UGX) 5,000 and 20,000.

Already the pilot created a demand for the stove in the areas where it was conducted.

5. District selection

In the development of commercially acceptable TLUD stoves and associated manufacturing and marketing techniques, the transfer of knowledge and capacity building played a crucial role. Originally the proposal required 50 tinsmiths from 25 districts (two per district) to be trained.

As will be discussed in the next chapter, it should be noted that the selected TLUD is only a heat source that must be developed into a proper stove. Through technical and social research, this cookstove was developed at and by CREEC. This knowledge thus had to be transferred to tinsmiths on the ground in the districts. To achieve that, first 25 districts had to be identified where the training would take place.

5.1 District Identification

The project team agreed that the 25 districts would be identified based on the four geopolitical regions of Uganda plus Kampala, the capital city itself. The chosen distribution was four districts in the Central Region and six districts each in the Eastern, Western and Northern Region. Because of its uniqueness, Kampala District was treated separately and three out of the five divisions of the city were selected.

Within a region, districts that would give the project a higher chance of success were considered for selection. The districts were ranked based on the following criteria, and the highest-ranking districts were selected to represent their region:

- population, because of market availability
- education, because of technology transferability
- poverty/wealth, because of affordability
- biomass availability, because of fuel accessibility

5.2 Data Treatment

A Selection Index (SI) for all the districts in the region was calculated. The data used in generating the SI was 'treated' to generate different indices, as indicated below, consistent with the SI model.

The Selection Index (SI) was the sum of the population index (PI), the Education Index (EI), the Wealth Index (WI) and the Biomass Availability Index (BAI) as follows:

$$SI = PI + EI + WI + BAI \quad [1]$$

5.3 Population Index

An available market for the cookstoves was required to have a successful product. The population of a district was a good indicator of market availability.

Since population was given in hundreds of thousands, the district population data [5] and the population data for Kampala [6] had to be divided by 100,000 to fit into the SI model.

$$PI = \text{district population} / 100{,}000 \quad [2]$$

5.4 Education Index

The transfer of information regarding cookstove manufacturing, marketing, and operability to tinsmiths, salesmen, and the general public was vital in establishing a viable cookstove market. The education status of the citizens of each district was used to estimate their ability to understand and adapt to the new information.

The number of students with at least two principle passes, which is the standard for passing the Uganda Advanced Certificate of Education (UACE), was obtained from UACE performance data [7].

In order to fit this data, which ranged between 0 and 2,000 into the SI model, the UACE successes per district were divided by 100 to generate the EI.

$$EI = \text{UACE successes} / 100 \quad [3]$$

5.5 Wealth Index

Affordability of the cookstoves was another important factor in successful market development. Wealth or its alternative, poverty, was used to reflect affordability.

The poverty incidence data [8], which is the percentage of people within a locality (in this case a district) living below the poverty line, was used to calculate the wealth index. In order to be representative within the SI model this data had to be put in ranges and reverse ranked as shown in the table below.

Poverty Incidence (%)	Rank
01-10	10
11-20	09
21-30	08
31-40	07
41-50	06
51-60	05
61-70	04
71-80	03
81-90	02
91-100	01

Table 6: Range and ranking of poverty incidence

The districts with very high incidence of poverty scored low ranks, while those with low incidences of poverty scored high ranks.

5.6 Biomass Availability Index

Favourable market conditions for cookstoves included sufficient quantities of fuel (biomass). The BAI was quantified from qualitative data of a map showing the supply versus demand of fuel in districts of Uganda [8], which depicted districts with surplus, balanced and deficit biomass energy.

Districts that registered surplus biomass energy scored a BAI of 3, those that registered balance biomass energy scored a BAI of 2 and those that registered deficit biomass energy scored a BAI of 1.

5.7 Project fatigue

During the project meetings it was noted that some districts were 'project-fatigued'. Project fatigue in this context refers to districts where people respond poorly to new projects due to excessive, previous project exposure. These people get a feeling that "nothing new can come out of these new projects" and start avoiding them. To that effect, if a district qualified for selection but had been previously identified as project-fatigued, it was dropped and replaced by a district following it.

5.8 Selected districts

The tables below give the ranking results for the various regions and Kampala district.

District	PI	EI	WI	BAI	SI
Nakawa division	3.59		6.00	1.00	10.59
Kawempe division	2.62		6.00	1.00	9.62
Makindye division	3.03		5.00	1.00	9.03
Rubaga division	2.53		5.00	1.00	8.53
Kampala Central	0.88		5.00	1.00	6.88

Table 7: Ranking Kampala District

District	PI	EI	WI	BAI	SI
Wakiso	9.08	101.75	9.00	1.00	120.83
Mukono	4.23	20.80	9.00	1.00	35.03
Luwero	3.41	18.04	8.00	3.00	32.45
Mityana	2.66	11.23	8.00	3.00	24.90
Buikwe	3.30	9.50	7.00	1.00	20.80
Kayunga	2.95	8.06	7.00	2.00	20.00
Buvuma	0.42	9.50	9.00	1.00	19.93
Lwengo	2.42	7.32	8.00	1.00	18.74
Masaka	2.28	7.32	8.00	1.00	18.60
Mubende	4.23	3.93	7.00	3.00	18.17
Kalungu	1.61	7.32	8.00	1.00	17.93
Mpigi	1.88	6.22	8.00	1.00	17.10
Bukomansimbi	1.40	7.32	7.00	1.00	16.72
Gomba	1.33	6.22	7.00	1.00	15.56
Rakai	4.04	2.12	7.00	2.00	15.16
Butambala	0.87	6.22	7.00	1.00	15.09
Nakaseke	1.37	2.53	8.00	3.00	14.90
Kyankwanzi	1.21	1.21	9.00	3.00	14.42
Nakasongola	1.27	1.99	8.00	2.00	13.26
Sembabule	1.80	1.14	7.00	3.00	12.94
Kalangala	0.35	0.51	10.00	2.00	12.86
Kiboga	1.09	1.21	7.00	3.00	12.30
Lyantonde	0.66	1.14	7.00	2.00	10.80

Table 8: Ranking Central Region

District	PI	EI	WI	BAI	SI
Jinja	3.88	20.23	5.00	1.00	30.11
Tororo	3.79	11.52	6.00	2.00	23.31
Manafwa	2.63	7.35	7.00	2.00	18.98
Mbale	3.33	7.35	7.00	1.00	18.68
Iganga	3.55	6.14	6.00	2.00	17.70
Bulambuli	0.97	7.35	7.00	2.00	17.32
Kamuli	3.61	3.55	6.00	3.00	16.16
Luuka	1.86	6.14	6.00	2.00	16.00
Busia	2.25	5.18	6.00	2.00	15.43
Kapchorwa	0.74	3.17	8.00	2.00	13.91
Pallisa	2.56	4.20	5.00	2.00	13.76
Kaliro	1.55	2.47	6.00	3.00	13.02
Soroti	1.93	4.00	4.00	3.00	12.93
Serere	1.76	4.00	4.00	3.00	12.76
Mayuge	3.25	2.28	6.00	1.00	12.53
Kibuku	1.28	4.00	5.00	2.00	12.28
Bugiri	2.67	2.14	5.00	2.00	11.81
Sironko	0.97	1.69	7.00	2.00	11.66
Bududa	1.23	1.07	7.00	2.00	11.30
Budaka	1.36	1.83	6.00	2.00	11.20
Namayingo	1.45	2.14	5.00	2.00	10.60
Buyende	1.91	0.65	5.00	3.00	10.56
Bukwa	0.49	0.98	7.00	2.00	10.47
Butaleja	1.57	1.79	5.00	2.00	10.37
Namutumba	1.68	1.48	5.00	2.00	10.15
Bukedea	1.22	0.74	5.00	3.00	9.96
Kaberamaido	1.32	0.63	5.00	3.00	9.94
Kumi	1.65	1.10	5.00	2.00	9.75
Amuria	1.80	0.86	5.00	2.00	9.66
Katakwi	1.19	0.07	5.00	3.00	9.26
Ngora	1.02	1.10	5.00	2.00	9.12
Kween	0.67	3.31	2.00	2.00	7.98

Table 9: Ranking Eastern Region

District	PI	EI	WI	BAI	SI
Mbarara	3.61	15.83	8.00	1.00	28.44
Kabale	4.58	14.53	7.00	1.00	27.11
Kasese	5.23	7.78	6.00	1.00	20.01
Kabarole	3.57	6.41	8.00	2.00	19.97
Ntungamo	3.80	5.92	8.00	2.00	19.72
Hoima	3.44	5.56	7.00	3.00	18.99
Rukungiri	2.75	6.28	8.00	1.00	18.03
Bushenyi	2.06	5.55	8.00	2.00	17.61
Sheema	1.80	5.55	8.00	2.00	17.35
Kibaale	4.06	2.33	7.00	3.00	16.39
Buhweju	0.83	5.55	8.00	2.00	16.38
Mitooma	1.61	5.55	7.00	2.00	16.16
Isingiro	3.16	2.81	8.00	1.00	14.97
Rubirizi	1.02	5.55	7.00	1.00	14.57
Ibanda	1.99	4.42	7.00	1.00	14.40
Kanungu	2.05	3.35	7.00	2.00	14.40
Kiruhura	2.12	2.20	9.00	1.00	14.32
Masindi	2.08	3.44	6.00	2.00	13.52
Kyenjojo	2.66	1.77	7.00	2.00	13.43
Kiryandongo	1.88	3.44	6.00	2.00	13.31
Kamwenge	2.64	2.25	7.00	1.00	12.89
Kisoro	2.20	3.35	6.00	1.00	12.55
Kyegegwa	1.11	0.29	7.00	2.00	10.40
Bundibugyo	1.59	0.42	6.00	2.00	10.01
Ntooroko	0.51	0.71	5.00	2.00	8.22
Buliisa	0.63	0.71	4.00	2.00	7.34

Table 10: Ranking Western Region

District	PI	EI	WI	BAI	SI
Arua	5.59	8.49	5.00	2.00	21.08
Lira	2.91	6.40	5.00	3.00	17.31
Gulu	2.99	4.64	4.00	3.00	14.62
Nebbi	2.66	1.94	4.00	3.00	11.60
Apac	2.50	1.72	5.00	2.00	11.21
Amuru	1.36	4.64	3.00	2.00	10.99
Oyam	2.68	1.21	5.00	2.00	10.89
Maracha	1.46	2.37	5.00	2.00	10.83
Koboko	1.29	2.52	5.00	2.00	10.82
Kitgum	1.67	2.82	3.00	3.00	10.49
Kole	1.66	0.00	5.00	3.00	9.66
Amolatar	0.96	0.58	6.00	2.00	9.54
Moyo	1.95	1.45	4.00	2.00	9.40
Adjumani	2.02	1.15	4.00	2.00	9.17
Yumbe	2.52	1.46	4.00	1.00	8.97
Dokolo	1.29	0.59	5.00	2.00	8.89
Alebtong	1.63	0.00	4.00	3.00	8.63
Nwoya	0.41	0.00	5.00	3.00	8.41
Agago	1.84	0.44	3.00	3.00	8.28
Zombo	1.69	0.29	4.00	2.00	7.98
Pader	1.42	0.85	3.00	2.00	7.27
Lamwo	1.15	0.00	3.00	3.00	7.15
Abim	0.52	0.32	3.00	3.00	6.83
Otuke	0.62	0.00	4.00	2.00	6.62
Napak	1.13	0.00	2.00	3.00	6.13
Kotido	1.22	0.69	1.00	3.00	5.91
Moroto	0.77	0.77	2.00	2.00	5.54
Kaabong	2.03	0.45	1.00	2.00	5.48
Nakapiripirit	0.91	0.00	2.00	2.00	4.91
Amudat	0.64	0.00	2.00	2.00	4.64

Table 11: Ranking Northern Region

The rankings resulted in the following districts and divisions being selected:

Nr	Region	District / Division
1	Central	Wakiso
2	Central	Mukono
-	Central	Luwero*
3	Central	Mityana
4	Central	Buikwe
5	Eastern	Jinja
6	Eastern	Tororo
7	Eastern	Manafwa
8	Eastern	Mbale
9	Eastern	Iganga
10	Eastern	Bulambuli
11	Western	Mbarara
12	Western	Kabale
13	Western	Kasese
14	Western	Kabarole
15	Western	Ntungamo
16	Western	Hoima
17	Northern	Arua
18	Northern	Lira
19	Northern	Gulu
20	Northern	Nebbi
21	Northern	Apac
22	Northern	Amuru
23	Kampala	Nakawa division
24	Kampala	Kawempe division
25	Kampala	Makindye division

Table 12: Selected districts and divisions

* Luweero was identified as project fatigued and thus replaced by the next ranked district in the Central Region which was Buikwe

6. The Top-Lit UpDraft gasifier

The type of stove chosen for this project was a Top-Lit UpDraft (TLUD) gasifier stove. Specifically Anderson's Champion 2008 was selected as the base model on which modifications were made.

6.1 History of biomass gasification

This section contains excerpts from "Handbook biomass gasification" [10], which reports on practical aspects, status and prospects, feedstock, gas cleaning technologies and economics of biomass gasification.

The first recorded use of combustible gas was in about A.D. 900, when the Chinese piped natural gas through bamboo tubes and used it for lighting. The first production of coal gas took place in 1665, in England, and its first utilization for lighting purposes was in 1792. In the 1850's much of London was illuminated by 'town gas', produced from the gasification of coal. Gas producers have principally been developed in Great Britain, France and Germany.

Producer gas was first used to power an engine in 1881. A revival in the use of producer gas occurred during both World Wars, but particularly during World War II when there was an acute shortage in liquid fuels. During WW-II approximately one million gasifiers using wood or charcoal were used to drive cars, trucks, boats, trains and electricity generators in Europe.

The oil crisis played a major role in the interest for biomass gasification. In the 1970's and later in the 1980's, interest in the possibilities of producer gas grew, especially for use in remote areas of several developing countries utilizing agricultural wastes.

Picture 13: Use of biomass gasification during WW-II

As can be seen from the above, gasification has been well-known for several centuries but has not yet captured the cookstove sector in large numbers.

6.2 Biomass gasification

Most of the text in this section is taken from the handbook "Micro-gasification: cooking with gas from biomass" [11], which contains a large volume of detailed information on gasifier cookstoves.

Micro-gasification for household cooking is a relatively young development. The principle was invented in 1985 and the first commercial micro-gasifier was available in 2003.

The solid substances in wood undergo changes determined by the presence of heat and oxygen:

- as biomass is heated, it evaporates excess moisture and its surface temperature increases
- at elevated temperatures, biomass pyrolyzes ('decomposes by fire') into combustible vapours and a solid, known as 'char'
- red hot char can be converted to ash if sufficient oxygen is available
- mixed with oxygen the vapours and gases generated can be combusted when ignited

During the whole conversion process, temperatures increase from ambient temperature to well above 800 °C, depending on local conditions. In each step vapours and gases are released and the solids reduce in mass and volume. If complete combustion is attained, emissions should be clean and only contain carbon dioxide and water vapour. If combustion is not complete, the smoke and vapours composed of unburned fuel and carbon monoxide will result, both of them being harmful to human beings and the environment.

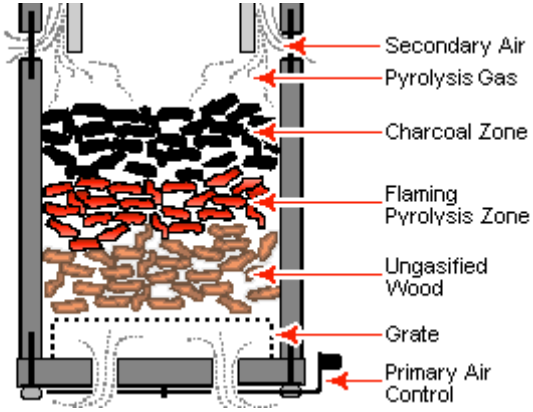


Figure 2: Gasification processes

Taken from www.solarberg.ch

Once conditions that influence combustion are known, they can be used to control and optimize the process. Therefore each step is explored separately below.

Step 1: Drying

The first change happens during drying. The amount of water transformed into vapour depends on the moisture content of the raw fuel, which also determines the heat input needed to evaporate all the water and the loss in mass and volume to get to dry fuel.

Step 2: Pyrolysis (carbonization)

Increased temperatures and absorbed heat eventually cause a complete decomposition of the biomass, which separates into volatile gases and vapours, as a solid char remains behind. The vapours contain various carbon compounds with fuel value, referred to by the term 'wood gas'. As the solid product of this stage is char, it is also referred to as carbonisation. Pyrolysis can happen in the complete absence of oxygen, the regulating factor is heat. In short: no heat input, no pyrolysis, no wood gas generation and no fire.

Step 3: Char gasification

Once char is formed, the next stage of the solid phase is to convert the carbon atoms to gases and the non-carbon portion to ash. This only happens if oxygen is available and reaches the char while it is still hot enough to react. Then 'char gasification' occurs: oxygen reacts with the char solids, yielding carbon monoxide, carbon dioxide and creating additional thermal energy. The fraction of non-burnable solid mineral content of the char remains as ash. Note: The regulating factor of char gasification is the amount of available oxygen around the hot char. If the char is cooled and/or the oxygen supply is restricted, the conversion from char to ash does not take place and the char will be conserved and no ash will be created.

