Overview of ICS market at the national and local levels in Kenya

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Executive summary

SalvaTerra and its Kenyan partner Dr. Kinyua Gitau bioenergy researcher, currently consulting with World Agroforestry (ICRAF), have been hired by PUR Projet to conduct a feasibility study for the dissemination of improved cookstoves (ICSs) among coffee producers' part of the Cherara Cooperative in Kericho County, Kenya.

The objective of the study is to provide recommendations to PUR Projet, in order to disseminate the promising ICSs and to coordinate this activity with the agroforestry ones. After a field and desk study to understand the baseline situation on ICS and fuels at national and local level, three promising ICSs have been identified in order to be tested in the next phase of the study. The field and desk study were carried out by cross-referencing the analysis of the ICSs market at the national and regional level, the household survey results that provide information on cooking habits, fuel and stoves use in the project area, as well as the assessment of available ICSs at the local level.

One of the leaders within Sub-Saharan Africa in ICS development and distribution, Kenya has a wide variety of stove models and manufacturers. Estimated at around 130 manufacturers, mainly small-scale producers, the ICS sector remains mainly informal and the quality of stoves on the market is uneven. Although many development projects contributed to the promotion of ICSs over the years at the country level, the demand is higher in urban areas, where charcoal prevails over fuelwood, as opposed to rural areas. One of the first improved charcoal cookstoves introduced in Kenya in the early 90's, the Kenyan Ceramic Jiko (KCJ), is still very used in urban areas, mainly because it is easily available and locally manufactured.

A multitude of entrepreneurs are active throughout the territory: the biggest producers (BURN manufacturing, Envirofit, etc.) are implanted around the capital, whereas most of the informal production is done in Kisumu County and Muranga County, western and central Kenya respectively, where clay is readily available. There is a multitude of projects at the national level, often funded by carbon finance mechanisms. In the project area, some initiatives have been implemented at household level. The technology of ICSs is therefore known to the population, but none of these projects directly involves the villages benefiting from PUR Project activities.

Over time, several points have emerged as crucial to the success of projects to promote ICSs. Among them: i) the need to adapt the stove design to users' needs and cooking culture, including labour requirement for fuel collection; ii) the efficiency of market-based approaches over strictly subsidised diffusions, and the interest of partnering with financial organisations such as microfinance structures; iii) the success of establishing long term partnerships with already implanted companies/stakeholders from the private sector.

At the local market level, only one manufacturer is active (since 2019), providing ICSs made from bricks, and cement or mud depending on what the customer can afford. She was trained by a non-governmental organization implanted in the neighbouring sub-district of Londiani. Stoves all have a chimney. Demand is not very high in the area, due to lack of funds and awareness among the local population. She installed fifteen ICSs in the past year.

Among surveyed Cherara cooperative members, the stove used is the local traditional mud stove, based on three stove open fire. Households rely completely on fuelwood for which they spend on average 5 hours collecting each week. The study of cooking habits leads us to think that the promoted ICS will have to be able: i) to generate both high intensity heat to boil water and fry, and low intensity heat for slow cook, ii) to be stable, allowing preparation of dishes that require vigorous stirring like Ugali, iii) to adapt to a variety of utensils used, iv) to last long with less requirement for maintenance-durability and, v) to run on fuelwood, which is the most commonly use locally.

Favouring the criteria of smoke reduction, fuel savings, adaptability of cooking methods and the local manufacture of stoves, the following three technologies are proposed for testing:

- **Stove A - Brighter Communities:** this locally made ICS is made of bricks fixed with a clay and mud mortar, and a chimney. It has one inlet and allow cooking with two pots simultaneously. It has been promoted by the non-governmental organization" Friends of Londiani and Kipkelion" since 2009 in Kericho County;

- **Stove B - BURN Kuni Okoa:** this portable stove is made by a Kenyan company BURN Manufacturing. It is light and portable, and allows important fuel reductions;

- **Stove C - Jiko fixed stove – 2 pots:** composed of a clay liner fixed in a mud mortar, this ICS has two inlets and no chimney. It fits local population uses and addresses the issue of stability while allowing most of cooking operations. Promoted by GIZ**.**

After validating this short-list and to move towards the next step, e.g. in situ trials, PUR Projet should as soon as possible finance the purchase (2nd ICS: 3,300KES/u or 27 €/u) or in situ building (1st ICS: 5,000 KES/u or 40 €/u and 3rd ICS: 6000 KES/u or 48 €/u) of 7 ICSs of each type (total estimated budget: 100,100 KES or 805 €), so that the 6-week in situ trials can start in the 21 pilot households. A slight upward re-evaluation of the budget may take place, depending on the associated transport costs.

Summary

Figures

Acronyms

CARE	Capital Access for Renewable Energy Enterprises
ACP-EU	African, Caribbean and Pacific Group of States – European Energy Facility
CZK	Carbon Zero Kenya
DEM	Danish Energy Management
EnDev	Energizing Development Partnership Programme
FOLK	Friends Of Londiani and Kipkelion
GACC	Global Alliance for Clean Cookstoves
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit* (German technical cooperation)
GVEP	Global Village Energy Partnership
HH	Household
ICRAF	World Agroforestry Centre
ICS	Improved Cookstove
KCIC	Kenya Climate Innovation Center
KCJ	Kenya Ceramic Jiko
KEEP	Kakamega Environmental Education Programme
KES	Kenyan Shilling
Ltd	Limited
MFI	Microfinance Institution
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization
PPI	Poverty Probability Index
SACCO	Savings and Credit Cooperative Organisation
SEI	Stockholm Environment Institute
SIDA	Swedish International Development Cooperation Agency
SNV	*Stichting Nederlandse Vrijwilligers*
TLUD	Top-Lit UpDraft
TSOF	Three Stone Open Fire
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WHO	World Health Organization

1. Introduction and methodology

1.1. Context and objectives

PUR Projet is a French Non-Governmental Organisation specialized in the development of forestry, agroforestry and agro-ecological projects. In Kenya, PUR Projet is currently supporting coffee producers members of the Cherara cooperative, in Kericho County, mostly promoting agroforestry implementation, the adoption of arabica coffee good agricultural practices, and the promotion of income-generating activities. It also aims to disseminate Improved Cookstoves (ICSs) among the coffee farmers' households (HHs).