Step 4: Gas combustion

The final stage of 'gas combustion' is where the gases are burnt (combusted) and the bulk of the heat is released that can be used e.g. for cooking.

Combustion is a series of oxidization reactions, which can only take place if sufficient oxygen is available. The main regulating factor of combustion is the amount of oxygen mixed with the hot vapours and gases. If there is not sufficient available oxygen, the gases cannot be burnt, combustion remains incomplete and unburnt smoke or carbon monoxide will be emitted.

Thorough mixing of oxygen provided by the air with the freshly generated hot wood gas and char gas (if char gasification took place), in combination with an existing flame, results in the complete combustion of the gas components.

The flame is the visible manifestation of combustion. Ideally only fully oxidized gases, without unrealized energetic value, leave the combustion zone, meaning that all hydrocarbons from the biomass fuel have been oxidized to carbon dioxide and water vapour.

If the combustion is incomplete due to the lack of oxygen or if the vapours have cooled down below the point where they will burn, they turn into undesirable emissions: in the case of wood gas it is in the form of noticeable, often irritating, smoke. In the case of char gas it is in the form of carbon monoxide, an odourless, imperceptible, and highly undesirable toxic gas. Carbon monoxide is poisonous and a danger for human health.

Energy input and output

The objective of burning biomass for cooking purposes is to provide thermal energy to heat up food. Yet, it takes energy to break the chemical bonds within the solid biomass. So the first two stages described actually consume heat, meaning they are endothermic. This is why a match or some other flame source is required to start a fire. Once the fire is started, the heat released by the combustion reactions supplies the necessary thermal energy to continue the fire and make it self-sustaining.

When designing a device to control the burning of biomass and regulate the rate of heat generation, it is important to note that the drying and pyrolysis stages are controlled by regulating the amount of heat that reaches the solid biomass, while the later steps of char gasification and vapour combustion depend on the availability of oxygen.

Picture 14: MWOTO gasifier cookstove

A biomass gasifier is the broad term for a device that turns solid biomass into gas that can subsequently be burnt in a controlled manner. Unlike in the open fire, the gas generation is controllably separate in space and time from the gas combustion. While open fires and most conventional cookstoves are regulated by the fuel supply, most gasifiers are controlled by the air supply.

Gasifiers offer the potential to deliberately optimize the frame conditions of each conversion step. By controlling the inputs heat and air, an exceptionally clean combustion of biomass can be achieved. The major challenge is to get the right amounts of air to the right places.

The step of char gasification can be suppressed, if the hot char does not get exposed to sufficient air. In this case the combustible gases are predominately generated by pyrolysis and a portion of the char is conserved. This type of gasifier device is often referred to as 'biochar'-making 'pyrolytic' gasifier.

Although the combustible gases could be piped and sent for other uses, for cooking purposes it makes most sense to have the combustion zone close-by and burn the gases while they are still hot.

In a nutshell: "gasification" is the broad term used for the conversion of a solid fuel into a gaseous fuel. The process to create heat from solid biomass goes in stages: wood gasification turns wood to char and gases. It is controlled by heat input and can be slowed by cooling. Char gasification turns char to ash and gases. It is controlled by oxygen and can be 'arrested' by deprivation of oxygen. Wood gas is often used as summarizing term for the mixture of combustible gases and pyrolytic vapours from both gasification reactions. It will combust when mixed with oxygen and ignited. In an 'open fire' all the stages of gasification and combustion occur simultaneously at the same place and with no or little control over the processes.

Because gasifiers require high temperatures and heat transfer into cold biomass, making them small is difficult. As such, it has been a challenge to make biomass gasification suitable for domestic cooking. Commercially viable gasifiers have long been understood and used in large industry and even in transportation: over one million vehicles were fuelled by biomass (mainly charcoal) gasification during WW-II, when liquid fuel was hard to come by (see section 6.1). But there was nothing similar for small applications such as household stoves.

The most common and best known industrial applications are downdraft gasifiers, where the gases are generated and removed from the reactor (gas generator), then combusted in a remote burner, e.g. in an internal combustion engine or in a street lamp supplied by town gas.

Fundamentally, the challenge in cooking is a question of scale; how to gain control over the pyrolysis, gasification and combustion in a small enough (vertical) space to be used by individual households.

Picture 15: Gasification in a small vertical space used by households

Solid biomass does not combust directly. Biomass gasification is the broad term used for the conversion of a solid biomass into wood gas. The process of combustion of solid biomass goes in stages: wood turns to char, and subsequently, char turns to ash. Wood gas, the mixture of combustible gases and pyrolytic vapours, is easily combusted when mixed with oxygen and ignited.

In an 'open fire' all the stages of gasification and combustion occur simultaneously and with no or little control over the individual processes.

The deliberate separation of the processes is the principle in biomass gasifiers. A gasifier is a device where the gas creation is controllably separate in location and time from the gas burner where the combustion takes place. Micro-gasifiers are small devices suitable for cooking purposes, generally small enough to fit directly under a cook pot.

6.3 History of TLUDs

The text below comes from the website http://www.drtlud.com [12], which is Prof. Paul S. Anderson's personal website.

In 1985 on a trip to South Africa, gasification expert Dr. Thomas B. Reed awoke one night thinking of a very small gasifier for the domestic stove needs of impoverished people. For ten years he worked to develop what is now called the TLUD (Top-Lit UpDraft) natural draft gasifier stove. Indeed, he is the recognized originator of what is now called Top-Lit UpDraft gasification.

In 1995 Dr. Ronal Larson joined the effort with a focus on the gasifier's capacity for producing charcoal as a valuable by-product in a household stove. After testing and publications, but no real success for applications, they stopped that work in 1996. However, in 1998 Dr. Reed began work on a smaller, forced convection model with a fan with the intention to make a stove for the affluent North American camper market. He has successfully produced the "WoodGas CampStove" for marketing in 2003 that can produce impressive heat for sustained periods. Some modifications are necessary for applications in developing countries.

Independently and virtually unknown until 2008, Norwegian Paal Wendelbo successfully developed the "Peko Pe" natural draft TLUD cookstove in Uganda in the 1990's.

Whereas Reed and Wendelbo are independent co-originators, others who have done significant work with TLUDs up through the present may be considered 'pyroneers'.

Picture 16: Peko Pe

In 2001, Dr. Reed lit his early prototype forced-air gasifier stove on a kitchen table for Dr. Paul S. Anderson and two others to see. Sufficiently impressed, Dr. Anderson started experimenting, studied Reed's original TLUD gasifier, learned much from the Stoves Listserv (an internet site with substantial information on cookstoves), and subsequently devised numerous modifications that resulted in the "Champion" TLUD model in 2005. There are important similarities between Anderson's Champion and Wendelbo's Peko Pe that result in successful natural draft Top-Lit UpDraft stoves (TLUD-ND).

Micro-gasification refers to gasifiers small enough in size to fit under a cook pot at a convenient height. It was conceptualized as a Top-Lit UpDraft process in 1985 and developed to laboratory prototype stages by Dr. Thomas B. Reed in the USA. Independently in the 1990's the Norwegian Paal Wendelbo developed stoves based on the same TLUD principle in refugee camps in Uganda.

TLUD devices have always been intended as biomass-burning cookstoves and there were some early Do-It-Yourself backpacker efforts, but it was only in 2003 that the first micro-gasifier was commercially made available by Dr. Thomas B. Reed when he presented the Woodgas Campstove to the outdoor camping niche market in the USA. Commercially available models are still scarce, though there is growing interest.

The first known micro-gasifiers from Thomas Reed and Paal Wendelbo respectively are pyrolytic TLUDs that can create char with a flaming pyrolysis and a restricted supply of primary air.

6.4 TLUD principle

Most of the text in this section is taken from the handbook “Micro-gasification: cooking with gas from biomass” [11], which contains detailed information on gasifier cookstoves.

The TLUD design principle is ‘open source‘, in the public domain and not protected by copyrights or patents. TLUD construction plans are publicly available on the internet or from some designers. Thus, TLUDs are easy to adapt and replicate in individual projects without patent infringement or copyright issues. Therefore the TLUD principle will be explained here in detail.

Figure 2 depicts the basic design features of a pyrolytic Top-Lit UpDraft micro-gasifier, derived from the principles of biomass gasification explained in section 6.2.

The simplest TLUD can be a single tin-can with separate entry holes for primary and secondary air as combustion unit. Thorough mixing of the gaseous fuel with the oxygen provided by the secondary air to ensure optimal combustion can be enhanced with a concentrator disk or forced air. A riser above the combustion zone can increase draft and further enhance thorough mixing of gas and oxygen.

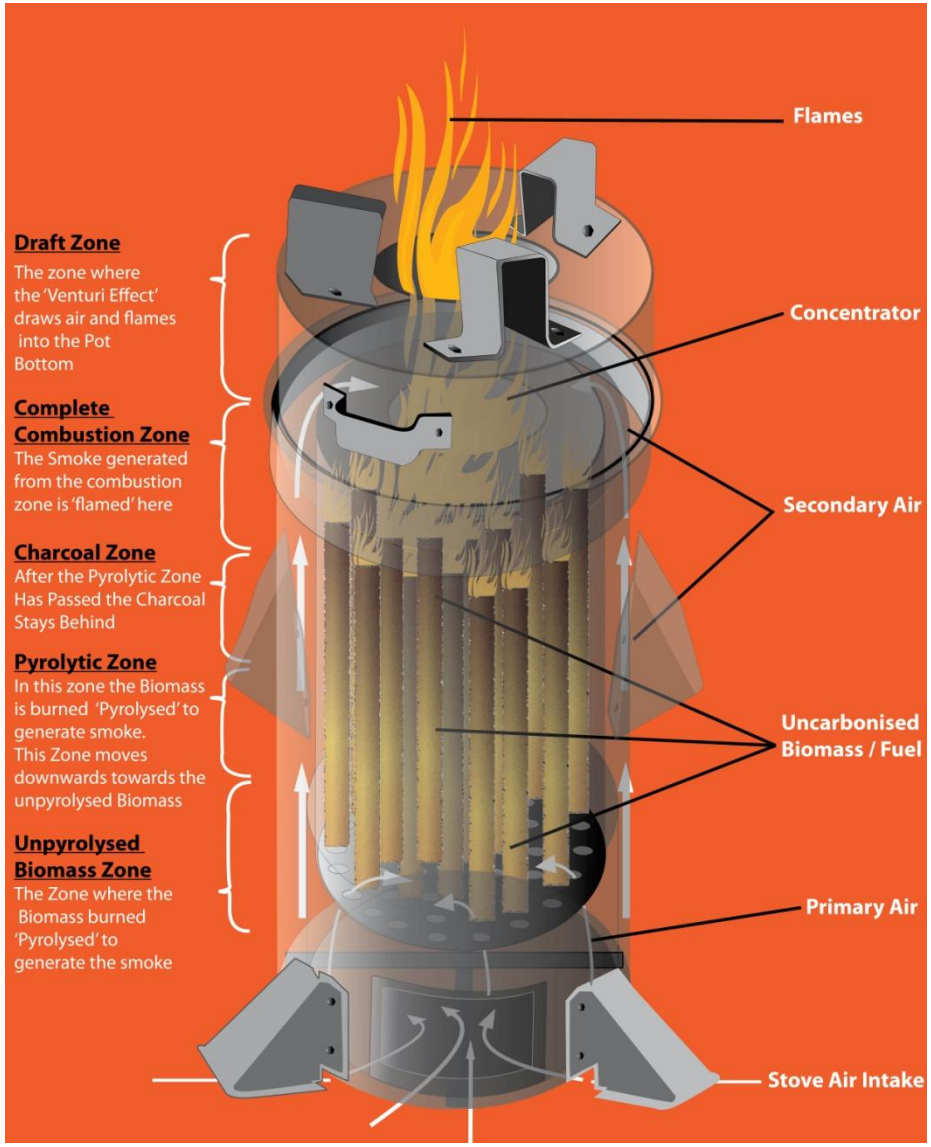


Figure 3: Basic design features

In TLUD gasifiers, the fuel does not move except by shrinkage in volume when pyrolyzed. Two things move:

- a hot 'flaming pyrolysis front' moves downward through the mass of solid raw fuel, converting the biomass to char
- the created gases travel upward towards the combustion zone, while the char remains behind above the pyrolysis front

The name "Top-Lit UpDraft" denotes two key characteristics of these types of micro-gasifiers: the fire is ignited at the top of the column of biomass fuel and the primary combustion air is coming upward from the bottom through the column of fuel.

The limited amount of primary combustion air allows only a partial combustion of the created wood gas, just enough to provide the heat required to keep the pyrolysis reactions going. Since the rate of heat generation is determined by the amount of available oxygen, the progression of the pyrolysis front is controllable by regulating the primary airflow.

Additionally, increased airflow (with a fan or sufficient riser/chimney) will result not only in faster progression of the flaming pyrolysis front down the column of biomass, but also in higher temperatures in the pyrolysis zone. This will impact the characteristics of the created char, which is important if it is intended to be used as biochar.

In a typical TLUD, the pyrolysis front moves downward 5 to 20 mm per minute, depending on the nature of the fuel and the amount of primary air.

Above the pyrolysis front, the created char accumulates, prevented from combustion because of the lack of oxygen. The remaining hot inert gases (mainly nitrogen) sweep the created pyrolytic gases and water vapour to the secondary combustion zone. There additional air is provided and the pyrolytic gases are burnt in a separate and very clean flame. The pyrolytic gases are tarry, long-chain hydrocarbons that, if not burned, form a thick smoke.

Picture 17: Gasifiers produce charcoal ...

Unique among the gasifiers, TLUDs operate in a batch mode and do virtually all of the biomass pyrolysis or wood gasification before doing appreciable char gasification. The transition between the two phases is quite distinct, changing from a characteristic yellow-orange flame (from burning tarry gases) to a smaller blue-ish flame that denotes the burning of carbon monoxide.

Picture 18: ... that can be used in a charcoal stove

6.5 Advantages of a TLUD

The TLUD technology comes with several advantages over the traditional three-stone fire and other cookstoves:

- It uses less fuel and emits less smoke (pollutants) and it is therefore environment-friendly.
- It cooks foods / boils water very fast, so it saves the user time.
- It can use multiple fuels: wood as well as agricultural by-products that are considered waste, such as maize cobs, bundles of grass, seeds or husks, that can be obtained for free or at low prices.
- It even produces fuel in the form of charcoal that can be used in a normal charcoal stove.

7. The MWOTO stove

The type of stove chosen for the BEIA project is a TLUD gasifier stove as discussed in the previous chapter. The project selected Prof. Paul S. Anderson's Champion 2008 as the base model on which specific modifications were made.

On the last day of the BEF Camp (see section 8.2) there was a cooking competition with a variety of TLUDs: an Indonesian, Kenyan and Indian TLUD, one from Mozambique, the Champion 2008 and a Peko Pe. Criteria such as stability, cooking time, safety and user-friendliness (judged by women living around CREEC offices) were used as selection criteria. The one from Mozambique was the winner.

Picture 19: Champion 2008

7.1 Champion 2008

The name "Champion" has been taken as a trademark name for the specific TLUD gasifier stove that won the award for the cleanest combustion at the Stove Camp of 2005 (see also the previous chapter).

Prof. Anderson continued to improve the TLUD, which resulted in the Champion 2008 version.

Picture 20: Prof. Paul S. Anderson explaining the TLUD technology

7.2 Stove modifications

After significant consultation and testing, the Champion 2008 was chosen as the foundation for the TLUD stove to be used in this study. Limitations of the Champion 2008 included its primary function as a heat source and a short pyrolysis time, so modifications were made to convert it into a more socially acceptable cookstove.

Since the Mozambique TLUD stove won the BEF camp cooking competition, changes were made to the Champion 2008 towards the Mozambique design. Necessary changes included an increase in height and diameter of the Champion 2008 and integration of a pot stand into the stove structure to make it more suitable for cooking.

Based on the desired changes listed above, four types of the Champion 2008 were created (T1 - T2 - T3 - T4):

T1 = the original Champion 2008, with a height of 30.4 cm and a diameter of the outer cylinder of 18.9 cm.

T2 = T1 + (d + 20%) with a height of 30.4 cm and a diameter of the outer cylinder of 22.0 cm.

T3 = T1 + (h + 20%) with a height of 35.0 cm and a diameter of the outer cylinder of 22.0 cm.

T4 = T1 + (h + 20% and d + 20%) with a height of 35.1 cm and a diameter of the outer cylinder of 22.1 cm.

Picture 21: Four variants

Observations including fuel tests, time to boil water, stability and, most importantly, the comments of cooks (thee women living around CREEC offices) were considered for each design.

Picture 22: Observation tests

T1 was considered too small since fuel would be used up quickly, requiring frequent re-fuelling of the fuel chamber

T2 improved on the design with a larger fuel chamber and therefore longer burning time. Water boiled quickly since the fire was powerful.

T3 had an increased fuel chamber, but it was considered too high by the cooks since they prefer to sit during cooking

T4 had the advantages of T2 (larger fuel chamber and powerful fire), but also the disadvantage of T3 (considered too high).

Therefore, T2 was selected as the start model for the project.

Several recommendations and observations were also made:

- The riser should be shaped in form of a funnel or a slanting pot rest should be used to equally distribute the flames around the pot.
- The char from the fuel chamber should be put in a charcoal stove whose size is proportional to the volume of the char.
- T2 has a good height for cooking

Picture 23: Discussions during the R&D phase

- The stove handles and primary air control handle both require insulators.
- There is need to add a metal strip to indicate and limit the amount of fuel to be used since filling the stove to the top will cause it to smoke when lit.
- The riser and the pot stand should be fixed together.
- The height of the stove stand should be increased to allow secondary air to flow in once the primary air inlet is closed.

Five people living near CREEC offices were provided with a stove as an informal pre-pilot study. They provided useful comments for the project start:

- They were impressed with cooking time.
- They were happy to obtain charcoal to cook other dishes.
- There are flames around pot since a small pan was used.
- The fire was too hot, so the pan had to be taken from the stove to mingle food.
- The pan was sliding on pot rests.
- Some operated the stove wrongly; it was lit from the bottom, resulting in significant smoke creation.

These experiences and the ones from the pilot (see chapter 4) led to modifications of the stove.

7.3 Modifications from BEF camp, observations and pilot

The shape of the pot rests were round and caused the pan to be unstable on the stove. The pot rests were changed from round to flat which prevented the pan from sliding.

Lid handles were added so that it could be carried on both sides, making operation easier.

Also stove handles were added which allowed easier handling of the stove. They however were sharp and could cut fingers of users. The handles were modified slightly to have a smoother edge.

The concentrator was incorporated into the riser to give the stove a neater look. It also resulted in a stove with fewer parts thus lowering the risk of parts being lost.

The stove's feet were adjusted to give it more stability and thus a safer way of operating it. This also provided a better air intake from the bottom of the stove.

To avoid overheating of the pan due to the flame on one spot, the flame had to be spread more evenly over the bottom of the pan. This was achieved by giving the concentrator a slope.

Picture 24: Concentrator slope

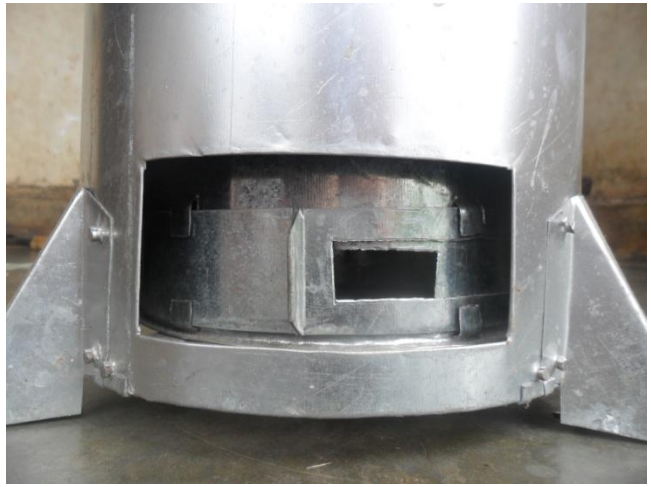
The parts inside the outer cylinder to hold the fuel chamber were modified to neutralize the problem of bending and deforming.

The air base was held in the outer cylinder by metal wires. However, these were too weak and would not last long. A new design with metal strips solved this shortcoming.

The fuel chamber has several supports and spacers which were modified to decrease on the amount of material used.

The mesh at the bottom of the fuel chamber was replaced by a grate, a thicker plate with holes drilled in it, because the mesh wore out quickly.

Initially the stove had no primary air controller. To allow control of the 'high firepower', as noted by respondents during the pilot, an air controller was added.



Picture 25: Primary air controller

This allows the stove to have some control of the flame and make the stove more suitable for cooking foods that require simmering.

The fuel chamber was fixed to the air base, which, together with some smaller changes, allows it to be removed from the outer cylinder. This enables users to empty and re-fuel the fuel chamber.

The stove was provided with hooks to give the opportunity to re-fuel the stove with another fuel chamber. The shapes of the hooks were adjusted to avoid dangerous situations when a hook slips out of its holder.

7.4 Modifications from field experiences and tinsmiths

Tinsmiths argued during training that too much material was used resulting in a modification where the fuel chamber was combined with the air base creating a removable part. This modification significantly reduced production time, construction complexity and material costs.

Some producers introduced shorter riser height (or even no riser) to save on material. This resulted in poor stove performance (too much smoke during start-up of stove). This modification was therefore no longer taken up and discouraged by the project team.

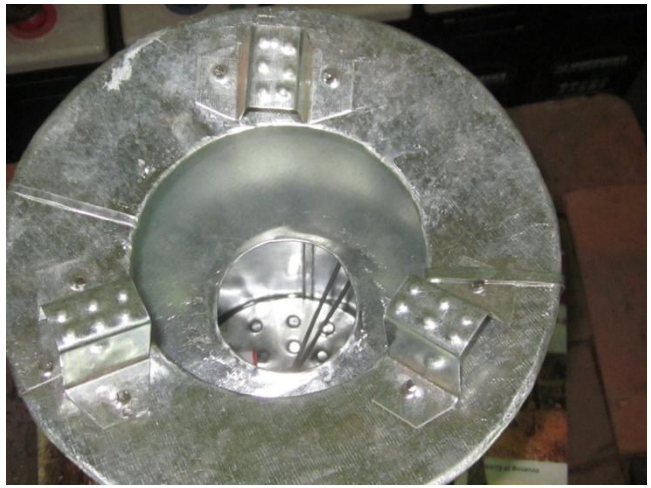
Riser handles were eliminated since it reduced material required and production time. The risers can be removed using the hooks for removing the fuel chamber.

The height of the pot stands was lowered to decrease the gap between bottom of the pan and top of the riser. The gap was too large and allowed wind to disturb the flames.

The grate of the fuel chamber contained many small holes. It was modified to contain fewer holes with larger diameters to reduce production time.

The size of the secondary air inlet was reduced to create a more stable and thus better controllable flame.
The air control holders were changed to prevent the air control slide from slipping out of the holders.

Sharp edges were removed from the stove's feet to prevent injury or clothes from catching on the edges.



Picture 26: Profile on pot stands

The pot stands were given a profile in the form of six dents to provide a less smooth surface. Previously, the pot stands were flat and smooth which did not provide enough resistance to prevent the pan from sliding.

Some tinsmiths spray-painted or stencilled the MWOTO logo on the stove, while others tried stickers. The latter were not successful due to the outer cylinder heating up and burning the stickers. A few tinsmiths engraved or punched serial numbers into the outer cylinder.

Some tinsmiths used scrap metal and therefore sprayed the stove in silver or their organization's colours. The disadvantage of paint is smoke creation during the first times the stove is lit and a less attractive look of the stove due to paint burning off. Other tinsmiths used galvanized sheets that present a good appearance of the stove and therefore do not require painting.

A variety a sheet gauges was used. Some tinsmiths used heavy gauge for the fuel chamber only, while others used it throughout.

Picture 27: Four main components of the MWOTO stove

From left to right: riser / pot stand combination, outer cylinder and fuel chamber, with in front the hooks for lifting of the fuel chamber

8. Training of tinsmiths in manufacturing

An important component of the project was knowledge transfer about stove manufacturing and capacity building of tinsmiths.

8.1 Training approach

The project manager and the master tinsmith travelled to the selected district or division to find and observe established tinsmiths. Tinsmiths must have previously made products requiring techniques used in manufacturing a TLUD stove to be eligible for this training because practising tinsmiths could use their knowledge and tools to more easily adapt to the new technology. The team then introduced the project to the tinsmiths and requested suitable and qualified tinsmiths to join the program. For future support and reference, data of the selected tinsmiths was recorded (such as bio-data, experience and business status).

During the actual training the master tinsmith of the project team first explained the TLUD technology. The master tinsmith then actually produced a stove to show the trainees the various steps in the manufacturing process. The last phase of the training consisted of a practical, hands-on experience in which the selected tinsmiths were given one square meter of metal sheet to produce their own TLUD under supervision of the master tinsmith.

8.2 BEF Stove Camp

In June 2011, the Biomass Energy Foundation (BEF) from the United States of America organized a four-day stove camp in collaboration with CREEC that took place at CREEC offices.

The focus of the BEF Stove Camp was on gasifier stoves. Prof. Paul S. Anderson and Christa Roth from Food and Fuel, Germany, taught about 25 trainees on a wide variety of topics concerning gasifier stoves, such as understanding combustion and pyrolysis, natural and forced draft, stove testing and fuels.

The project team and project partners attended this stove camp to get a basic understanding of the TLUD technology.

8.3 Initial training

As mentioned in chapter 4, the pilot study took place in three villages in the Wakiso district: Kisenyi, Koona and Budalazizi and in two villages of the Nakawa division of the Kampala district: Komamboga and Kyanja. During the pilot the team realized that there was high demand for the stove and decided to train tinsmiths established in the pilot areas. The project therefore selected tinsmiths from Wakiso district and Nakawa division for the initial training from August 22 to 24, 2011.

Picture 28: Six trainees with their stove

On the first day, the project leader and the master tinsmith went to Wakiso district and Nakawa division to select tinsmiths in accordance with the above mentioned training approach. In total, six tinsmiths from Wakiso district and Nakawa division were selected.

On the second day, the tinsmiths were introduced to the TLUD technology at CREEC's workshop. The master tinsmith then showed the trainees how to produce a TLUD stove. Next the tinsmiths were tasked to manufacture a stove in groups of two.

On the third day, again at CREEC's workshop, the tinsmiths produced their first individual TLUD stoves to gain further practical experience in the technology.

For the project team, the initial training was an important milestone which contained a very important learning moment: how to train a tinsmith. This experience was vital for future trainings.

Picture 29: Only female tinsmith in the project

The initial training enabled the project team to understand the manufacturability and, most importantly, the timeframe required to train tinsmiths in producing a TLUD. An established tinsmith can be trained in one to two days. By the second day he is proficient enough to produce a good quality stove.

The original work plan indicated that one week would be needed to train a tinsmith, which meant spending two weeks in the district. The initial training showed that the project can dramatically reduce the time spent in the field to produce the same impact.

8.4 Training St. Jean M. Muzeeyi vocational training institute

On August 24, 2011, the project team visited St Jean Marie Muzeeyi vocational training institute in Mengo, an area in Kampala, to introduce the project to the principal. The stove was demonstrated and six students that showed interest were identified.

Picture 30: Students of St. Jean M. Muzeeyi producing their TLUDs

August 30 through September 2, 2011 were the training days on which the master tinsmith explained the technology, demonstrated the manufacturing steps and supervised the trainees during the construction of their own TLUD.

Picture 31: One of the students proudly presenting his finished stove

The training took place at CREEC's workshop and provided insights by comparing the work of these students with established tinsmiths.

8.5 Training in Mbale

Eleven tinsmiths from Mbale were trained on September 17 and 18, 2011 at Bugwere market, Majanga Road, Mbale municipality. They were chosen from Bugwere Market (seven) and Mawungano Garage (three) during the selection day on September16, 2011.

Picture 32: Initial demonstration and explanation about TLUD

Each participant was given one square meter of metal sheet to produce a stove during the training session.

Picture 33: Training of tinsmiths in Mbale

This training took place during the Energy Efficiency Week which provided a platform for the launch of the TLUD stove to the general public by demonstrating the stove, explaining its operation and pointing out its benefits.

8.6 Training in Nakawa

From October 12 to 15, 2011, the team set out for training in Nakawa division of Kampala district.

Picture 34: Training location in Nakawa

Day one and two were used to introduce the project to Nakawa's Deputy Resident City Commissioner at the Nakawa division headquarters and to search for tinsmiths. A total of fourteen tinsmiths were selected: eight from Nakawa market, four from Naguru market and two from Kitintale market.

Picture 35: Working on the handles

On the third day, the tinsmiths gathered at Nakawa market where they were introduced to TLUD production. Each tinsmith was given one square meter of metal sheet to produce a stove in a hands-on training.

Picture 36: Construction of the riser / pot stand combination

The tinsmiths returned on the fourth day to finalize the training, because rain disorganized the training of the previous day.

Picture 37: Finishing the riser / pot stand combination

Picture 38: Presenting the finished product

The fourth day was also utilized to identify suitable mobilizers together with the tinsmiths. These people assisted in informing the public about upcoming promotions. Announcements were made using local mobilisation systems like megaphones through mobilizers walking around informing the public about the trainings and through strategically located stationary loudspeakers of local radio stations airing the promotional activities to take place at Nyanya section of Nakawa Market in the next week.

Picture 39: Stove demonstration in Nakawa

On October 17, 2011 the promotional activities were held where the project team cooked beans, rice and chicken for the public. The stock of ten stoves was sold in the first hours of the demonstrations.

8.7 Training in Kawempe

On October 19, 2011, seven tinsmiths from Kawempe division received a practical training in Kikoni market in Makerere. Also in Kawempe, the training day was utilized to inform the public about upcoming promotions at Growers Ground in the next week, in the same manner as in Nakawa: through megaphones and stationary loudspeakers of local radio stations.

Picture 40: Cutting of metal sheets in Kawempe

A week earlier, on October 12 and 13, 2011, the project team visited the Deputy Resident City Commissioner at the Kawempe division headquarters to introduce the project and to select tinsmiths.

Picture 41: Demonstration and awareness creation in Kawempe

As in Nakawa, the project team cooked beans, rice and chicken for the public during the promotions on October 24, 2011. The initial stock of cookstoves was also taken quickly here.

8.8 Training in Kampala Central

Also on October 12 and 13, 2011, the project team visited the Deputy Resident City Commissioner at the Kampala Central division headquarters to introduce the project. A total of eleven tinsmiths were selected: eight from Kisenyi and three from Katwe market.

Picture 42: Begin of the riser / pot stand combination

On October 24, 2011, the tinsmiths from Kampala Central division were trained at Kisenyi Kumbuzi Workshop.

Picture 43: Taking measurements for the outer cylinder

Again using megaphones and stationary loudspeakers of local radio stations, the public was informed on the training day about upcoming promotions at Owino market.

Picture 44: Awareness creation in Owino market

Demonstrations of the cookstove with beans, rice and chicken took place on October 26, 2011. Again there was significant interest from the public, evidenced by the fact that all stoves brought to the promotions were sold in a few hours.

Picture 45: Actual cooking on the stove in Nakawa

Picture 46: Scouting of tinsmiths

Although the original plan included Makindye division (see chapter on district selection), the scouting in that area revealed that there were no suitable tinsmiths in Makindye division. In the vicinity of Makindye division are Katwe and Kisenyi, informal industrial complexes with many metal workers. Therefore the Makindye division was replaced by Kampala Central division.

8.9 Training in Arua

On October 29 and 30, 2011, the team trained a group of tinsmiths from Arua in Northwest Uganda.

On the first day, the team visited the Arua district authorities, such as the Resident District Commissioner (RDC), at the Arua district headquarters to introduce the project to the government officials. They also visited, observed and selected tinsmiths for the training.

The second day, the tinsmiths were taught how to manufacture the TLUD in a hands-on training session at NUSAF-TONGILO Metal Fabrication's workshop in Arua.

Picture 47: Training facility in Arua

Picture 48: Measuring and cutting the metal sheet

For this each tinsmith was provided with one square meter of metal sheet.

Picture 49: Explanations by the master tinsmith Sadam

Picture 50: Producing cylinders

A total of twelve tinsmiths participated in the training. Irrespective of their working area all tinsmiths belonged to the NUSAF-TONGILO Metal Fabrication project.

Picture 51: Producing under supervision of the master tinsmith

Picture 52: Cutting metal strips for the riser / pot stand combination

Picture 54: Manufacturing the concentrator disc ...

Picture 53: Riser / pot stand combination by the master tinsmith

Picture 55: ... with the slope

Picture 56: Finished products

On November 1, 2011, the trainers were joined by other project members for demonstrations and awareness creation at Arua Police Grounds in Arua.

Picture 57: Creating awareness among the police force

8.10 Training in Wakiso

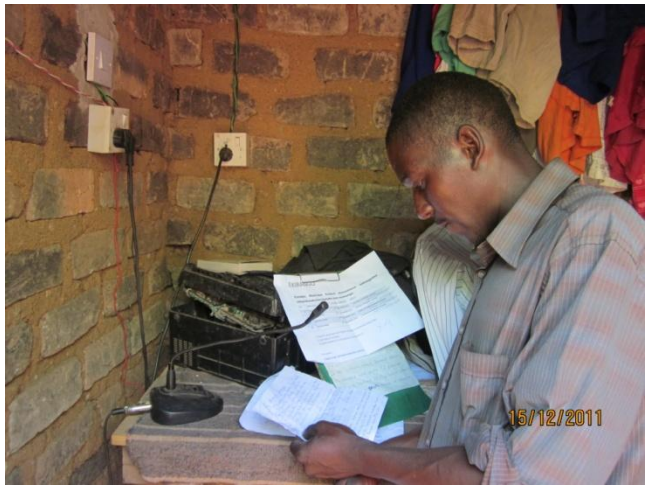
The team visited Wakiso district on December 12 and 13, 2012, to recruit tinsmiths for the training and to introduce the project at the Wakiso district headquarters to the RDC.