SalvaTerra and its Kenyan partner, Dr. James Kinyua Gitau (bioenergy researcher currently consulting with World Agroforestry - ICRAF), have been hired to conduct a feasibility study for the dissemination of ICSs among these coffee producers' HHs. Dr. Mary Njenga (Bioenergy research scientist at ICRAF) also supported in the writing of this report.

The steps of the feasibility study can be summarised as follows:

- **Preparation:** To understand the baseline situation on wood fuels, cooking devices, and cooking habits, at the national and local levels, in order to identify three promising ICSs to be tested;
- **Fieldwork:** To propose and test three different ICSs for local HHs and assess their performance and the satisfaction of the users;
- **Recommendations:** To provide recommendations to PUR Projet, in order to disseminate the promising ICSs and to coordinate this activity with the agroforestry ones.

This report presents the results of the first step, the market assessment of ICSs at the national and local levels, as well as a summary of the consumer survey on fuels, cooking devices, and cooking habits. The cross-analysis of these studies leads to the recommendation of three ICSs to be tested.

1.2. Methodology

Literature review: A literature survey was conducted that mainly focused on the ICS sector in Kenya and in the project area (Western Kenya, Kericho County). A long list of ICSs promoted in Kenya has been established, then narrowed down by targeting ICSs successfully disseminated, preferably in rural areas.

Local market survey: ICS producers operating in the project area were subject to semi-directive interviews in order to understand their business structure and the nature of their products, the target market, and to estimate their production volumes.

Baseline survey: The HH surveys were conducted in 21 HHs among Cherara cooperative's members in Kericho County. Currently numbering 747, the members of the cooperative have been preliminarily sorted by village and type. Members of the cooperative are schools, groups, churches, Savings and Credit Cooperative Organisation (SACCOs) that have been excluded from sampling list. Sampled HHs, shown in the figure 1, were randomly selected from the list of 676 members equitably distributed among the three villages targeted by the project. The questionnaire is inserted in Annex 1, and its detailed results are inserted in Annex 2.

S/N	Village	Nb of members of the cooperative	Surveyed HH
1	Mugut	286	7
2	Cherara	171	7
3	Kipsumei	219	7

Figure 1: List of villages targeted for the HH survey (*Authors, 2020*)

The survey tool was uploaded on tablet-based Kobo toolbox survey platform for an easy and fast data collection process.

2. Overview of past initiatives: national level

The analysis under this Part 2 are mostly based on the own experience and knowledge of the national expert, Dr. James Kinyua Gitau and Dr. Mary Njenga, as well as the following reports: Anderson, 2017[1]; Ministry of Energy of the Republic

[1] Anderson, 2017. Classification of stove technologies and fuels. 4p.

of Kenya, 2019[2]; Gold Standard, 2020[3]; Global Alliance for Clean Cookstoves (GACC), 2014 & 2020[4]; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 2019[5]; Global Village Energy Partnership (GVEP), 2015[6]; *Stichting Nederlandse Vrijwilligers* (SNV), 2016[7];

2.1. Available ICS on the market for rural users

Three types of traditional cookstoves are currently in use in Kenya:

Three Stones Open Fire (TSOF)	Mud Stove	Metallic Charcoal Stove
Users: Rural	Users: Urban/rural	Users: Urban
		

Figure 2: Three types of traditional cookstoves in use in Kenya (*Authors, 2020*)

With ICSs technologies being promoted for over 30 years, Kenya is a leader within sub-Saharan Africa in developing and distributing clean cookstoves. ICSs promotion has been integrated in the National Energy strategy, planning to "*Develop and distribute 4 million improved biomass stoves by 2022*" (Ministry of Energy, 2018)[8]. The country has adopted the ISO 19867-1:2018 standards for testing the performance, emissions, safety and durability of the stoves for quality assurance. Transition to ICSs in the country is also aligned to the Nationally Determined Contributions (NDCs) towards the Paris Agreement on climate change mitigation such as 50% of households using fuelwood shifting to ICSs, efficiency improved by 10% from the reference by 2030 as well as reduced deaths associated to smoke in the kitchen.

There are approximately 130 producers in Kenya and 4 000 entrepreneurs that distribute ICSs throughout the country. A large part of the ICS market is still informal, and the quality of stoves available is uneven. According to GIZ census (GIZ, 2019), 90% of producers are small-scale stove artisans who produce less than 100 stoves per month. Over the 28 large scale producers such as Burn Manufacturing, the Paradigm Project, and Envirofit. ICS sales are registering a modest growth of 5% per year, and demands remain concentrated in limited geographic areas mainly in urban areas. A study at national level by the Kenya Climate Innovation Center (KCIC, 2016)[9] shows that Kenyan Ceramic Jiko (KCJ), one of the first improved charcoal cookstoves introduced in the 90's is still the most used in urban areas countrywide, mainly because it is easily available and locally manufactured. Most of the informal ICSs production is done in Kisumu County and Muranga County, western and central Kenya respectively, where clay is readily available (STEVENS et al., 2019)[10].

The following stoves have been selected in the long list of ICSs to be assessed, regarding their target users (peri-urban and rural areas) and type of fuel used (biomass stoves).

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[2] Ministry of Energy of the Republic of Kenya, 2019. Kenya household cooking sector study, 176p.

[3] Gold Standard, 2020. *BURN Jikokoa Project: Verification Report.* 39p.

[4] Clean Cooking Alliance, 2014. *Clean cookstoves and fuels: A Catalog of Carbon Offset Projects and Advisory Service Providers. 2nd Edition.* 84p. & http://catalog.cleancookstoves.org

[5] GIZ, 2019. *Climate Friendly Cooking in Kenya and Senegal: Environmental and social assessment.* 83p.