Picture 58: Producing a TLUD from scrap metal

Ten tinsmiths from different parts of Wakiso were trained on December 15, 2011 at Balikudembe Workshop, Highland-Kitooro, Entebbe municipality. Again, each tinsmith was given one square meter of metal sheet to produce a stove for the training. Some participants even started using their own materials to make more stoves.

Unfortunately, the project team was unable to identify any suitable tinsmiths from Bweyogerere.

Picture 59: Local radio station in Entebbe



Picture 60: Announcements being made

Picture 61: Lighting the stove during demonstrations in Entebbe

Demonstrations similar to those in the other areas were held on December 16, 2011.

8.11 Training in Mbarara

Western Uganda was visited on August 14 through 16, 2012 for tinsmith selection from Mbarara. Two tinsmiths were trained at MWOTO Factories (see section 11.15) in Kampala on August 17 through 20, 2012.

The training approach was different from the previous trainings. People with a business interest and mindset were chosen for the training and not 'just' tinsmiths. As done before, the tinsmiths were taken through practical sessions where they were shown how to make a stove and then were tasked to produce one themselves. However, as mentioned, the training took place at a factory, so in a different setting than the tinsmiths' workshops as previously done.

8.12 Output of the trainings

The project trained in total 80 tinsmiths from seven districts / divisions. The table below provides an overview of the trainings.

Training location	Tinsmiths from	Number of tinsmiths
CREEC (initial training)	Wakiso district, Nakawa division	6
CREEC	St. Jean M. Muzeeyi vocational training institute, Mengo, Kampala	6
Bugwere market, Majanga Road, Mbale municipality, Mbale district	Mbale district: - Bugwere Market - Mawungano Garage	 7 3
Nakawa market, Nakawa division, Kampala district	Nakawa division: - Nakawa market - Naguru market - Kitintale market	 8 4 2
Kikoni market, Makerere, Kawempe division, Kampala district	Kawempe division	7
Kisenyi Kumbuzi Workshop, Kampala Central division, Kampala district	Kampala Central division: - Kisenyi - Katwe	 8 3
Arua municipality, Arua district	NUSAF-TONGILO Metal Fabrication project, Arua	12
Balikudembe Workshop, Highland-Kitooro, Entebbe municipality, Wakiso district	Wakiso district	12
MWOTO factories	Mbarara district	2
Total		80

Table 13: Overview of training of tinsmiths

The following districts / divisions were covered:
- Arua district
- Kampala district, Kampala Central division
- Kampala district, Kawempe division
- Kampala district, Nakawa division
- Mbale district
- Mbarara district
- Wakiso district

Upon completion of training, the tinsmiths were given a certificate of completion and the project team followed up with them at a later stage of the project.

9. World Bank visit

On January 30 and 31, 2012 Waqar Haider and Jing Li of the World Bank visited the project.

9.1 Meeting with Ministry of Energy and GIZ

The World Bank team met officials of the Ministry of Energy and Mineral Development (MEMD) of the Government of Uganda and GIZ Promotion of Renewable Energy and Efficiency Energy Programme (PREEEP) on January 30, 2012.

During the meeting the project was discussed and participants shared experiences and views on renewable energy and its related policies in general and cookstoves in specific.

9.2 Meeting with CREEC

On January 30, 2012, the World Bank team visited CREEC to evaluate and discuss the project progress.

9.3 Field visits to tinsmiths and users

After the meeting at the CREEC offices, the World Bank team visited tinsmiths trained by CREEC in Kikoni parish, Kawempe division, Kampala district, and stove users in Naluvule division, Wakiso district to gain firsthand experience on MWOTO stove production, promotion, distribution and use. The team observed and interacted with the tinsmiths and users. This allowed them to understand the processes and challenges involved and made recommendations to the project team.

9.4 Meeting with World Bank Uganda office

The same day, the World Bank team and the project team met with the Country Manager, Procurement and Financial Management Specialists and the Senior Financial Analyst, Sustainable Development Department for the Africa region at the World Bank Uganda Office at Rwenzori House in Kampala. The BEIA project was introduced and advice shared on project management, procurement and financial management.

9.5 Meeting with JEEP and field visits to tinsmiths

On January 31, 2012, the World Bank team met with CREEC and JEEP staff at JEEP's offices in Kyanja, Kampala. The purpose was to understand JEEP's role in the project.

After the meeting, the World Bank team went on a field trip to visit and interact with tinsmiths trained by CREEC in Luteete parish, Wakiso district, and Kamwokya parish, Nakawa division, Kampala district.

9.6 World Bank report

The text below is copied from the World Bank report that was provided to CREEC with the World Bank team's findings and recommendations.

9.6.1 Introduction

The pilot project called "Promotion of Improved Biomass TLUD Stoves in Uganda" is financed under the Biomass Energy Initiative for Africa (BEIA). The grant recipient is a research institution, Centre for Research in Energy and Energy Conservation (CREEC), and the project aims at producing and promoting 10,000 air controlled top lit updraft (TLUD) stoves called MWOTO, produced by local tinsmiths and small business entrepreneurs in 25 districts of Uganda, and making it manufacturable, usable, and marketable.

9.6.2 Progress

The mission undertook the following activities:

- Met with CREEC, implementing partners, Promotion of Renewable Energy and Energy Efficiency Programme (PREEEP), Joint Energy and Environment Programme (JEEP), and GIZ to review their actions to implement the project
- Met with Ministry of Energy and Mineral Development to raise awareness and garner policy support
- Facilitated meetings of World Bank's Uganda Country Manager; and Energy, Procurement, and FM Specialists with CREEC to discuss biomass energy development and obtain guidance on procurement and financial management arrangements
- Met with tinsmiths and stoves retailers, and stoves beneficiaries in Kawempe, Wakiso Luteete, Kamwokya, and Nakawa divisions

Training/technology transfer on MWOTO stove manufacturing has been provided to 10 tinsmiths per district in 6 districts. A total of 795 stoves have been made and sold by 106 tinsmiths up to December 31, 2011. Awareness rising has been carried out nationwide by CREEC and JEEP through:

- Road-shows
- Advertisement on regional radio
- Interviews with international and national media
- Dissemination of documentaries, and stories on national media and internet
- Public awareness campaigns (cooking demonstrations for water, beans, rice and chicken for the public) to demonstrate MWOTO stoves
- Distribution of promotional materials (fliers, posters, t-shirts, and brochures)

9.6.3 Challenges and way forward

The mission identified the following challenges, and provided advice to resolve the issues:

Interviews with tinsmiths and end-user households indicated the advantage of the MWOTO stoves, including:

- Savings in fuel and time, compared to other alternatives
- Health benefits
- Production of charcoal at the end of the cooking practice

However, the following market barriers have also been identified during the interviews:

- Availability of fuel wood in some regions has been a challenge in promoting this wood stove
- Wood has to be cut into small pieces to be fitted into the stoves, and for households, this process could be time-consuming
- Affordability of the MWOTO stoves, Uganda Shilling (UGX) 35,000, has been a barrier for low-income household to adopt the new concept, given a traditional charcoal stove is sold only at UGX 6,000

To address those challenges, the mission advised tinsmiths to:

- Sell MWOTO stoves together with packages of cut wood
- Offer lay-buy to end-users to make the payment in several instalments

While there has been support to the initial sale of MWOTO stoves, the short duration of the marketing did not translate into high market penetration yet. Most of the tinsmiths are multi-tasked and producing MWOTO stoves on a part time basis when order comes. The mission advised CREEC to think through how to increase the motivation for tinsmiths and retailers to promote this stove while providing more training on marketing and sales.

9.6.4 Findings and Recommendations

The task team advised tinsmiths several ways of strengthening marketing/sale skills and increasing productivity/efficiency:

- Make product and price differentiation between MWOTO stove and other alternatives, and foster willingness-to-pay through explaining the benefits of MWOTO
- Packaging of stoves could be made more attractive, operating brochure is provided in the package, CREEC logo is included, receipt is provided for each sale, and after-sale guarantee for a specified period is included in the price
- Package MWOTO stove in comparison with traditional charcoal stoves, since the MWOTO produces charcoal after the cooking practice
- Undertake division of labour among tinsmiths for manufacturing different parts of the stove to enhance efficiency and productivity
- Explore the possibility of producing the core sheet locally to bring down the cost of production

While the project shows results in promoting the MWOTO stoves in 6 districts, there are still 19 districts to be trained by the end of September 2012. The task team advised CREEC not to spread itself in the market too thin, and concentrate on areas where the trained tinsmiths are actually making and selling the stoves and make a larger impact. Feedback from end-user households indicated areas for design improvement as follows:

- Larger size that could adapt bigger pots
- Stronger structure, in particular the cooking top.

To increase awareness of the pilot project and maximize synergy with the World Bank's operations, and to provide the grantee with continued implementation support, the mission arranged meetings between CREEC and the Country Manager.

The meeting with the Country Manager discussed the sustainability of the biomass project, who advised that given the cross-sectorial nature of biomass energy, the team should coordinate efforts with environmental team in the World Bank, and coordinate efforts with other donors. The team arranged a meeting between CREEC and the Ministry of Energy and Mineral Development and GIZ, who are jointly developing Biomass Energy Strategy for Uganda.

The authorities expressed strong interest in the stove pilot project, particularly on the potential for nation-wide extension given that biomass energy accounts for 91 per cent of energy mix in Uganda. In addition, the huge potential for promotion and incentive for biomass stove was identified. CREEC expressed willingness to join the government's effort, including establishing a regular dialogue between CREEC and the government in its development of the biomass strategy (assisted by GIZ). The Ministry also indicated interest in the research and development of the MWOTO stove promoted by CREEC.

The mission advised CREEC to inform the Ministry on the progress, and any bottlenecks as the project moves forward. The mission introduced the Africa Clean Cooking Initiative, and the Ministry expressed strong interest to participate in it.

9.7 Strategy change

Tinsmith training consumed a considerable portion of the project's time, but did not result in satisfactory market penetration of the MWOTO stove. The project team was therefore advised to change the strategy from an emphasis on training to an emphasis on awareness creation, promotional activities and marketing campaigns.

10. Follow-up visits of trained tinsmiths

To monitor and evaluate the progress of the trained tinsmiths, the project team visited them during the second half of February 2012.

10.1 Methodology and general response

The project team visited Mbale, Nakawa, Kawempe, Kisenyi, Arua and Wakiso (Mbarara tinsmiths were not trained at that time) to determine how the tinsmiths were doing, what their challenges were and to get feedback and recommendations.

Picture 62: Follow-up visit in Arua

Methods used included informal interviews (such as conversations held while posting of promotional materials), specific questionnaires, photographs and group discussions. Language barriers and absence of some trained tinsmiths were hurdles that were overcome through the use of translators and telephone interviews.

Out of the 66 tinsmiths trained from the mentioned areas, the project team managed to interview 52 tinsmiths (almost 80%). One was not interested in participating in the follow-up visits and 13 were not available.

Of the 52 interviewed tinsmiths, 48 (92%) of them responded that the training provided was good to very good, while three tinsmiths (6%) reported it as fair. Only one tinsmith called it poor since he did not understand the training. The tinsmiths indicated that the stove was not difficult to make since it was related to their usual work. Some stated that there were some new concepts that they were able to add to their knowledge and capacities.

It was noticed that most of the tinsmiths' workshops were located in productive areas like markets and trading centres. They were usually small in size, housings of semi-permanent nature with plastered walls and iron sheets on the roof.

10.2 Changes to the stove design

Almost half of the tinsmiths indicated that they had made changes to the design of the stove. However, no further investigations were made in the consequences of the changes in the stove design.

The most frequent reported changes were different gauges of metal and the size of the stove to suit customers' demands and preferences.

This was followed by modifications on the primary air inlet: round instead of rectangular, different dimensions of the inlet, making it look like that of a charcoal stove or producing the air controller as a flap that opens and closes instead of a slide because it gets too hot and cannot be held.

Other changes included: using smaller pot rest holes, applying harder materials for the grate, making the pot rest surface flat or straight, reducing the size of the base holes in the fuel chamber and painting the stove in various colours.

10.3 Production rates

At the time of the follow-up visits, the tinsmiths reported a total of 642 stoves produced since training. Taking the number of tinsmiths as well as the number of weeks since the training was given, the average production rate was somewhat less than one stove per tinsmith per week. This was caused by the fact that the majority of tinsmiths produced less than ten stoves in total. Only 22 tinsmiths produced more than ten stoves (see Figure 3). The seven highest-producing tinsmiths (12% of the total) produced almost half of the total amount of stoves (see Figure 4).

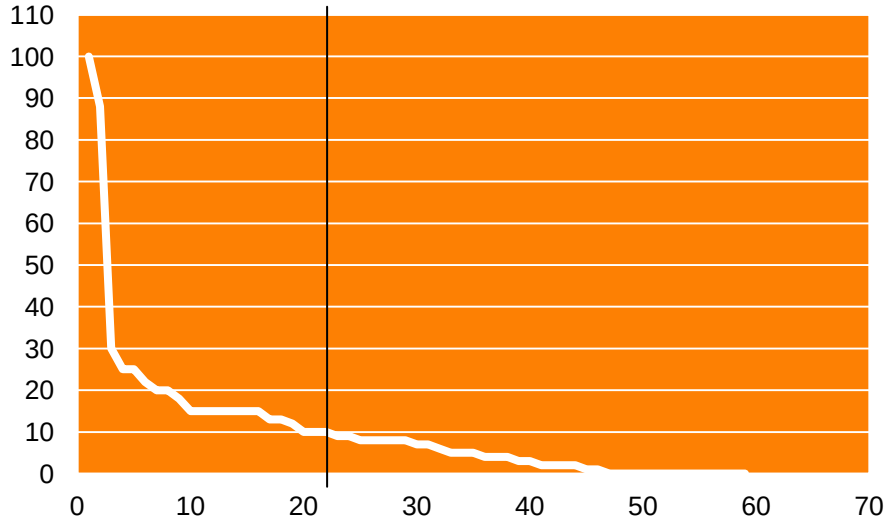


Figure 4: Stoves manufactured per tinsmiths

The lowest-producing half of the tinsmiths contributed only 9% to the total amount of stoves produced (see Figure 4). Some did not produce any stove after the training.

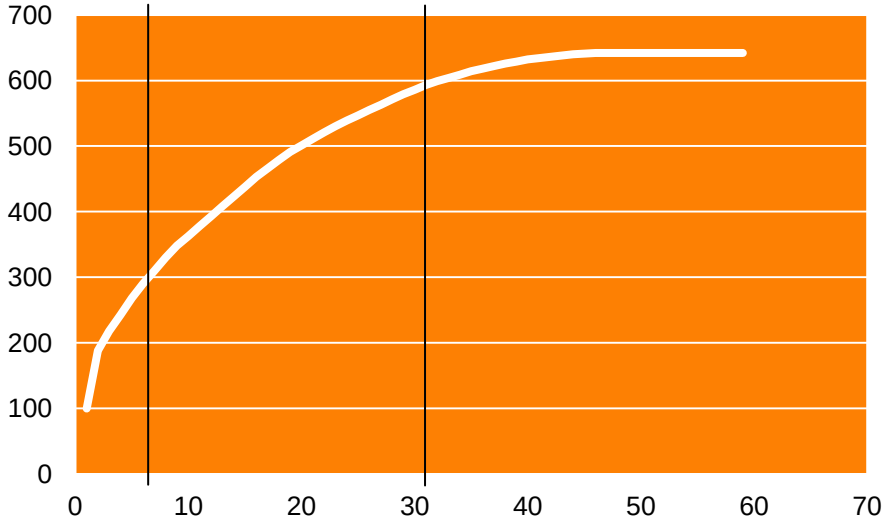


Figure 5: Cumulative stoves manufactured by tinsmiths

Prices for the stove ranged from UGX 15,000 to UGX 60,000.

10.4 Hindrances

Compared to other types of cookstoves and other products manufactured by the tinsmiths, the tinsmiths produced very low quantities of MWOTO stoves. The tinsmiths mentioned several reasons they did not produce more gasifier stoves.

The main causes mentioned were lack of awareness among customers and insufficient / expensive materials.

Some tinsmiths pointed out that they were in a season where other products, such as metal boxes / suitcases for students, were in high demand. They therefore focused on products that brought in cash directly.

10.5 Mode of selling

The majority of stove producers sold their products themselves at their shop or elsewhere by hawking. Some tinsmiths provided family members with a cookstove, which gave opportunities for promotions and demonstrations and thus created further demand. During the Christmas holidays, one tinsmith took a MWOTO stove to his home village where he did cooking demonstrations resulting in some orders for the stove. Several tinsmiths reported that they usually take a MWOTO with them on business trips for awareness creation.

Picture 63: Many tinsmiths depend on visiting customers

A few tinsmiths (less than 10%) mentioned that they also sell through distributors coming from Northern Uganda, the Kalangala Islands (an island group belonging to Uganda in Lake Victoria) and even from South Sudan and the Democratic Republic of Congo.

10.6 Other findings

The team made several other discoveries that provided interesting insight to the project. The findings were not researched further due to limited time available but are mentioned here for reference or learning purposes.

Uptake of the cookstove appeared easier when tinsmiths, after learning how to use the stove, taught people in their local languages on stove use and its benefits. Furthermore, local communities seemed more motivated to buy a MWOTO stove because they were produced by 'their own' tinsmiths. Bringing tinsmiths along on demonstrations enabled awareness creation and credibility due to a sense of belonging to the local communities.

Picture 64: Tinsmith with his 'own' t-shirt

The project team provided t-shirts to tinsmiths, which motivated them and made them more willing to travel for the demonstrations of the stove. One tinsmith even produced his own t-shirts with the MWOTO stove printed on them for his workshop team.

The name of the stove was associated with the culture of the Bagisu, a tribe living in Eastern Uganda around Mbale, who use the same word during their circumcision proceedings.

Although most customers did not return to give feedback on the stove, tinsmiths reported that these customers directed other potential customers to them.

Picture 65: Stove branding and advertising

One tinsmith produced a stove with a hollow shape in the middle of the fuel chamber. He used coffee husks as a fuel source and lit it from the bottom. He mentioned that he was able to cook on it for a long time.

Tinsmiths in Kawempe worked in an assembly line production method where each person produced one specific component of the stove. Other company members mainly dealt with managerial businesses of the company.

Except for the one tinsmith who had already made 100 stoves, the remaining tinsmiths in Kisenyi used scrap metal (such as used iron sheets) to make stoves. The one tinsmith makes ordered materials directly from manufacturers of steel products and purchased them in bulk.

A tinsmith from Arua took MWOTO stoves with him on the monthly market trips he made to South Sudan and the Democratic Republic of Congo. He marketed the stove there as he was selling other types of stoves and products as well. He also trained two boys to assist him in producing MWOTO stoves in his workshop.

Several tinsmiths indicated that they had spread the 'MWOTO gospel' to other areas of Uganda where the project team had not planned to travel.

As mentioned before, these findings have not been investigated any further, but they indicate the willingness, innovativeness and commitment of tinsmiths who understood the business potential of the MWOTO stove.

10.7 Recommendations from tinsmiths

The tinsmiths provided several recommendations for improving the project and providing greater benefit to themselves. Although the recommendations have not been researched in detail, they are listed in this section for the sake of completeness.

The follow-up visits with trained tinsmiths showed the following:

- The tinsmiths complained about not having the cookstove measurements in writing and some technicalities being difficult to grasp in a short while.
- The training could be improved through teaching them how to adjust the sizes and its effect on stove performance. Sizes can then be catered to customer preferences.

- Some tinsmiths would like to have a 1-2 day intensive workshop to gain a full grasp of the stove and learn more marketing strategies for their MWOTO stoves.

Picture 66: Measurement of stove dimensions

- During training a stronger gauge should be used since tinsmiths started using it themselves.
- The follow-up should be done much sooner.
- The criteria for choosing tinsmiths for training should be clearer to avoid recruiting people who are not motivated or interested.
- To counter the lack of awareness, more and longer promotional campaigns should be run through radio and television advertisements, talk shows, exhibitions and market radios.
- The tinsmiths should be taught how they can benefit from investing in these new stoves. Business development is needed so they learn how to make savings as a result.
- Some tinsmiths suggested that CREEC should get them a common MWOTO workshop where they can all work together instead of working independently.

- Over the same time frame, the amount of other cookstoves produced is higher than that of the MWOTO stoves. Explanations given were: the stove requires a lot of material, the detailing on the stove takes a lot of time, the stove is expensive and therefore not many customers buy it, distributors do not know about the stove so there is no demand for it and the public is not aware of it.

Picture 67: Tinsmith training in Entebbe

Note the metal boxes and the traditional open charcoal stoves which are MWOTO's competition for the tinsmith's time

- They mentioned that it would be good to have a central location where stoves are showcased and demonstrated. Customers' attention would be drawn much faster by doing so. This is what was done when getting the small clay stoves on market.
- The project team found very few stoves with the tinsmiths. However, most of the tinsmiths had made one for their homes or sent one to their families.
- The tinsmiths advised the project team to donate stoves to local restaurants and roadside cooks for further promotion and uptake.

Picture 68: Proudly showing the produced MWOTO stoves

- Some tinsmiths did not believe the stove should be made from scrap metal because scrap from cars often contains a filler that smokes when lit. One advantage of the MWOTO stove is its lack of smoke production, and using scrap metal negates this benefit. Unfortunately, better quality metal directly from manufacturers of steel products is expensive.
- Promotions could be enhanced by holding them on Saturdays during markets when many people are around.
- The market announcer system could be used as a medium of communication when talking about the stove because it reaches all the corners of the market.
- Some tinsmiths suggested finding a political figure or another celebrity to acquire and use the stove in public, which could even be filmed. The endorsement of this person will entice other people to also use it.
- End users complained about cutting of wood to fit the stove being tedious. Promotions should therefore also promote the sales of prepared wood as another business opportunity.

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- Popular television stations should be utilized to increase awareness about the stove.
- Some tinsmiths claimed that they did not need promotional posters at their workshops, but that they would rather have posters at busy areas where people can see them and then contact the tinsmiths.
- Posters can easily be spoiled during the rainy season. Therefore, they need to be protected.
- The tinsmiths proposed attending exhibitions to target larger crowds and informed the project team about some upcoming exhibitions and events. They suggested that the project team hire exhibition space for the tinsmiths to advertise and sell their stoves. This would also force them to compete for sales and make their stoves stand out by, for example, painting the stoves to attract customers. Promotional materials such as posters and brochures should be made available by the project team. At the venue, stoves should be sold at promotional prices to encourage buyers.
- Some tinsmiths were said to increase the sales price of the stove to such a level that would discourage potential buyers.
- Some tinsmiths suggested lending them money so they could afford the material to produce the stoves in bulk / in advance, not just on demand. Advanced, bulk production would bring more visibility to the stove.
- Customers appreciated the stove, as evidenced by future orders for more stoves and referrals to new customers.
- Some tinsmiths would like to see that the project team orders from them and that the project team finds a market for the stoves.
- Customers mentioned that the price of the stove is relatively high compared to the price of the other, less efficient stoves.
- One distributor suggested approaching different supermarkets to provide space for displaying the stove to increase further access to potential customers.

11. Awareness and promotion campaigns

As mentioned in the previous chapter, the awareness campaigns and promotional activities in the original plan did not result in many stoves penetrating the market. Production rates were shown to be low, hindrances were discussed and modes of selling mentioned; all of them contributing to a low number of stoves in the market. Therefore, the project team decided to increase the marketing of the stove considerably and reduce drastically on training of tinsmiths in order to enhance market penetration of the stove.

11.1 Initial promotion approach

Originally, promotion activities were designed to take place at the end of each tinsmith training. The divisions of Nakawa, Kawempe and Kampala Central and the districts of Wakiso, Mbale and Arua were the locations of these promotions.

Tinsmiths were asked to bring stoves they had produced, space was arranged within a market place in cooperation with local authorities and advertisements were made through the use of megaphones and local market radio stations. The project team provided cooking demonstrations and explanations about the MWOTO stove.

11.2 Re-designed promotion approach

In line with the recommendations made during the visit of the World Bank team (see chapter 9), the project team embarked on a re-designed, more intensive awareness and promotion campaign.

No further training programs were planned, but the focus shifted towards awareness creation. A new marketing plan was drafted containing a new structure where marketing coordinators and salesmen had a prominent place.

A media plan was also written in which advertisements and features in newspapers, on radio and television stations, as well as a website and a Facebook page, were included for further promotional activities.

The follow-up visits indicated that many tinsmiths sold the stove from their workshop and did not do much distribution. They preferred to work on orders from distributors and shops.

Picture 69: Promotional poster

The project team decided to adjust the approach from training-centred to promotion-centred and from tinsmith-centred to distributor-centred. Use of a broad range of marketing and promotional tools, both on a national and local level, would create further awareness and increase demand for the stove.

Focal areas were Kampala and Entebbe (Central Uganda), Mbale and Jinja (East), Arua and Gulu (North) and Mbarara (West).

11.3 Promotion materials

The project team designed a range of printed promotion materials such as flyers on A6-format, posters on A2- and A3-format, product brochures (A3-format folded), user manuals and lists with tinsmith contacts.

During promotional activities such as exhibitions, events and demonstrations, the project team used a tent as its base from where they operated. A banner was designed that could be hung at the tent to attract people.

Picture 70: MWOTO t-shirts

T-shirts with the MWOTO logo (see next section) were introduced for marketing coordinators, salesmen and tinsmiths to provide better visibility and to distinguish the project team from the crowd.

Picture 71: Sign post at a tinsmith's workshop

Some tinsmiths were also provided with metallic sign posts to indicate where people can buy stoves.

Picture 72: MWOTO booth at an exhibition

11.4 Branding

In November 2011 it was decided that the stove should be branded and have its own name, logo and slogan. From the final two names, IMARA and MWOTO, the latter was chosen. In Swahili “mwoto” means fire. A logo was designed with the shape of a flame surrounding the last ‘o’ of the stove’s name. Lastly a slogan was developed: “MWOTO, the Power of Fire” with a reference to the strong flame and the various benefits of the stove.

Figure 6: MWOTO logo

The name “MWOTO” has been registered as a trademark owned by CREEC in order to keep a close eye on quality assurance and quality control. See also section 13.2.3 for the use of the brand name.

Promotional materials were made uniform to reflect the branding. To avoid being associated with one particular political party or movement, the colour orange was chosen since it is not related to any player in the political field.

The project team realized that a strong emphasis needed to be put on this branding, making sure every stove produced gets the right logo (sticker or similar), uses the right colour and promotional materials.

11.5 Marketing coordinators

A total of three marketing coordinators were selected to cover various geographical areas: one for the Nakawa division of Kampala, Jinja district (Central Uganda) and Mbale district, another for the Kawempe and Makindye divisions of Kampala, Wakiso district (Entebbe) and also Jinja district and the last one for Rubaga division of Kampala, Arua district and Kasese district (Southwest Uganda).

The tasks of the marketing coordinators included the following: supervising the salesmen (see next section), identifying populated areas such as markets and trading centres, knowing when market days took place, securing licenses from local councils to hold demonstrations, drawing marketing plans for specific segments, identifying stove manufacturers and potential distributors, contacting local radio stations and identifying distributors.

Picture 73: Marketing coordinators in the field

11.6 Salesmen

In total 20 different salesmen were selected from the areas mentioned in the previous section. Interviews were conducted and salesmen recruited on the following criteria: speaking both English and the local language, having fine communication skills and demonstrating good customer care).

The tasks of the salesmen comprised of creating awareness about the stove and holding demonstrations while covering the geographical areas assigned to them. Usually the salesmen walked around talking to people, creating awareness and directing interested people to the tent (see section 11.3), the base from which the project team was operating.

Picture 74: Salesmen with stoves

At the tent the salesmen and marketing coordinators held cooking demonstrations comparing the MWOTO stove to other cookstoves. The food or tea prepared was shared with the interested public to demonstrate the stove's good performance.

Picture 75: Handing out tea boiled with the MWOTO stove

Water was boiled to show how quick it can be brought to boiling and cooking was done for foods people though were impossible to cook on a MWOTO stove, like beans and kalo (a local dish made of millet flour).

Picture 76: A salesman giving details at a food market

11.7 First introduction of the stove to the public

One mandate of the government is to promote the efficient utilization of energy in all sectors of the economy i.e. industries, households, institutions and private and public sectors. The Ministry of Energy and Mineral Development (MEMD), which is the key institution responsible for carrying out programmes and activities to ensure good energy management and efficiency, has been holding the Energy Efficiency Week (EEW) as an annual event since 2005.

Picture 77: Explaining the MWOTO stove ...

The objective of this week is to sensitize the public on renewable energy and energy efficiency technologies and practices. The 7th EEW took place from September 19 to 23, 2011 at Mbale Cricket Grounds in Mbale and was organized by MEMD with support from GIZ-PREEEP.

Picture 78: ... and more explaining

The training of tinsmiths in Mbale was organized during this week since the EEW provided an excellent opportunity to first introduce the TLUD stove to the public. Cooking demonstrations were held, where rice and beans were cooked for the public. On the first day, the stock of 15 stoves was sold in less than three hours.

Among the guests were Hon. Irene Muloni, State Minister of Energy and Hon. Angelina Wapakhabulo, Uganda's ambassador to Kenya. Both women publicly applauded the stove and realized the potential it can have on women (who are usually in control of cooking and cooking fuel collection) and the environment. In her speech the minister called the cookstove the 'best product exhibited' while the ambassador bought three stoves and promised to take one to the Ugandan embassy in Kenya for demonstration purposes. The Local Councillor 5, the highest government official in a district, also procured his own stove.

Picture 79: Ambassador with her stove

The launch of the stove onto the market was very successful with many people expressing their appreciation for the stove, especially the fact that the stove was locally made. Tinsmiths were also pleased to be able to sell the stoves they had just learned how to produce. Promotional materials supported the market launch by increasing the stove's visibility, identity and popularity.

11.8 Field visits

The project team, marketing coordinators and salesmen visited a wide range of organizations and institutions including churches, women groups (that sometime spontaneously gathered), youth groups and saving cooperatives.

Door-to-door promotion and marketing, demonstrations during market days and cooking competitions were used to create further awareness about the benefits and use of the stove. The cooking competitions usually utilized one MWOTO and one charcoal stove to cook two kilograms of beans. This enabled the public to compare the performance of the stoves.

Picture 80: Groups of women are among the target audiences

11.9 Exhibitions and trade fairs

The project team participated in a number of exhibitions, events and trade fairs:

As mentioned in section 11.7, the 7th Energy Efficiency Week in Mbale provided the occasion where the stove was presented to the public for the first time. The MWOTO stove also appeared on the 8th EEW held at the National Theatre in Kampala from September 25 through 29, 2012.

The College Grounds in Makerere University, Kampala, were the venue of CEDAT's first Annual Open Day on November 18 and 19, 2011. Among other departments and projects of the college, CREEC showcased the MWOTO stove. The second edition of the event that took place from September 25 to 29, 2012, also featured the project team treating visitors with a cup of coffee freshly prepared with the use of the MWOTO stove.

Picture 81: Demonstrating the stove at the CEDAT Annual Open Day

A Sciences' Expo was organized by the College of Agriculture and Environmental Studies in Makerere University, Kampala, from March 13 to 18, 2012. At the College Grounds, CREEC presented the MWOTO stove to wide variety of visitors, from teaching staff in agriculture, forestry and environmental studies to students and the general public.

Picture 82: "The Power of Fire" was explained again and again

On March 31, 2012, the Earth Hour Exhibition took place in the gardens of the Sheraton Hotel in Kampala. The Earth Hour is an annual event, organized by World Wide Fund for Nature (WWF), that takes place every last Saturday of March. It is an environmental awareness campaign to get people doing small things in their daily lives that together can have huge impacts like simply turning off your lights for one hour. CREEC participated by demonstrating the MWOTO stove.

April 22, 2012 marked the Earth Day Exhibition organized by GIZ in Centenary Park, Kampala. CREEC was one of the main sponsors of the event and promoted the MWOTO stove among other products such as solar lamps. GIZ offered to promote the stove during their Energy Explorerz campaign (see below). For these purposes the project team decided to donate some stoves to the GIZ programme together with promotional materials.

The Bulange-Buganda Real Estates and Homes Expo 2012 took place from May 2 to 5, 2012 at Bulange, in Mengo, Kampala. CREEC was awarded the best exhibitor with the MWOTO stove. The Minister of Lands. Housing and Urban Development, Hon. Daudi Migereko visited the exposition and welcomed the innovative stove.

Picture 83: Hon. Daudi Migereko at the CREEC booth

The Energy Explorerz' West Nile Day was held on May 25, 2012 at Arua Hill Ground in Arua. "Energy Explorerz is an awareness campaign of GIZ, targeting secondary school children and young Ugandans, educating them about climate change, energy efficiency and renewable energy. The event was very successful, with the large crowd size surprising even the event organizers.

Mpondwe Primary School in Kasese district was the venue of the World Environment Day on June 5, 2012. This is an annual WWF event which also marked the launch of Kasese as WWF's clean energy champion district.

Picture 84: Handing out information at Arua Hill Ground

The 17th National Technology Conference of Uganda Institute of Professional Engineers showcased the MWOTO stove at the Golf Course Hotel in Kampala on June 14 and 15, 2012.

From June 15 to 24, 2012 the Eastern Trade Fair was organized at Mbale Stadium in Mbale. Unfortunately, heavy rains disrupted the fair and people did not show up in large numbers.

Lubiri Grounds in Kampala hosted the 5th Annual Buganda Expo from June 27 to July 1, 2012. Again, CREEC was named with best exhibitor.

The Kasangati Exhibition was organized at Kasangati Ssaza Grounds in Kampala from July 15 to 19, 2012. Although this event was not well visited during daytime, the grounds were flooded in the evenings because of the performances of local artists. The project utilized especially this time to create further awareness about the stove. The Chief Guest of the exhibition, Eng. J.B. Walusimbi, the Katikkiro (prime minister) of the Buganda Kingdom was impressed with the MWOTO stove and requested the project team to encourage the youth to take this opportunity.

Picture 85: Promotion team at the 7th EEW in Mbale

The largest agricultural fair in Uganda, the Source of the Nile National Agricultural and Trade Exhibition, took place from July 23 to 29, 2012 in Jinja. At this event organized by the Ugandan National Farmers Federation in collaboration with the Ministry of Agriculture, Animal Industry and Fisheries, the MWOTO stove again attracted many people who were impressed by the stove's performance.