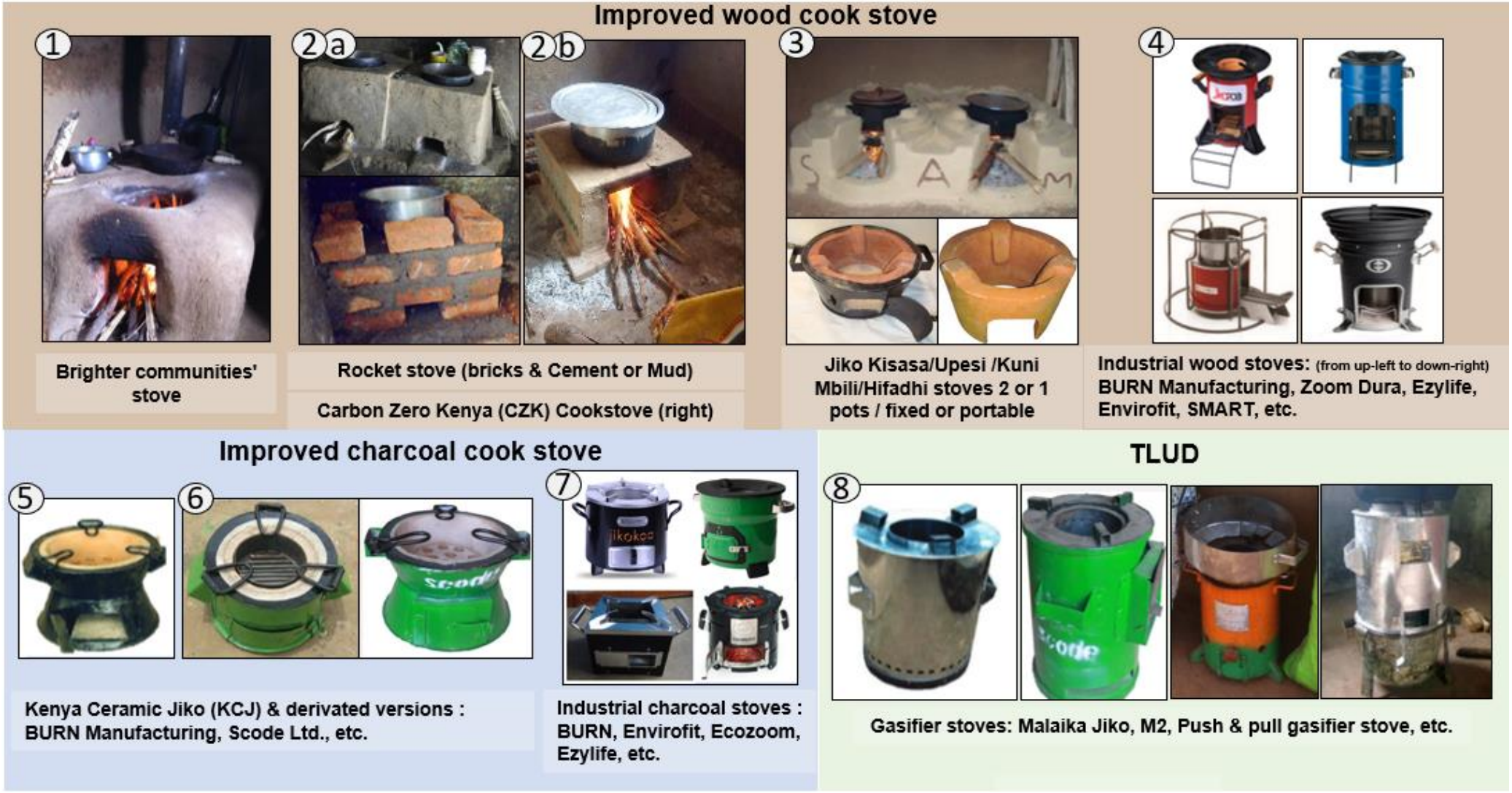
[6] GVEP, 2015. Spark Fund- Improving the performance of locally manufactured biomass cook stoves in Kenya. 70p.

[7] SNV, 2016. *Final Project Report: Fuel and Efficient Cook stove and Adoption Project*. 16p.

[8] Ministry of Energy of the Republic of Kenya, 2018. *National Energy Policy*. 103p.

[9] KCIC, 2016. *Sector Mapping and Market Assessment on the Improved Cookstoves (ICS) Sector in Kenya.* 58p.

[10] STEVENS et al, 2019. *Market mapping for improved cookstoves: barriers and opportunities in East Africa.* 16p.



NB: Top-Lit UpDraft (TLUD) also known as Advanced ICSs is a wood burning stove which has a high thermal efficiency due to the combustion of gases from pyrolysis, thus reducing indoor air pollution. They run on biomass (wood, corn husks, cow dung, coffee husks, dried bio mass briquette, etc.).