At the MAK@90 Celebrations Makerere University, Kampala celebrated her 90th birthday with a large exhibition at the College Grounds. The president of Uganda, H.E. Yoweri K. Museveni was among the guests, as well as several high-ranking officials from Makerere University. The CREEC team was proud to present a MWOTO to Museveni who was very impressed to find this technology being developed and manufactured in Uganda. The team was proud to see that the president commended the stove.

Picture 86: The president of Uganda getting MWOTO documentation

On August 10 and 11, 2012, the East Africa Regional Youth Conference was held in Speke Resort in Munyonyo by Uganda Youth Network in partnership with the Ministry of East African Community Affairs. CREEC exhibited MWOTO stove as a way of potential income generation.

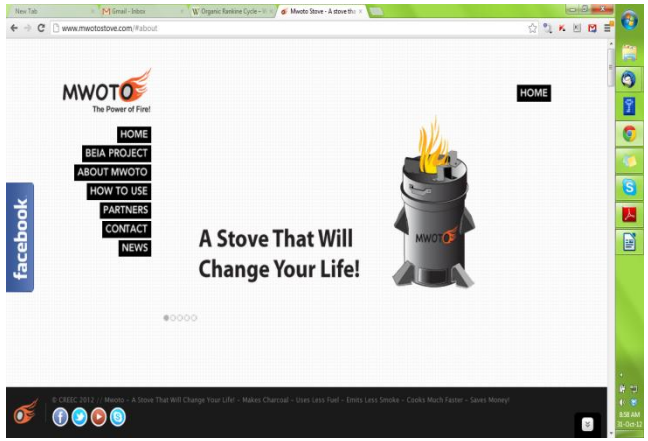
The last event where the MWOTO stove was promoted with support from the project team was the UMA International Trade Fair from October 4 to 10, 2012.

Picture 87: MWOTO booth at UMA International Trade Fair

The Uganda Manufacturers Association (UMA) every year organizes a large trade fair at its own UMA showground, which attracts many visitors since it is held over October 9, Uganda's Independence Day and thus a public holiday. Many companies showcase their products and usually sell them at promotional prices. The participating stove producers sold over 50 stoves and received several orders.

11.10 Internet

A website was specifically designed to promote the MWOTO stove. On www.mwotostove.com basic info about the stove can be found. CREEC's own website, www.creec.or.ug, also contains information concerning the stove and a link to the MWOTO webpage.



Picture 88: MWOTO website

Furthermore, the MWOTO stove has its own Facebook page (www.facebook.com/Mwotostove) as well as a dedicated Twitter account (twitter.com/Mwotostove) where the latest news about the project was shared. On average 60 visitors per week are registered on the MWOTO website.

Statistics show approximately 250 likes and between 100 to 150 people who have seen any content associated with the Facebook weekly.

11.11 Newspapers

The MWOTO stove was featured in a number of newspaper publications:

The Observer
"Unveiling MWOTO, the wonder stove" (September 10, 2012)

The New Vision
"Deforestation, MWOTO stove better energy saver" (August 24, 2012)
"The wonder stove that makes charcoal" (July 3, 2012)
"Heavy rains disrupt Eastern Trade Fair" (June 27, 2012)

The Daily Monitor
"How it works, MWOTO cookstove" (May 1, 2012)
"CREEC promoting clean, affordable energy in Uganda" (February 23, 2012)
"Enhancing access to modern types of energy" (February 23, 2012)
"Energy saving. Arua advocates for stoves" (December 9, 2011)

East African Business Week
"Firewood stoves, an effective energy saver" (October 3, 2011)

The Independent
An untitled feature (October 20, 2011)

11.12 Collaborations

During the project CREEC collaborated with a variety of organizations such as GIZ, WWF and Makerere University to promote the stove during their exhibitions.

Another interesting cooperation started with Formula feeds that offered to promote the MWOTO stove alongside their briquettes at retail locations in Kampala and Entebbe.

11.13 Radio

The radio campaign was designed to cover almost all of Uganda through three broadcasting companies: Sanyu FM, CBS and the Vision Group. The first two operate in Kampala while the latter one operates in Arua through the local station Arua One, in Mbarara through Radio West and in Guly through Rupiny.

Through interviews, general mentioning of the stove, specifically designed advertisements and a competition, the radio promotions intended to create further awareness and increase adoption rates of the stove.

Picture 89: Answering questions from callers in Mbarara ...

Normally, a team of three people visited the radio station. First, a project team member gave an explanation of the MWOTO stove and an overview of the awareness campaign. Then, a tinsmith informed listeners that the stove was made locally and where it could be purchased. This was followed by a salesman explaining the use of the stove and its advantages in the local language.

Listeners indicated that the advertisements, especially the ones in the local language, were catchy, captivating and made them eager to see how the stove makes charcoal.

Picture 90: ... and in Arua

During the radio programs studio phone lines were opened for the listeners to call in and ask questions related to the stove. The number of callers continued to increase as more advertisements were aired in local languages.

The campaigns were designed to be implemented in stages:
- July, August & September 2012: Sanyu FM
- August, September & October 2012: CBS
- September, October & November 2012: Arua One, Radio West and Rupiny

As part of the radio campaign, a competition was held for listeners to call the radio station and answer questions about the stove. Winners were awarded with their own MWOTO stove.

Picture 91: A winner receiving her stove

People called from many places to participate in the competition. Even Congolese and Sudanese, as well as from neighbouring districts such as Gulu, Koboko, Moyo and Nebbi called Arua One and won stoves. Listeners from Kampala won stoves with Radio West and participants from the Ssese Islands won stoves with CBS in Kampala. This indicates the wide reach of the campaign throughout Uganda which was very encouraging with regards to the creation of awareness. However it also presented a problem since many winners could not travel these long distances to collect their stoves.

Some of the winners were interviewed by phone to get feedback on the stove. The majority appreciated the fact that the stove uses less firewood than a three-stone fire, that it cooks food very quickly without smoke and even produces charcoal.

Tinsmiths reported that their sales increased and they became more confident adding the MWOTO stove to their product line. Advertisements on Radio West in particular motivated the newly trained tinsmiths in Mbarara to produce more MWOTO stoves.

Furthermore, Rhino FM in Lira (North Uganda) mentioned the MWOTO stove a few times as did several local market radio stations (such as in Kampala divisions and Entebbe) during the trainings and promotions.

11.14 Television

The MWOTO stove also made several television appearances:

In November 2011 Deutsche Welle World did a documentary about the MWOTO stove. It can be found on YouTube as “Master ASE 0019 Stove web.flv”.

A crew from NTV, one of Uganda’s broadcasting companies came to shoot the stove capturing the assembly process, how the stove works and the production of charcoal. Their show “Ecotalk” broadcasted on April 26, 2012 resulted in lots of inquiries and feedback from potential users.

UBC news did a feature on April 22, 2012 about Earth Day (see also section 11.9).

On July 9 2012 Urban TV aired a special on innovation that contained the MWOTO stove.

Picture 92: Interview with a tinsmith by Step TV

One week after the Eastern Trade Fair in June 2012 (see also section 11.9), Step TV, the local television station in Mbale, broadcasted a special covering the training of local tinsmiths by the project team.

11.15 Spin-offs

In addition to the trained tinsmiths who have taken up the TLUD gasifier technology in their product range, three small enterprises sprung forth from the project: Awamu Biomass Energy, MWOTO Factories and Pamoja. These private businesses have been started by a number of people who had been in contact with CREEC previously and saw the business opportunities in the project.

All three companies focus on TLUD cookstoves and are producing them commercially. Currently they are the largest producers of the MWOTO cookstove.

11.16 Reach

Over the project duration approximately 1,200 MWOTO stoves have been registered as produced by tinsmiths and about 800 by the MWOTO Factories. The latter company and Pamoja together have secured orders for another 1,200 cookstoves. Taking into account non-registered but produced stoves and orders with tinsmiths, the total amount of cookstoves under the project amounts to roughly 3,500 pieces.

The project reached 27 districts in Uganda through a variety of ways:

- Tinsmiths were trained in Arua, Kampala, Mbale, Mbarara and Wakiso.
- Products bought from trained tinsmiths were promoted, sold and used in Bududa, Busia, Ibanda, Kalangala, Koboko, Kumi, Mukono, Nebbi, Pakwach, Sironko, Soroti, Tororo and Yumbe.
- Awareness campaigns were held in Jinja and Kasese and the radio campaign reached Lira and Moyo.
- Official distributors for MWOTO Factories introduced the stove in Gulu, Kisoro, Kitgum, Masaka and Mubende.

Picture 93: Ready for demos with promotional material and firewood

The number of districts is most likely greater than expected because people have taken stoves back to the regions and villages from where they originate.

The MWOTO stove technology also has been 'exported' through relatives, friends and traders to Argentina, the Democratic Republic of Congo, Germany, Kenya, Rwanda, South Sudan, Tanzania and the United States of America. The Netherlands and most probably some other countries will be added to this list

Interest has also been expressed from Egypt and Thailand.

Picture 94: Made in Uganda, ready to conquer the globe

"The Power of Fire" is thus seen on various continents and since the technology is open-source, the project team is confident that the fire will spread further around the globe.

12. Business research and training

A project member visited tinsmiths to observe their business methods and to develop and give business training. This 'business specialist' had not participated in any of the other project activities in order to keep an 'independent outsiders' view' on the project and to remain unbiased towards any benefits or disadvantages of the stove, the training or any other project-related issue.

Note: the business research and follow-up visits were done in parallel, resulting in some overlaps between this chapter and chapter 10.

12.1 Assessment approach

The project team designed a questionnaire to capture data relating to the technical training that was given to the tinsmiths, production and sales of stoves, business knowledge, marketing and distribution strategies employed, customer satisfaction and possible financing possibilities.

12.2 Field visits and observations

The project member spent at least one week visiting the various districts, interacting with the tinsmiths and with their customers when possible, filling out questionnaires and observing and documenting activities of a normal trading day.

As the business specialist was finalizing the data collection and analysis, the project team recruited four salesmen in different areas who would undergo an orientation for about one week. The salesmen would thereafter be introduced to the tinsmiths to establish a business relationship.

After the induction and introductions, the project team sent promotional materials to the salesmen as well as t-shirts for ease of identification during the promotions.

Picture 95: Preparing simsim (sesame seeds) on the MWOTO stove

The basic idea behind the concept of introducing the tinsmiths to the salesmen was to create a model which ensured that the tinsmiths concentrated on the manufacture of the cookstoves while the salesmen sourced for the market.

The project team continued to participate in exhibitions and give demonstrations of the stove to different groups (such as women groups, church groups and employees of private companies) in different areas of Uganda. Talk shows and advertisements on local radio stations were also part of the on-going promotion programmes.

With a team comprising of marketing coordinators and salesmen (see section 11.5 and 11.6) , the campaign included activities like educating people about the MWOTO stove technology and its benefits, disseminating the contact information of trained tinsmiths, selling stoves in selected areas and giving demonstrations on how the stove is operated. The demonstrations included preparing and arranging fuel, lighting the stove and obtaining charcoal from the process.

Picture 96: Lighting the stove at a market place

Various divisions of Kampala (Kawempe, Rubaga, Makindye and Nakawa) and the Wakiso district had been visited by the time the business specialist finalized his part of the project. A further aim was to extend promotions to other areas of the country not yet covered (such as Gulu and Mbarara).

12.2.1 Arua district

Stove demonstrations and follow-up visits to the tinsmiths took place in Arua. In addition to these promotions, a project team member accompanied by a salesman and a tinsmith participated in a 30-minute talk show at Arua One FM Radio to discuss and promote the MWOTO stove project in the Arua district. The project team also joined GIZ with other private sector companies at Arua Hill road grounds for the launch of the Energy Explorerz' campaign in Arua and the northwestern region. Participants in this interactive exhibition took keen interest in learning more about how the stove works.

The following observations were made during the field visit in the Arua district:

- The tinsmiths in Arua feel that they need training in building their personal income, goal setting, sales and marketing.
- The tinsmiths lack sufficient tools for working.
- More public awareness is needed. The single promotion that was held on National AIDS day at the police grounds was insufficient.
- Some of the tinsmiths have a good savings culture. They save some of their earnings among themselves.
- In the opinion of most of the tinsmiths, market for the cookstoves is not a problem; however, scarcity of raw materials, which translates into high production costs, is a major problem.
- Arua has a strategic location; sharing a border with the Democratic Republic of Congo and South Sudan greatly increases the potential market for the cookstoves. Arua's status as a trade hub can be capitalized on to widen the market base for the cookstoves.
- The display area for the cookstoves is strategically located on the main road and can easily be accessed by customers.
- Some tinsmiths have a workshop about two kilometres out of town and only display their products at the roadside; other tinsmiths work from their homes and bring their products to the markets.
- People travel from neighbouring districts like Nebbi and Pakwach to buy cookstoves, which indicates a great potential for the expansion of their market base. Some wholesalers even travel from as far as South Sudan to buy the cookstoves.

- Most of the tinsmiths purchase their raw materials from nearby scrap yards at UGX 1,500 per kilogram.
- The tinsmiths are willing to buy raw materials from CREEC if they are of a high quality and offered at an affordable price.
- Some of the after sales services offered by the tinsmiths include repairing the stoves when damaged.
- The high cost of materials has caused the cookstove price to be too high for local consumers.
- The tinsmiths asked that more promotions be held in neighbouring districts such as Nebbi, Koboko and Yumbe and would also like to be supplied with further promotional materials.
- Some of the tinsmiths are training others in stove manufacturing to assist them.
- People trained by GIZ in cookstove manufacturing are selling their products at UGX 15,000. This is the biggest competition for the MWOTO stove, hence the need to source cheaper materials to drive down the unit cost.
- One tinsmith complained that they have been demoralized by unfulfilled promises for t-shirts, certificates and support after the training. The trainers should avoid making promises they cannot / will not keep.
- Most of the tinsmiths sell the cookstoves themselves, although some have wholesalers who buy from them in bulk.

12.2.2 Nakawa division

The project team continued with door-to-door campaigning to create awareness about the MWOTO stove in market areas and trading centres, moving from suburb to suburb teaching people and distributing contacts for tinsmiths in Kampala.

Additionally, the team was also able to meet a women's group in Mbuya and another one in Ntinda where the women were taught more about the MWOTO stove technology.

Picture 97: Using every opportunity to create awareness

The field visits to Nakawa division showed the following:

- There is a very low demand for the cookstoves due to lack of public awareness. Advertising materials and the promotion were insufficient to garner enough publicity for the cookstoves.
- Because of the very low demand, the tinsmiths are not willing to make the cookstoves and tie up their capital. They are instead opting to make the metallic boxes/suitcases for students because they have a higher demand. One of the tinsmiths openly mentioned that if he is supplied with materials without first boosting the cookstove market, he will use the materials to make boxes/suitcases instead of cookstoves.
- Only Local Councillors were called for the promotions, instead of announcing the promotions in the market. This resulted in lower awareness among potential clients.
- The tinsmiths are impressed with the performance of the cookstoves.
- Advertising needs to be done through the local radio stations like CBS, Super FM and Radio Simba. Also, market radio stations should be targeted.

Picture 98: Motivated tinsmiths picked up the business idea

- There is a truck going to Nakawa market every Friday to sell small quantities of charcoal in polythene bags at UGX 1,000. These people announce that they are coming throughout the week and build anticipation. When they finally arrive, all the charcoal is bought within a few hours. The tinsmiths advised that such a strategy should be employed.
- Most of the tinsmiths work alone, but they sub-contract other tinsmiths in case of big orders. Their customers usually contact them directly.
- The majority of the tinsmiths do not have sufficient space to sell firewood alongside the cookstoves.
- The tinsmiths generally have low morale because a new and exciting product was dumped on them without sufficient marketing.
- The tinsmiths have a separate workshop and bring the products to the roadside for display.
- The tinsmiths obtain their raw materials from hardware dealers or directly from manufacturers of steel products. They find the cost very high because they buy a square metre of steel sheet at approximately UGX 15,000.
- Cello tape was used for the posters instead of gum which did not stick very well.
- The MWOTO cookstove is a new product and therefore needs to be advertised aggressively to penetrate the market.
- The gauge of sheets recommended by the trainers was thin. They were soft and yet the customers demand a thicker gauge.
- The tinsmiths sometimes sell full lorries of cases to NGOs and schools. This implies that they have a potentially broad market base which needs to be harnessed by stimulating demand through improved promotion and market penetration strategies.
- The location of the tinsmiths is by the roadside and very strategic. This opportunity needs to be exploited to the fullest.
- Some of the customers travel from very far to the tinsmiths so selling firewood to them together with the stove is not a feasible option.

12.2.3 Mbale district

Additional promotional campaigns were held and four salesmen were recruited by the project team.

Observations in Mbale district provided the following information:

- There is a need for more advertising. Local radio stations such as Step Radio, Signal FM and Open Gate were suggested.
- Some of the customers do not use properly dried firewood. Hence the stove does not work efficiently. There is a need to distribute operating manuals in the local languages to customers and to emphasize verbal education.
- Some customers come from neighbouring districts such as Soroti and Bududa. Selling firewood to them would not be beneficial since they would incur extra costs for transportation that would not occur if they acquired firewood from their home areas.
- Other potential customers do not know where to find the cookstoves because of the insufficient publicity.
- There is further need to educate customers on how to use the cookstoves.

- The tinsmiths observed that on the day of the promotion, there was significant demand, but the preparation time had not been enough to fulfil that demand.
- There is no display area at the workshop. Since it is not easy to find customers, do not know about the stoves.
- One of the tinsmiths said he finds it easier when the design measurements are in millimetres because it enables him to adjust the sizes of the stoves he makes.

Picture 99: Firewood must be chopped to the right length

- Firewood must be chopped into small, even pieces to use in the MWOTO stove, which is difficult for many customers. They have difficulties adjusting from just chopping firewood with an axe and putting it in their stoves. This issue needs to be examined by the design team. Alternative fuels like maize cobs should also be promoted through more live demonstrations.
- On the day of the promotion some people wanted to make down payments, but the stove supply was not sufficient. One customer even offered UGX 45,000 for a cookstove.
- The main complaint from the customers is that the flame diminishes quickly, and dismantling and putting more firewood in the fuel chamber is a problem.
- One client travelled all the way from Busia (more than 80 kilometres) to buy some cookstoves. This indicates far-reaching demand by customers who are aware. Hence the need for further promotion campaigns.

Picture 100: Much interest from tinsmiths

- One of the tinsmiths moved with his cookstoves to Sironko, which is 23 kilometres from Mbale. He has many potential clients but is limited by scarcity and high cost of raw materials. Sometimes the clients provide materials for their own stove and only pay him a labour fee. This shows the initiative of some of the tinsmiths who are doing their own marketing.
- Some of the tinsmiths are willing to sell stoves at wholesale prices of UGX 18,000 to 20,000 to a distributor.
- In Soroti, the MWOTO cookstoves are sold as high as UGX 60,000.
- There are some wholesalers who come from Soroti and purchase five to eight cookstoves at one time.

- One tinsmith made adjustments to the stove to make it more user-friendly. Customers had complained that it was very difficult to add more firewood to the chamber when it run out of fuel since it becomes very hot.
- He has also made adjustments to the top of the stove to enable it to use charcoal like an ordinary charcoal stove.
- On average, a kilogram of scrap metal in Mbale costs UGX 3,500 to 4,000.
- Good quality raw materials are available in Busia, Malaba and Tororo, but it is expensive to get them.
- Some of the tinsmiths feel that their contact information was not well-publicised at the promotion. They feel that it would have been more beneficial to move around in a car because some people did not know the event was taking place at the cricket grounds.
- The tinsmiths would prefer to have an outlet to supply their stoves for sale.
- One tinsmith has wholesalers who usually return after three weeks.

12.2.4 Kampala Central division

By the time the business specialist visited the Kisenyi area, additional promotional campaigns were yet to begin in that area.

The field visit to Kampala Central division resulted in the following observations:

- The main problem faced by the tinsmiths is lack of raw materials. This, in turn, makes the available materials very expensive.
- The main complaint from the customers is that the size of the fuel chamber is small which makes cooking a hassle.
- The tinsmiths complained that the promotion was done for very few minutes and hence was insufficient.
- The high cost of the materials drives up the final stove price to UGX 50,000 which the customers complain is too expensive.

Picture 101: Women are the main users of the stove

- Some of the tinsmiths already have wholesalers for other cookstoves but not for the MWOTO stove. Their wholesalers say that their clients do not know about the MWOTO stove; hence it is not yet a marketable commodity for them.
- Only two tinsmiths are active. They are willing to sell the MWOTO stove to the distributors at price of UGX 20,000.
- The market area where they operate is somewhat hidden and not easily accessible.
- The working area is the same as the display area.

12.2.5 Kawempe division

Activities in Kawempe division came to a complete halt on the second day, 8th May 2012 due to the incredible demand for MWOTO stoves in the areas of Bwaise and Kubiri near Kalerwe market.

Awareness creation activities were carried out in Kawempe division including interactive group sessions or one-on-one instructions where marketing coordinators and salesmen answered questions and demonstrated the stove.

Cooking competitions were held in some areas with women using other wood stoves. These competitions entailed cooking standard lunch meals with matooke (plantains), groundnuts, beans and posho (maize flour mingled with water).

Picture 102: Explaining the stove while cooking food

The following was noted during the field visit in Kawempe division:
- The tinsmiths are organized into a registered company called Uganda Energy Foundation Limited.
- They use an assembly line production method: some do riveting, others joinery and again others painting.
- The tinsmiths feel that the promotions done in their area were adequate.
- The tinsmiths indicated that the MWOTO stove takes longer to make than other stoves which may make it less attractive.
- The tinsmiths have distributors for other stoves they produce.
- They have a unique colour for their stoves as a way of differentiating their product from the ones by other producers.
- The promoters of the MWOTO stoves did not inform them whether carbon credits were available or not. This is a major incentive for them as they are looking at financial gain for their company.
- The company is willing to sell MWOTO stoves to distributors at a unit price of UGX 45,000.
- They currently have an order of 100 MWOTO stoves from the Sudanese embassy. This is their first big order so far.
- The main limiting factors are lack of market and high costs of materials.
- The tinsmiths would be interested in buying raw materials from CREEC if they were of high quality and affordable.
- Their main clientele are the distributors and a few walk-in customers from the neighbourhood.
- The main complaint from their clients is that the fuel chamber is small.

12.2.6 Wakiso district

Promotion campaigns similar to the other regions were undertaken in the Wakiso district.

The visit to Wakiso showed the following:
- It is difficult to obtain firewood.
- The main problem facing the tinsmiths is lack of market.
- The tinsmiths felt that the promotion did not raise enough awareness for the MWOTO cookstoves.
- One of the main complaints by the customers is that putting firewood in the fuel chamber is time consuming.

- Lack of materials is also a large problem. This makes the few available materials very expensive for the tinsmiths.
- Tinsmiths indicated other potential market locations since people come from relatively far places to those market areas.
- The average selling price of a MWOTO stove is UGX 25,000.
- Production of a single cookstove costs the tinsmiths an average of UGX 18,000.
- The tinsmiths are organized into an association of tinsmiths (Bwakola Blacksmith Group). The group has 18 members. They also collect and save money in their group.
- The business environment in Entebbe is generally slow.
- The tinsmiths are trying to get stalls in the market to enhance sales of their products.
- The chairman buys materials for the tinsmiths to make stoves and metal boxes / suitcases.
- The chairman failed to sell all ten cookstoves he made. The other tinsmiths pointed out that it is probably because he did not make them well.
- The chairman's view is that they would prefer to be supplied with materials and just paid the labour. After producing, the stoves could be taken to the market.
- The chairman did not want the business specialist to interact with the other tinsmiths and became hostile when the business specialist ignored his wishes. He was bitter and asked to be excluded from the project henceforth.
- The chairman did not want the tinsmiths to have their pictures taken and their names registered by the CREEC team during the trainings.
- The chairman is creating a lot of confusion in the group of the tinsmiths.
- The tinsmiths feel that their chairman is taking advantage of them.
- They are willing to sell to wholesalers at a price of UGX 15,000.
- They are also willing to sell cookstoves on credit.
- Feedback has been positive from their few customers so far.
- The tinsmiths are interested in being supplied with scrap metal.
- New customers are usually referred by neighbours who have already purchased MWOTO stoves.
- The manufacturing and display area is easily accessible.

Picture 103: Convincing tinsmiths by cooking food for them

12.3 Analysis of findings

12.3.1 Trainings and promotions

All the tinsmiths interviewed received training. The tinsmiths from Mbale, Kawempe and Arua understood the training fully while some of the trainees from Nakawa, Kisenyi and Wakiso experienced some difficulties in understanding it. This indicated that, to a very large extent, the training was highly effective.

The attendance by the tinsmiths at the promotions was also encouraging with 100% attendance in Mbale, 86% in Nakawa, 100% in Kawempe, 83% in Arua and 100% in Wakiso. This shows a willingness and commitment by the tinsmiths to promote their MWOTO cookstoves with a hope that it is a potential source of income. With a more strategic and well-coordinated promotion campaign, the tinsmiths are likely to participate even more actively and capture a well-targeted market segment.

Despite these positive figures, the effectiveness of the promotions fluctuated highly for the tinsmiths in the various locations. The most successful were the promotions in Kawempe since they brought new customers for all tinsmiths. With new customers for 89% and 75% of the tinsmiths in Mbale and Wakiso, respectively, the promotions were good. The promotions in Arua and Nakawa were insufficient with only 56% of the tinsmiths receiving new customers in Arua and even no new customers for the tinsmiths in Nakawa.

Picture 104: Road side explanations

12.3.2 Business knowledge

Most tinsmiths did not fully understand the concept of a business plan, with the exception of those at Kawempe, where all of them understood business plans. None (0%) of the tinsmiths from Mbale, only 29% from Nakawa, 22% from Arua and none (0%) from Wakiso knew what a business plan was. Most probably the tinsmiths in Kawempe knew because they are organized in a company.

Given the low number of those who knew what a business plan is, it was not surprising to find that only 14% of the tinsmiths in Nakawa, in addition to all the tinsmiths of Kawempe, actually have business plans.

Keeping records of sales and expenses was also found wanting: 0% of tinsmiths in Mbale and Wakiso, 14% in Nakawa, 33% in Arua and 100% in Kawempe actually keep records.

All the tinsmiths from Arua and Mbale are keen on receiving some kind of business training. A great proportion of the tinsmiths from Nakawa (86%) and Wakiso (75%) are also interested. None of the tinsmiths from Kawempe are interested in receiving this training; they feel that the knowledge they have is adequate.

12.3.3 Production and sales

The levels of production of the cookstoves are low to non-existent (see also chapter 10). On average the tinsmiths of Arua and Mbale make three to five MWOTO cookstoves weekly, those of Nakawa make three and those of Kawempe and Wakiso make zero cookstoves per week on average. The tinsmiths in Kawempe later got an order for 100 stoves from the Sudanese Embassy.

Due to the previously mentioned constraints of a scarcity of raw materials and a narrow market base, most of the tinsmiths in Arua, Kawempe and Mbale (56%, 100% and 89% respectively) opt to make the MWOTO cookstoves on order, mainly because they do not want to tie up their limited capital unnecessarily.

From the tinsmiths actually making some MWOTO stoves, almost half source their raw materials locally and the rest source their materials externally. All the tinsmiths in Arua, 89% of those in Mbale and 86% from Nakawa source their materials locally. On the other hand, all the tinsmiths from Kawempe and Wakiso with about 14% and 11% from Nakawa and Mbale respectively, get their materials from sources outside their localities.

Picture 105: Tinsmith workshop with other types of cookstoves

Picture 106: Potential users at a market

The business specialist observed that almost all the tinsmiths need a reliable and affordable source of materials. This is probably why all the tinsmiths (with the exception of Nakawa and 25% from Wakiso) are willing to be supplied by materials from CREEC at a fair price.

The production costs of a MWOTO cookstove varies over the different areas. This can be largely attributed to the scarcity and cost of the raw materials. On average, the costs of production were: UGX 15,000 (Arua), UGX 17,000 (Mbale), UGX 18,000 (Wakiso), UGX 21,000 (Nakawa) and UGX 35,000 (Kawempe).

This in turn accounts for the different selling prices which create disparities in the profit margins of the tinsmiths in the different areas. The average selling prices were: UGX 26,000 (Arua), UGX 31,000 (Mbale), UGX 20,000 (Wakiso), UGX 41,500 (Nakawa) and UGX 50,000 (Kawempe).

One salesman commented that the stove should be made of new material, such as galvanized steel. This gives the stove a modern and attractive look, discouraging customers to bargain for lower prices.

The table below shows the average unit cost and selling prices of the MWOTO stoves in the different districts.

	Arua	Mbale	Wakiso	Nakawa	Kawempe
Average production cost (UGX)	15,000	17,000	18,000	21,000	35,000
Average sales Price (UGX)	26,000	31,000	20,000	41,500	50,000
Average profits (UGX)	11,000	14,000	2,000	20,500	15,000

Table 14: Average production cost, sales price and profits

The table below show the levels of production in the different areas and their main limiting factors.

	Arua	Mbale	Wakiso	Nakawa	Kawempe
Average weekly production	21	14	6	2	7
Market limiting factor	0%	78%	100%	100%	100%
Materials limiting factor	100%	67%	100%	29%	100%

Table 15: Average weekly production and main limiting factors

Note: the percentages are not mutually exclusive

As can be observed, in areas like Arua, market is not a problem at all. All the tinsmiths there experience scarcity and high cost of materials as their main limiting factor to production. This is different from other areas like Kawempe and Wakiso where the tinsmiths feel that they are equally constrained by the lack of market and scarcity (thus high cost) of materials.

In other areas like Mbale, both the limited market and scarcity of materials are a problem; although, the majority of the tinsmiths feel that the limited market is a greater problem.

The Nakawa tinsmiths feel that the limited market is their greatest constraint, but 29% of the tinsmiths mention that scarcity and cost of the materials is also a major barrier.

12.3.4 Linkages with SACCOs

From the table below, it can be seen that membership of the tinsmiths in a Saving and Credit Cooperative (SACCO) is very low.

	Arua	Mbale	Wakiso	Nakawa	Kawempe
Number SACCOs Around	4	37	5	3	4
SACCO member-ship	56%	11%	0%	29%	0%

Table 16: SACCOs in locality and tinsmiths' membership

The business specialist observed that most of the tinsmiths were averse to saving their money with SACCOs. The reported amounts of frauds within these organizations are keeping the tinsmiths from joining a SACCO. Since the Kawempe tinsmiths are organized in a registered company with a bank account, they can save their profits and access finance facilities from their bank. They therefore have no need for joining a SACCO.
The business specialist discussed the options of accessing finances by tinsmiths with SACCOs and was informed that SACCOs only extended finances to their members. Therefore, this option would only, to some extent, be feasible for the tinsmiths of Arua who have the largest membership in the SACCOs (56%).

12.3.5 Quality assurance and monitoring

As with any other new product being introduced to the market, the importance of quality assurance cannot be emphasized enough. A high quality and durable product that meets the expectations of the clients as advertised is vital to capturing and maintaining a stream of loyal customers.

The table below shows the percentage of tinsmiths in the different areas who have loyal customers.

	Arua	Mbale	Wakiso	Nakawa	Kawempe
Tinsmiths with loyal customers	44%	78%	100%	14%	100%

Table 17: Tinsmiths with loyal customers

The table below shows the percentage of tinsmiths who receive complaints and those who address them. It can be seen that the tinsmiths from all the areas except Arua received complaints.

	Arua	Mbale	Wakiso	Nakawa	Kawempe
Tinsmiths received complaint	0%	44%	100%	14%	100%
Tinsmiths addressed complaint	0%	44%	75%	0%	100%

Table 18: SACCOs in locality and tinsmiths' membership

Tinsmiths from all areas received complaints except those in Arua. Less than half (44%) of the tinsmiths from Mbale got complaints, but they were all dealt with. In Wakiso 75% of the tinsmiths who received complaints addressed them. Only 14% of the tinsmiths interviewed from Nakawa got complaints from customers but none of the complaints was attended to. Although all tinsmiths in Kawempe received complaints, also all of them were addressed. This means that customer care is good to very good except in Nakawa.

The most common consumer complaint was that the fuel chamber of the stove is rather small. This may result in fuel running out during cooking, which necessitates dismantling of the stove and re-filling with fuel. Customers experience this as an inconvenience since it interrupts the cooking process for quite some time. They also complained that the stove is still very hot and thus not easy to handle. Some tinsmiths were creative enough to produce stoves with two fuel chambers, thus simplifying the task.

Picture 107: Fuel preparation requires some attention

Other clients faced difficulties in fuel preparation since they have to cut firewood in pieces to suit the cookstove. This is a lot of work compared to other cookstoves where the fuel does not require as much preparation.

During the course of the business research, the project team introduced the concept of providing cookstoves with serial numbers. Each stove will be provided with a serial number which connects the customer to a particular tinsmith and gives the customer a contact for voicing complaints.

12.3.6 Business models

Arua district

The majority of the tinsmiths visited by the business specialist are their own bosses. They raise capital by themselves and from relatives and they operate a sole proprietorship. Despite the fact that they are working for themselves, they operate in the same area as a group.

Picture 108: Packing stoves ...

The tinsmiths buy the materials from neighbouring scrap yards. Some of the tinsmiths work from their homes and only bring the finished products to a common display area with the other tinsmiths.

Picture 109: ... and off to the radio station

The majority of the tinsmiths (64%) have their customers pay physical visits to them. Only one of them sells to a few wholesalers and the rest of the tinsmiths wait for customers to place an order before they start producing. Wholesalers are coming from neighbouring districts (such as Koboko, Nebbi and Pakwach, Nebbi) or even as far as Juba (South Sudan). Usually these wholesalers buy in bulk a maximum of 20 cookstoves. Most probably they do not want to buy more stoves at this stage since they are still marketing the new product themselves.

Arua has an advantage of a strategic location (sharing a border with both the Democratic Republic of Congo and Southern Sudan). The marketing of cookstoves could thus also target these two countries, probably on radio and television stations that broadcast across the borders. South Sudan is a new country that has just come out of war and is re-building its communities. Boosting demand in these areas might not only increase local production in Arua but also in other areas with trained tinsmiths. Arua has only nine active tinsmiths and therefore it is very unlikely that they will be able to satisfy the demand from neighbouring districts and countries.