Figure 3: ICSs available on the Kenyan market *(Authors, 2020)*

#	Stove type	Manufacturer	Cost range*	Average lifespan	Key features	Area of dissemination	Projects/ organisations	Introduction date
1	**Brighter Communities stove**	Bricks, clay/soil mortar or cement & sand, sawdust	5,000 KES 40 €	Depending on raw materials	locally manufactured	Kericho County, Londiadi & Kipkelion sub-counties	Promoted by Friends of Londiadi / Brighter communities	2009
2a	**Fixed Rocket stove (brick, cement / mud)**	Mud Brick, cement	mud stoves: 600-2,000KES / 5-16 € brick/ cement: 1,300-12,500 KES 10-100 € [Scode Ltd.]: 20,000 KES 155 €	7 years	Locally manufactured Scode Ltd.	Country wide (Nairobi region, Mt. Kenya region, South Rift region, North Rift region and West Kenya region) Targetting fuel-scarce, highly populated rural districts	Developed by GIZ, promoted by EnDev Promoted by Fastenopfer in the project "Improved Jikos: Better living for Rural populations"	2006 - 2009
2b	**Carbon Zero Kenya Cookstove**	inner ceramic liner surrounded by extruded clay components and mortar	-	7 years	Mombasa manufacture	Central, Northern, Western Kenya	Promoted in all CO2balance projects e.g. the "Isiolo Cookstoves project"	2010
3	**Jiko Kisasa/Upesi /Kuni Mbili/Hifadhi stoves 2 or 1 pots / fixed or portable**	Ceramic liners and grids surrounded by metal casing (optional)	(for basic liners) 270 – 1,300 KES 2 - 10 €	2- 5 years	Locally manufactured - Keyo Pottery Group	Countrywide [Hifadhi: Central region (Thanaka Withi County)]	- "Mogotio ICS project", CO2 balance - WorldVision Intermediate Technology Development Group (now Practical Action), Ministry of Energy and Agriculture and GIZ - My Climate Foundation, "Stoves for life project" - Hifadhi stove: Livelihoods ICSs (Livelihoods Fund, EcoAct, Climate Pal)	1995

4	**Industrial wood stoves: BURN Kuniokoa Zoom Dura Jiko Smart Wood, etc.**	Metal	1,600 - 450,000 KES 13 - 100 €	4 - 5 years	BURN Manufacturing Zoom SMART Envirofit Ezylife (raw material from China, locally assembled), etc.	Countrywide (mainly urban and peri-urban areas)	"The Kenya Off-Grid Solar Access Project (KOSAP)" (WB) GIVEWATTS project Burn project The Paradigm Project « Flamingo cookstove project » etc.	2000's
5	**Kenya Ceramic Jiko (KCJ)**	Metal cover, ceramic liner	550-700 KES 4-6 €	3 years	Locally manufactured,	Countrywide (urban/peri-urban)	Promoted in all CP EU Energy Facility cookstove projects in Kenya	80's
6	**KCJ derivated versions**	Metal cover, ceramic liner	1,400 – 1,600 KES 11 – 13 €	4 years	SCODE Ltd. BURN Manufacturing	Countrywide (urban/peri-urban)	"The Kenya Off-Grid Solar Access Project (KOSAP)" (WB)	2000's
7	**Industrial charcoal stoves: Jiko Bora, BURN Jikokoa Metalrax HH Charcoal**	Metal	2,800-10,500 KES 22-80 €	2 - 3 years	BURN Manufacturing Zoom SMART Envirofit Ezylife(raw material from China, locally assembled), etc.	Countrywide (urban/peri-urban)		2010's
8	**Gasifier stoves: Malaika Jiko, M2, Push & pull gasifier stove, African Clean Energy etc.**	Metal	4,000 – 9,000 KES 32 – 75 €	5 years	Wisdom Innovations SCODE Ltd. MiniMoto Holding	Countrywide (urban/peri-urban	"On-farm biochar production and use project" by SIDA	2010's

***costs cover material costs only, exchange rate used 1 KES = 0,0079 Euro*

Figure 4: Long list of ICSs considered in the study (Authors, 2020)

2.2. Recent and ongoing initiatives in the Cookstove Sector in Kenya

2.2.1. ICS initiatives at national level

At the national level, there are a number of existing and planned initiatives to stimulate the cookstove sector in Kenya.

On-going	**"Stoves for life: Energy Efficient Cook Stoves Project",** My Climate Foundation (2016-2024) (My Climate foundation, 2019)[11] (Gold Standard, 2017a)[12] The project involves introducing locally made, fuel efficient Upesi cooking stoves (ICS n°3 in section 2.1) to around 90,000 households in forest adjacent communities around Kakamega Forest in Western Kenya over the next 7 years. The Kakamega Environmental Education Programme (KEEP) and Eco2librium will work with local women's groups to build their capacity to make the stoves. KEEP and Eco2librium will also assist stove making groups to market, distribute, and install the stoves in households which includes training of women in homes in their use and care.
	"Kenya Improved Cookstoves project", Natural Capital partners (2013-2020) (Natural Capital Partners, 2019)[13]: The project aims at building sustainable supply chains for the provision of efficient cooking products by distributing ICSs and strengthening distribution networks from manufacturers to sellers. By April 2016, 251,000 ICSs had been sold: 150,000 locally manufactured and imported HH and institutional wood and charcoal ICSs directly to end consumers through "EzyLife" activities; 101,000 ICSs through third-party distributors (ICS n°7 in section 2.1).
	"International Programme for Safe Water Access and Efficient Cookstoves" CO2balance UK Ltd. (2019-2039) (Gold Standard, 2017b)[14]: This project involves the distribution of improved cook stoves and safe water technologies across several countries. Although no information is yet available on the type of stove selected, the technology distributed will be locally manufactured.
	"Hifadhi II - Improved cookstoves in Tharaka Nithi County" funded by the Livelihood Fund, in partnership with EcoAct and its subsidiary Climate Pal, (2019-2029) (UNFCCC, 2020)[15] (EcoAct, 2020)[16]: This project follows a first phase which had achieved the distribution of 60,000 "Hifadhi stoves" (ICS n°3 in section 2.1) to 300,000 beneficiaries and the training of 30 local artisans. The objective of the second phase is to keep on manufacturing and distributing ICSs.
	"The Kenya Off-Grid Solar Access Project (KOSAP)" [17](2018-2023) financed by the World Bank (WB) and jointly implemented by the Ministry of Energy, Kenya Power and Lighting Company (KPLC) and Rural Electrification and Renewable Energy Corporation (REREC). It aims to increase access to modern energy services (electrification) in 14 underserved Counties in the North of the country, and to facilitate the provision of 150,000 ICS in West Pokot, Turkana, Marsabit, Samburu and Isiolo (ICS n°4, 7, 8 in section 2.1: African Clean Energy cookstove (ACE), Biolite home stove, Ecozoom Zoom Dura, Burn Kuni Okoa, Envirofit Super Saver Wood, Prime stove, EcoSmart stove Charcoal, Jiko Kisasa Multipurpose, Ecozoom Jiko fresh, Burn Jikokoa, Envirofit Super Saver Charcoal)
	"BURN Stove Project" BURN Manufacturing Ltd. (2010-2017/2017-2024) (Gold Standard, 2020): This project follows a first phase, it still aims to promote and sell improved Jikokoa stove to HHs in urban areas countrywide ((ICS n°4 & 7 in section 2.1).

[11] My Climate Foundation, 2019. *Less Deforestation of the Rainforest due to Efficient Cook Stoves*. 3p.

[12] Gold Standard, 2017. *Stove for life project: Monitoring report.* 36p

[13] Natural Capital Partners, 2019. *The Kenya Improved Cookstoves project.* 4p

[14] Gold Standard, 2017. *International Programme for Safe Water Access and Efficient Cookstoves PoA-DD. 19p.*

[15] UNFCCC, 2020. Hifadhi-Livelihoods Improved cookstoves in Tharaka Nithi County Validation report form fro CDM project activities. 63p.

[16] EcoAct, 2019. Hifadhi -*Livelihoods: Fiche projet*. 4p.

[17] https://kosap-fm.org/

	"Wema & Mogotio Improved cookstoves project" implemented by World Vision (2014-2021): This project seeks to remove market barriers to the adoption of sustainable energy technologies by households in Mogotio through the promotion of fuel-efficient cook stoves (Kuni Mbili stove i.e. (ICS n°3 in section 2.1)) using established micro finance institutions.
	"Oserian Flower Farm Offset Project 4 – Ngondi" South Pole Carbon Asset Management Ltd. (2013-2023) (Gold Standard, 2015b)[18]: the project objective is to distribute about 1,986 fuelwood ICSs in Kenya, particularly to the Maasai HHs living in Ngondi. The project activity will replace traditional fuelwood TSOF stoves with Envirofit M5000 fuelwood cooking stoves (ICS n°4 in section 2.1).
	"Flamingo Cookstove Project" South Pole Carbon Asset Management Ltd. (2017-2024): The purpose of this project activity is to distribute approximately 2,400 fuel-efficient fuelwood cookstoves in the Kenya, particularly to employees of Flamingo Horticulture Ltd. in the Mt. Kenya farms and members of communities neighbouring the farms. The project activity will replace traditional three stone fires or conventional stoves without grate or chimney with Zoom Dura fuelwood cook stoves (ICS n°4 in section 2.1).
	"Isiolo Cookstoves project" CO2balance UK Ltd. (2013-2020): The project involves the distribution of domestic fuel-efficient Carbon Zero Kenya (CZK) cook stoves (ICS n°2b in section 2.1) to HHs within Isiolo County in the Eastern Province, Kenya.
	"Improved Jikos: Better living for Rural populations" Fastenopfer (2014-2020) (UNFCCC, 2015)[19]: The project's purpose is to promote and disseminate energy efficient, clean and affordable cooking technologies among HHs in rural communities in central and south Kenya. Rocket stoves were disseminated in Central Kenya (ICS n°2a in section 2.1)
	"On-farm biochar production and use project" (GITAU et al. 2019; SUNDBERG et al. 2020)[20] funded by SIDA and implemented by ICRAF, The International Institute of Tropical Agriculture (IITA), Lund University, Swedish University of Agricultural Sciences (SLU) y and the KTH Royal Institute of Technology in Stockholm (2013-2020): through this research project, 150 biochar producing gasifier cookstoves (ICS n°8 in section 2.1) were distributed to farmer at Embu, Kwale and Siaya (50 stoves per site).
	Mimi moto pellet cookstove and Burn pilot study, a collaborative study between SEI, Burn Manufacturing in Kenya and Mimi-Moto company based in Netherlands but implemented by SEI. Mimi- Moto stoves (forced air gasifier pellet stove) were issued to 30 HHs at Gachie a peri-urban area within Nairobi County (LAMBE et al. 2020)[21] The stove contains an integrated fan powered by an inbuilt battery pack or a separate solar panel for operations in off-grid areas. It uses biomass which is processed into pellets or unprocessed macadamia shells.
	"Promotion of Climate-Friendly Cooking in Kenya and Senegal" funded by the Green Climate fund and implemented by GIZ (2019-2025) (GIZ, 2019): This project aims to accelerate the growth of ICS markets in Kenya and Senegal and significantly increase the level and quality of ICS production and sales, particularly in remote rural areas. The intended outcome is to triple annual ICS production and sales by project end, and to achieve a six-fold increase by 2030, thereby supporting Kenya and Senegal to reach their stated NDC targets (ICS n°2a in section 2.1).
Past	**"Capital Access for Renewable Energy Enterprises – II (CARE II)"**, funded by the Swedish International Development Cooperation Agency (SIDA) and Spark Fund (2013-2014) (GVEP, 2015): In Kenya, the project's goal is ICS (ICS n°4 in section 2.1) and Briquette production to increase the quality and uptake of locally made domestic biomass stoves and biomass briquettes

[18] Gold Standard, 2015. *Activity design document-Oserei flower farm offset project- Ngondi.* 42p.

[19] UNFCCC, 2015. *Better living for rural population- Project Design Document form*. 43p.