Picture 110: Other stoves competing with MWOTO

Mbale district

The tinsmiths in Mbale have a business model similar to the one in Arua: they are sole proprietors, working individually in a common area and sell to their clients directly. Also here, only one tinsmith has a few wholesalers who come from neighbouring districts to buy cookstoves in bulk.

Wholesalers take the stoves to the neighbouring districts of Bududa, Busia, Sironko and Soroti. This is a clear indicator of the far reaching demand from the few people who currently know about the MWOTO stoves.

At least half the tinsmiths receive phone calls from their clients to get orders, one tinsmith is contacted by wholesalers and the rest have clients place orders directly at the shop. All the tinsmiths obtain their materials mainly from scrap yards or neighbouring car garages.

Nakawa division

Several of the Nakawa tinsmiths are inactive and not producing MWOTO stoves despite their strategic roadside location. Like the Mbale and Arua tinsmiths, the tinsmiths in Nakawa are clustered in the same area. They buy materials from hardware shops or directly from manufacturers of steel products. The tinsmiths produce the cookstoves at the road side.

They sell the MWOTO stoves themselves to customers directly, with no wholesalers, since the demand is still very low. Interestingly, they do have wholesalers for some of their other products (like metallic boxes / suitcases) who come from as far as Arua. They also have big clients like NGOs which buy other products in bulk.

Eighty-six percent of the tinsmiths get physical visits from their clients and 29% of them have clients who make phone calls to place orders.

Picture 111: Sourcing scrap metal from garages

Kawempe division

The tinsmiths in Kawempe are highly organized. They operate under a registered company called Uganda Energy Foundation Limited. The tinsmiths buy their materials from hardware shops and scrap yards, and they manufacture the MWOTO stoves and other products in an assembly line system. Different tinsmiths make different parts of the stove for assembling. As a way of differentiating their products from the rest, all their products are painted red.

The tinsmiths do sell to local people visiting their workshop, but their focus is mainly on supplying wholesalers in other areas who distribute their products.

Wakiso district

The tinsmiths are operating under an association called Bwakola Blacksmith Group although each tinsmith remains his own boss. The chairman of group buys materials from scrap yards for the group. Each tinsmith makes his own products (including the MWOTO stove) and sells to individual customers who had either placed orders or visits the tinsmith's workshop.

The tinsmiths lamented that recently each had been operating on his own since the chairman brought a lot of confusion into their group.

12.4 Lira workshop

To address the business development issues the project team organized a three-day workshop to bring trained tinsmiths, marketing coordinators, salesmen and distributors together. Also several stakeholders in the cookstove / renewable energy sector and the press were invited for the first day of this workshop that ran from August 22 to 24, 2012. In addition to business training for tinsmiths, salesmen and distributors, the workshop focused on formulating means of sustaining the MWOTO cookstove program.

Picture 112: Participants at the Lira workshop

On the first day, which was attended by over 80 participants, the project team gave an overview of the project's goals, activities and achievements. The TLUD gasifier technology was presented and the operation of the stove was demonstrated.

In another session the meeting focused on the question of how to sustain what has been set in motion by the project. The various ideas that were shared included the following: further support by GIZ if the MWOTO stove complies to certain criteria the organization has set for eligibility of support, combined efforts in continued marketing and sales and investigating in how the various stakeholders could work together to further the MWOTO stove's adoption rate.

The second day was reserved for a business training given by the expert that had done the business research (see earlier sections in this chapter). The tinsmiths, salesmen and distributors were taught about business basics in a number of sessions.

The training dealt with topics such as what is a business plan, how to write a business plan, record-keeping of stoves sold, financial bookkeeping, customer care and handling complaints, what factors influence the price of the stove, how to determine the cost price and the sales price of the stove, reasons for marketing and awareness creation and other general business principles.

Picture 113: Business training

The tinsmiths, salesmen and distributors expressed their gratitude for being provided with tools and guidelines for sustaining their MWOTO stove business. They stated that the training had been very useful and that they would like to receive more of it.

The second day of the workshop also featured a competition where each tinsmith could showcase his MWOTO stove product. The stoves were judged by a team having considerable experience with gasifier stoves on criteria such as product quality, branding, design details and general presentation.

On the third and last day, the tinsmiths that participated in the competition were rewarded with tools for stove manufacturing. A question and answer session addressing challenges, hindrances and opportunities proved to have great importance since this was a time where the tinsmiths, salesmen and distributors shared their experiences with the project team and, more importantly, among themselves.

Picture 114: Tinsmiths with their stoves and presents

This last session resulted in the birth of an umbrella organization for the MWOTO cookstove sector in the form of Uganda Mwoto Stove Association (UMSA). It was very encouraging that this was an initiative that came from the tinsmiths, salesmen and distributors themselves without any influence from the project team. The team was greatly encouraged by the initiative taken to sustain the MWOTO cookstove business in the Ugandan energy sector.

A few weeks after the workshop, tinsmiths in Arua decided to also unite themselves regionally in the Arua MWOTO Stove Association (AMSA) subscribing to UMSA.

13. Conclusion and way forward

Although the project in general was received as successful, several lessons were learnt that are shared here together with potential avenues for the future.

13.1 Conclusion

The BEIA project focused on capacity building of tinsmiths in manufacturing, marketing and selling of TLUD stoves. Business development was an integral part of this goal. Secondly, the project aimed to create awareness about the TLUD stove, its use and the benefits. Activities were designed around these objectives in the form of selection, research and development, testing and adapting the stove to the specific Ugandan environment and customs. Furthermore, a marketing and promotional plan was formulated to support the market development of this relatively new stove on the Ugandan market.

The Champion 2008 TLUD was selected as the base model for the project. Based on feedback from stove users, tinsmiths, salesmen and distributors during observation tests and a pilot study, several modifications were made to the stove to adapt it to the Ugandan situation. CREEC tested the stove, but due to CREEC's status as a testing centre, it can and will not publish these results. The MWOTO stove, however, was selected by the US Environmental Protection Agency for testing.

Mohamad Sadam Ssembatya was selected as the project's master tinsmith to train the other participating tinsmiths. He was a practicing tinsmith and assumed to be exemplary for Ugandan tinsmiths in general. Sadam's success in producing and marketing the MWOTO stove was attributed to his ability to adapt previous tinsmithing experience to the new stove; therefore, future tinsmiths were selected based on existing tinsmithing experience. In reality, Sadam was primarily a businessman and secondly a tinsmith and much of his success was more dependent on his business expertise than tinsmithing. The majority of the other tinsmiths in the project were primarily tinsmiths with only enough business experience to support their trade. This greatly hampered business development and production rates of TLUDs.

A large portion of the tinsmiths did not actually produce any TLUD stoves after the training due to high raw material prices, lack of product market due to poor customer awareness and higher demand for competing products. A few tinsmiths, however, seriously adopted the business, started producing and marketing stoves and are now selling them at good profit margins. Some have personally trained others to assist them in manufacturing since the market demand is more than they can produce. They also were prepared to travel fairly long distances for marketing their stoves in other districts or to visit Kampala for further training. The associations formed during and after the workshop on business development and sustainability indicated that a number of tinsmiths are committed to the MWOTO stove and are looking to further sustain and expand their businesses.

The training of tinsmiths was continuously developed and improved to implement feedback from field experience on stove use and production. Various modifications were made to the stove itself and to the manufacturing process to make the stove more user-friendly, robust and attractive as well as to lower production time and stove costs. This resulted in a stable and consistent design.

The original proposal contained training of 50 tinsmiths in 25 districts (two per district). When visiting Kampala, North, East and West-Uganda it was decided to train fewer districts with more tinsmiths per district. In total 80 tinsmiths were trained from four districts plus three divisions of Kampala district. Through a variety of methods including training, awareness campaigns, distributions and promotions, the project was able to reach a registered amount of 27 districts. Most probably the total number is higher, since people have taken the stove to villages and regions where they originate.

The total number of stoves sold was approximately 3,500, which is 35% of the number of 10,000 stoves in the original proposal. Although this number may seem rather low, the project showed that TLUD stoves have been accepted and adopted by customers. People were convinced to adopt the stove after witnessing its advantages such as increased fuel efficiency, decrease in smoke emissions, faster cooking time and charcoal production. This supports the idea that demonstration and promotion are very important for adoption of improved cookstoves on a large scale.

Refusal to accept the TLUDs due to price, lack of reputation and unfamiliarity with the technology were remedied by the product demonstrations and promotions. Competition from the three-stone fire remained a challenge, especially in rural Uganda, because it does not require an initial financial investment. A quick analysis revealed that a MWOTO stove, which costs UGX 30,000 to 50,000, has a pay-back time of 15 to 50 days. This is based on information obtained from users who previously spent UGX 2,000 per day on charcoal and now spend UGX 0 (when collecting wood for free) to 1,000 (when buying wood), resulting in savings of UGX 1,000 to 2,000 per day. Future marketing campaigns should not focus on environmental protection due to fuel savings and reduced smoke emissions, although it is important. The main focus should be on saving of money, since it is a tangible benefit and strongly influences consumers' decisions.

Although certain solutions are logical to adopt, it does not mean that users will do so. Human factors such as peer pressure and cooking habits have a huge influence on the decisions made. For example, the fact that the TLUD stove produces less smoke may be a disadvantage since smoke gives certain foods a distinct flavour which is missing when the food is prepared on a TLUD.

The project team realized that the gasifier stove will not solve all the demands and challenges of cooking in urban and rural areas of Uganda. Most probably, households will obtain a variety of stoves that will be used for specific cooking and boiling tasks.

The original market demonstrations were judged insufficient by many tinsmiths since they did not result in many new customers. Insufficient preparation time, lack of publicity and incomplete stove demonstrations were mentioned as shortcomings of the demonstrations. Furthermore, the project team found that the production and sales of stoves was very low, a view that was also supported by the visiting World Bank team. A re-designed approach emphasising intensified awareness and promotional campaigns included newspaper advertising, radio and television exposure, participation in more exhibitions and fairs, introduction of marketing coordinators and salesmen, stronger internet presence and targeted field visits. The approach shifted from training-centred to promotion-centred and from tinsmith-centred to distributor-centred in order to create further awareness and increase demand for the stove.

This change of focus resulted in greater awareness about MWOTO and increased stove sales. Extensive demonstrations and explanations about the stove's benefits gave rise to more confidence in the technology. Marketing coordinators and salesmen, who were not included in the original proposal, were introduced to the product for these specific activities. Tinsmiths and salesmen taught customers to use the stove correctly since its operation method differs substantially from that of traditional stoves or the three-stone fire. This was supported by a graphic operation manual, which can be easily understood.

Financial issues, both on the tinsmiths' side for procurement of materials as well as on the customers' side for purchasing a MWOTO stove, still prevail. Some investigations with SACCOs did not produce satisfying results and this should thus be further researched by the MWOTO associations.

Some general obstacles to be overcome included language barriers, unwillingness of tinsmiths to cooperate after the training, availability of raw materials from manufacturers of steel products, sudden changes (for example a new exhibition opportunity) which disrupts the planned activities, no availability of electricity due to load shedding and

inflation. These were taken as 'given' and the project team worked around them.

Due to time constraints, the project team was unfortunately not able to develop a quality label for monitoring and compliance with certain quality standards. The shortened project time also did not allow for proper investigations into Clean Development Mechanisms and carbon financing. The project did some preliminary explorations, but these were deemed insufficient to be shared in this report. Both the quality label and CDM possibilities form excellent opportunities for the newly formed associations to strengthen, sustain and expand the MWOTO stove sector.

The best use for the stove's charcoal by-product has also not been researched in the project. Briquette making or sales as a soil enhancer provide further profit opportunities for the new associations to investigate.

In conclusion, if CREEC had to do the project again, the training would be similar to before but with greater focus on business development and sustainability. Training people in a certain technology is fairly easy, but changing people's business mindset is very difficult.

Two misunderstandings about the project also have to be addressed:
1. The primary focus of the project was opportunities for tinsmiths and energy entrepreneurs, not stove manufacturing.
2. CREEC is not a stove manufacturer; the centre is strictly stove and fuel neutral.

13.2 Way forward

The World Bank funded project ended on September 30, 2012, but CREEC has sustained some of the project activities. The responsibilities for further sustainability of the MWOTO stove sector have now been transferred to individual tinsmiths, newly founded companies, salesmen and the MWOTO associations. Several issues however need some further elaboration, which is included here.

13.2.1 UMSA and AMSA

As mentioned in section 12.4 two associations were established: a general one, the Uganda MWOTO Stove Association, and a more local one, the Arua MWOTO Stove Association. This initiative came from committed tinsmiths, salesmen and distributors who wished to unite themselves concerning issues all of them face. Both individuals and project spin-off companies (see section 11.15) joined the associations.

Topics such as further training (both technical and business), access to funding through financial institutions, quality assurance and control, supply of raw materials, use of charcoal, potential CDM projects and carbon finance, branding and promotion should be tackled by these associations.

The network of tinsmiths can also contact each other with regards to technical matters or to assist in supplying stoves where the individual tinsmith or company is not able to satisfy the demand.

Picture 115: Elected UMSA representatives

13.2.2 PATH

The TRAction (Translating Research into Action) program of USAID is funding a behaviour change project for PATH in Uganda. This project will develop, test, and evaluate behaviour change interventions to improve the acquisition and correct use of a locally-fabricated TopLit UpDraft (TLUD) MWOTO stove in Uganda.

CREEC is responsible for identifying and training six tinsmiths, conducting quality comparisons and evaluating alternative fuel sources and their acceptability for the MWOTO stove.

13.2.3 Use of MWOTO trademark

As mentioned in section 11.4, CREEC registered he name “MWOTO” as a trademark. Being an open source organization, CREEC will grant individuals and companies a no-cost license to use the name “MWOTO” for marketing stoves. The license will be for one year but is renewable. Through this plan, CREEC wants to monitor the licensees with regard to quality assurance and quality control.

Customer care, after sales and quality issues should also be addressed by the associations.

13.2.4 Fuels

Further business opportunities exist in preparation and sales of fuels for the MWOTO stove. Entrepreneurs can process wood or agricultural by-products into non-carbonized briquettes or pellets that can be used in the cookstove.

This will require a whole business evaluation taking into account the logistics, amount and continuity of feedstock supply to produce the briquettes, processing capacity and costs, distribution of briquettes and determination of sales prices.

13.2.5 Creation of demand

First and foremost, the demand for MWOTO stoves must be stimulated. The different market niches must be identified and targeted with comprehensive sales promotions adapted for each. Domestic cooking activities in Uganda are traditionally dominated by women, hence the women in the different market niches need to be targeted primarily; however, the men usually make family decision makers and must not be neglected.

The target groups should not be limited to women’s groups, but also include SACCOs, large supermarket chains, NGOs, companies and religious organizations. Through the use of social media like Facebook and Twitter, Ugandans abroad can be reached and encouraged to purchase MWOTO stoves for relatives back home.

Different approaches should be developed for different areas. Use of local languages should be included in demonstrations to reach people more effectively.

Opening a MWOTO Centre could provide support and address topics such as training, demonstrations and marketing. It could serve as a store or depot for MWOTO stoves and a point for placing larger orders that cannot be fulfilled by individual tinsmiths or companies. Another possibility is making MWOTO stoves available in retail shops like any other commodity to enhance accessibility.

Picture 116: Demonstration at a women's group

After stimulation of the demand, wholesalers and retailers should be recruited. Wholesalers usually have more financial resources than tinsmiths. Boosting demand is key to recruiting the wholesalers because they do not want to tie up capital to invest in products that do not have a ready market.

Some tinsmiths already have distributors who indicated a willingness to take on the MWOTO cookstove, but only if it has demand. The wholesalers will boost production among the tinsmiths by continuously placing orders. A reward scheme for the wholesalers, tinsmiths and customers could also be developed.

End-user surveys should be carried out to gather feedback from customers and potential customers. This should, however, be done after promotion campaigns are held and a customer base has been created.

13.2.6 Supply of raw materials

The associations should engage in discussions with manufacturers of steel products to ensure continuous supply of raw materials. Buying in bulk for the association can result in discounted prices. This lowers the cost price and increases the tinsmiths' profits. However, this can only be done once the association is strong enough to have negotiation powers, not only in number of tinsmiths but also having their authorization.

The government can also be addressed to purchase, for example, scrap from police stations be bought at discounted prices. This is an untapped source of metal but, due to legal encumbrances, this must be researched thoroughly by a lawyer.

13.2.7 Finance

As mentioned in section 13.1, tinsmiths often lack financial resources to buy raw material in advance and stock stoves. They are simply not in a position to tie up their money for long periods of time. Wholesalers may also demand lower prices or the option of buying on credit, which weakens the tinsmiths' liquidity. Affordable loan schemes could be made available through financial institutions such as SACCOs, rural banks or micro-finance organizations to enable tinsmiths to grow their businesses.

On the other side of the spectrum are customers who cannot afford the initial capital cost to buy a stove. Over time they would be able to save money from fuel-saving and pay for the stove, but first they must be able to purchase a fuel-saving stove. To break this vicious circle, financial institutions such as those mentioned above can be brought on board to offer financial schemes to make the stove more accessible.

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