[20] SUNDBERG et al. 2020. *Biochar from cookstoves reduces greenhouse gas emissions from smallholder farms in Africa. Mitigation and Adaptation Strategies for Global Change.*

[21] LAMBE et al. 2020. *Opening the black pot: a service design-driven approach to understanding the use of cleaner cookstoves in peri-urban Kenya*. 13p.

	through capacity building, marketing and distribution and scaling up production for high potential local producers.
	"Msambweni Improved Cook Stoves" CO2balance UK Ltd. (2011-2018) (Gold Standard, 2015)[22]: This project, as the ones developed in Meru, Aberdares Range and West Kisumu areas (2012-2019), have distributed over 83.000 CZK cookstoves (ICS n°2b in section 2.1) in rural communities.
	"The Paradigm Healthy Cookstoves and Water Treatment Project" The Paradigme Project, (2010-2017): The project uses carbon finance to develop local market channels and to support non-governmental organisations (NGOs) as they create sustainable distribution networks of locally appropriate efficient stoves, as well as HH (JikoPoa and Envirofit stoves, before launching Ezylife i.e. ICS n°4 in section 2.1)) and institutional ICSs distribution.
	"**The Energizing Development Partnership Programme**" (EnDev) is implemented by GIZ and SNV in Kenya, with a multidonors funding (Germany, Sweden, Switzerland, United Kingdom, Norway, the Netherlands) (2005-2009/2009-2019). It gives permanent access to modern energy technologies and energy services to HH, social institutions, etc. The projects take place in 24 countries in Africa, Latin America and Asia. EnDev also supports the private sector and enhances demand through raising customers and public institutions awareness. In Kenya, it provided rocket style stoves ((ICS n°2a in section 2.1).
	"Clean Cooking-Fuel and Efficient Cook Stove Adoption in Kenya" (2013-2016) Implemented by SNV, the project aims to give access to and use of clean and efficient gasifier stoves and fuel pellets in the urban and peri-urban market and eventually improve the livelihoods of estimated 15,000 people in poor urban and peri–urban areas.

Figure 5: Existing and past ICSs initiatives in Kenya (Authors, 2020)

2.2.2. ICS initiatives at regional/district level

At the regional / district level, there are a few programs and initiatives for ICSs' promotion:

2009 - ongoing	**"Harambee - The smokeless stoves programme"** is a project implemented by the NGO Friends of Londiani and Kipkelion (FOLK) in Londiani and Kipkelion, sub-counties part of Kericho County that introduced a new fuel-efficient stove and installed HH and institutional stoves with chimney (ICS n°1 in section 2.1) (more than 400 stoves have been installed) (FOLK, 2016)[23]. Installers are trained and a system of "smokeless stove loan" through a community-developed fund have been implemented to facilitate stoves adoption.
2019 - ongoing	**"West region project: 1000 Solar Lamps, 1000 Clean Stoves"** funded by Jochnick Foundation (Sweden), GIVEWATTS plans to distribute 1000 charcoal and woodfuel ICSs in Kericho County ((ICS n°4 in section 2.1: Burn, Envirofit and Ecozoom branded).
2014	**"West Kisumu Women's Cookstove Project"** funded by Australian Aid**:** This project implemented by CO2balance took place in the neighbouring district of Kisumu (100 km from Kericho town). It aimed at training a women's group in manufacturing CZK stove (ICS n°2b in section 2.1).

Figure 6: Existing and past ICSs' initiatives in Kericho County area (Authors, 2020)

NB: **The ICSs presented in 2.1 that were not mentioned in 2.2.1 and 2.2.2 are still available on the market but are no longer the subject of particular programs or initiatives (distributed by the private sector only).**

[22] Gold Standard, 2015. *Msambweni ICSs: Project Design Document.* 34p.

[23] Friends of Londiani, 2016. *Harambee project report*. 9p.

2.2.3. Lessons learned

The Stockholm Environment Institute (SEI, 2016)[24] identifies several key success factors for ICSs initiatives : i) stove quality and features (efficiency, reduced emissions, design that meets the diverse needs of users, accessibility, ease of use); ii) finance for both end-users and stove enterprises; iii) an enabling policy and regulatory environment including the establishment of standards for cookstoves; iv) and a strictly commercial approach (and not only distribution of ICSs).

ESMAP (ESMAP, 2019)[25] also emphasises the importance of offering innovative and appropriate financing and promotion through community savings and loans organizations/local financial institutions to limit the economic barriers due to the adoption of ICSs by rural HHs. Other studies show the importance of how well the stoves meet the user's needs and fit into the cooking culture including labour requirement for fuel preparation (GITAU et al., 2019)[26].

The World Health Organization (WHO, 2018)[27] completes these analyses by recommending a differentiation of financial mechanisms according to the distribution of the working population in urban and rural areas: "*market-based interventions might be targeted to urban areas and subsidized or non-governmental organization interventions to rural areas. Cross-subsidies could offset the costs of transport and distribution in poor rural communities in remote areas*".

Concretely, various mechanisms are developed within the projects with a number of local partners, including a variety of formal microfinance institutions (MFIs), etc. aimed at manufacturers as well as end-users. For example, the Kenya ICSs project works with a local MFI and NGO to support small businesses and HHs, and offers direct consumer financing programmes, such as extending payment terms, which allows the project to penetrate even lower income groups that may not have access to the MFI.

Regarding the stove technologies themselves, the CARE II Kenya project (GVEP, 2015) confirms the importance of the design and delivery systems to the end-user, recommending that ICS should not be selected on engineering principles and laboratory experiments only, but should endeavour to improve the local technologies that are already known and accepted among local communities. Moreover, it is noted that the involvement of target groups that will be producing, promoting and using the stoves is a key input for success. STEVENS et al. (2019) note that in several cases, stoves given free of charge were left unused because the designs do not fit with local cooking practices (e.g. the pot rests or the openings to insert fuel were too small).

Based on an integrated approach to household energy issues, key learning from EnDev Project (GIZ, 2013)[28] were:

i) to mobilise the public sector in order to create a favourable business environment by developing supportive policies, enforcing standards development, and make adoption funds available over a limited period of time to raise awareness;

ii) to establish long term partnerships with already implanted companies/stakeholders from the private sector in order to ensure supply (helping them access legal status, capacity building both administrative and technical to keep enterprises in business and ensure growth, facilitating access to financial support on the long term);

iii) to work on the demand side by ensuring the sustainability, quality and functionality of ICSs, raising public awareness and establishing long term partnership with other stakeholders to build a functioning market system since consumer subsidies hasn't been effective.

In addition to the points developed above, the experience gained from all the projects carried out by the CP-EU Energy Facility (DEM, 2019)[29] highlights the success of initiatives that have focused on one technology only, biomass cookstoves. It has proven to be successful in reaching a large target group with high rates of adoption. Moreover, sustained feedback between cookstoves developers and the end-users is also mentioned as a factor of successful up-take of new technologies.

3. ICS local market

Only one stove manufacturer is active in the project area:

[24] SEI, 2016. *Policy brief Bringing clean, safe, affordable cooking energy to Kenyan households an agenda for action*. 6p.

[25] ESMAP, 2019. *KENYA Beyond Connections - Access to electricity and clean cooking in Kenya based on the Multitier Framework survey and data analysis*. 111p.

[26] GITAU et al. 2019. *Factors influencing the adoption of biochar-producing gasifier cookstoves by households in rural Kenya*. 9p.

[27] WHO, 2018. *Opportunities for transition to clean household energy in Kenya*. 60p.

[28] GIZ, 2013. *Catalysing Rural Energy Access - Kenyan experience*. 13p.

[29] DEM, 2019. *Best practices for promoting Improved cook stoves in the ACP Region*. 20p.

Ms. Jane C., 41, started her activity in early 2019, but is not yet registered with the authorities. She is based in Kipsumei, and does not work in a permanent structure as she travels directly to her customers' houses to build the ICS (ICS n°1 in section 2.1). She currently builds the ICSs alone.

She was trained in the manufacture of ICSs by a local NGO called "Friends of Londiani", based in the neighbouring sub-district on Londiani actually supported by the Irish NGO "Brighter communities". Since 2009, they have been disseminating ICSs in the district through the "Harambee project" (cf. section 2.2.2).

She built her enterprise on her own savings, but also has access to credit facilities through loans contracted from table banking (women groups), but repayment period is short, one month, and interests' rates are quite high (10% per month).

So far, orders are uneven: she installed 3 ICSs last month, 15 since the beginning of the year. The stove she sells is made of clay, bricks, cement/sand and sawdust with a stainless-steel chimney. She pays 1,950 Kenyan shillings (KES) for raw materials that come from hardware shops. Clay is from specific local farms while sawdust is from customer's farms. She orders the chimney from a wielding workshop in Londiani (32 km away from Kipsumei). The purchase of the chimney is the biggest part of the raw materials budget (1,000 KES per piece).

Transportation costs and availability of materials are an issue since she buys materials according to orders, in small quantities. Those transportations limitations imply she only targets customers in her immediate community. She wishes to buy raw materials in bulk in the future, so she can reduce her costs and therefore reduce stoves' price, but does not have a storage facility to do so. The final price for one ICS is 4950 KES (39 euros), including 3,000 KES for labour. However, she pointed out that when having more than one order at a go, the price goes down since the transportation cost is shared among the customers.

She deplores the low awareness about benefits of using ICS among the population, and also notes that very few HHs can afford an ICS, despite increasing deforestation and reducing fuelwood availability in the area she observes.

4. Consumers' habits

4.1. Respondents profiles

The results presented below are mainly based on the questionnaire administered to 21 HHs part of Cherara Cooperative.

It is worth noting a Poverty Probability Index (PPI)[30] analysis has been included in the questionnaire to determine the poverty likelihoods and to extrapolate on the willingness to pay of these HHs, regarding ICSs (in case these are partly subsidised).

95% of respondents were women, either HH head or spouse to the HH head. Respondents were aged between 22 and 72 years old and were either directly involved in cooking activities or making decisions on acquiring HH fuels and cooking technologies. HH size varies from 2 to 9 members, with an average size of 6 persons per HH. 35% of the interviewed HHs live under the national poverty line of Kenya (based on the 2015 Kenya National Poverty Lines equivalent to 133.61 KES per adult equivalent per day) (PPI, 2015)[31].

4.2. Cooking practices

All HHs cook in the same cooking area all year long. 15% of the respondents cook in an indoor poorly ventilated cooking area which is also the sleeping area. Other HH surveyed cook in outdoor sheltered kitchens, well ventilated. In the majority of cases, a space is left between the walls and the roof for ventilation purposes.

Respondents use a wide variety of pans, both in term of diameter (from 16 cm to 31 cm) and bottom shapes (with a majority of HHs using a mix of flat and curved bottom shaped pans). In spite of this great diversity, the most commonly used saucepan is made of metal.

All respondents use their stove to stir fry, slow cook and roast food (meat, maize when it is the season, etc.). Only one respondent was using the stove to smoke fish. Stoves are also used to boil water for drinking and dry seeds like maize or beans by a majority of respondents.

All respondents cook three times a day for an average of three hours in total on the same stove (except for one respondent who uses two stoves). In 66% of HHs, families drink tea for breakfast, which takes approximately half an hour to prepare. Lunch and dinner are the longest meals to prepare, taking in average one hour and one and a half hour respectively. The main dishes consumed at mealtimes are Ugali (maize flour boiled in water and agglomerated into a

[30] https://www.povertyindex.org/

[31] PPI, 2015. *Kenya 2015 PPI - User Guide*. 37p.

ball) and vegetables, or rice accompanied by beans. Most of these dishes are simmered or cooked for quite some time, thus requiring a constant heat supply.

ICS requirements:

- ➔ **Ability to generate both high intensity heat to boil water and fry and low intensity heat for slow cook;**
- ➔ **Good stability to cook dishes that require vigorous stirring like Ugali;**
- ➔ **Adaptability to a variety of utensils used;**
- ➔ **Ability to last long with less requirement for maintenance-durability;**
- ➔ **Ability to use the locally available fuels.**

4.3. Stove usage

95% of respondents use mud stoves locally called "*Koitamaa*" (from "*Koita*" – stone and "*Maa*"-fire) that consist of three stones fixed by a mud mortar, inside a hole leaving one opening for putting fuelwood through and fire space for one or two pans. Those stoves are home-made and repaired by users from locally available materials such as mud, ash, and cow dung. In fact, most of them have been using their stoves for years and maintain them over time when they develop cracks as a result of the heat. Only two HHs use two cook stoves. One HH uses a fixed ICS made of cement, sand and a clay liner (no chimney) and a Koitamaa stove as back-up. After gathering the raw materials, HH members called on a manufacturer to install it for 500 KES (4 euros). The other HH has one Koitamaa stove and one TSOF, for when she needs to cook fast.

When asked about the main advantages/disadvantages of the Koitamaa stove, respondents declared that this stove model was easy to light, enabled a rapid cooking and was easily available because it is self-built from readily available materials, thus free of charge. On the other hand, a large majority of respondents agreed that smoke generation and high fuel consumption were an issue. They also mentioned frequent cracks needing repairs, exposure to heat and instability (cf. Annex 2).

ICS user enjoys the rapidity of cooking, fuel economy and aesthetics aspects of their ICS. She particularly appreciates that it retains heat for long time thanks to its clay liner and allows food to be cooked safely, limiting the risk of burns. However, she deplores the heavy smokes generated while cooking, the fact that it cannot be moved and that fire needs more tending than with traditional cook stoves.

In addition to being used for cooking, the fireplaces are also used to heat the space in 90% of cases, and two respondents mentioned using the stove in the production of local brew (locally known as *chang'aa*).

90% of respondents plan to change their stove, 66% on the short term (within 6 months), mainly because of the smoke generated and because of the wood scarcity. This shows the communities emphasises on the need for improved stove to have lower smoke emissions and fuel use. Lack of information on where to find good quality stoves is one of the barriers to the adoption of ICSs: "*I want to change to a stove which smokes less or have a chimney but don't know where to get one which is good and durable* "says Ms. Emily M. Another major issue is the lack of funds to change the stoves.

ICS requirements:

- ➔ **Ability to save fuel compared to traditional stoves;**
- ➔ **Less smoke emissions compared to traditional stoves and chimney;**
- ➔ **Equal or faster cooking time;**
- ➔ **More stable than traditional stoves;**
- ➔ **Durable and easy to fix stove.**

4.4. Fuel usage

All HH depend on fuelwood and crop residues (maize cobs and stalks) for cooking. About half of the HHs collect their main cooking fuel while the other half buy and collect fuel. In these cases, HHs collect more fuel than they buy. Wood is sold in bundles of 100 KES or in loads of 150 to 200 KES.

80% of the respondents collect their fuelwood from their farms which is less than 1 km from their homes. The average distance to fuelwood collection points covered by the rest of HHs is between 2 km and 5 km. A majority of respondents fetch fuelwood twice a week (67%) or up to three times a week (30%), only one respondent collecting once a week. Collecting fuelwood is mainly done by women and girls, who spend between two and nine hours a week (five hours a week on average). HHs use on average 41 kg of fuelwood per week, i.e. 7 kg/person/week equivalent to a daily

consumption per capita of 1 kg. This estimate agrees with results of a study in Embu County, a tea growing area in the Kenyan highlands (NJENGA et al., 2019)[32].

All respondents report collecting fuel on their own farm, some of them collecting supplements from friends/neighbours' land (20%) or from open bush / abandoned private farms (10%). Most of the women are concerned about the scarcity of fuelwood, and suffer from having to walk long distances to find dry wood. They experience pain in their legs and back, as well as injuries from using machetes or axes to prepare the wood. The risk of falling is particularly high during the rainy season, when it is difficult to walk over steep terrain. Many collectors report risks of attack by animals or humans during fuelwood collection, especially in the bushes. "*I walk for a long distance to collect fuelwood which is tiring. There is also a risk of being attacked by animals while collecting fuelwood from farms which have been left fallow and grown into bushes. One gets injured by the machete/axe used to prepare fuel"* explains a 29 years old respondent.

Crop residues are available right after the harvest on the HH's farm, two respondents value their neighbours' maize residues as well. They are collected right after harvest by women and girls, which does not take much extra time (two hours maximum).

ICS requirements:

- ➔ **ICS that runs on wood and other types of dried biomass locally available and accessible.**

4.5. Consumers' opinions and knowledge of ICSs

86% of the respondents were aware of ICSs, hearing from friends and relatives (44%), neighbours (50%), TV or radio commercials (12%), manufacturers (1 respondent) or women's group (1 respondent).

Although unable to cite a particular brand, they all mention the use of bricks, cement and sand as the basic materials for making an ICS, as well as a chimney to evacuate the smoke outside. When asked about ICS main advantages, respondents agree that ICSs are fuel saving (95%) and emit less smoke (86%). They also mention the rapidity of cooking (71%) and cleanliness of the kitchen and pots (58%). 28% of the respondent also highlighted the comfort of cooking over a higher stove, as well as the fewer burns. Some also value stability and durability of the stove. When asked about the most important advantage, priority is clearly given to smoke emissions and fuel use reduction.

Not being able to sit around the fire, the impossibility of cooking certain types of food (like roasted food), the incompatibility of the stoves to accommodate with big pots, and the need of maintenance were highlighted as disadvantages.

All respondents are willing to buy an ICS, on the conditions that the stove is good quality and provided with clear instructions on how to use it. While some respondents declared being ready to pay out up to 5,000 KES for a good quality ICS, 50% are willing to pay 100 to 500 KES. However, most HHs explain that this is an indicative price and that if proof is provided on the savings on fuel, time spent to cook or collect fuel, money spent on fuel and reduced exposure to smoke, they would be willing to put in more money.

ICS requirements:

- ➔ **Ability to save fuel compared to traditional stoves;**
- ➔ **Less smoke emissions compared to traditional stoves and chimney;**
- ➔ **Capacity of HHs to invest in a good quality ICS.**

4.6. Indoor air pollution awareness

90% of the respondents declared having suffered from ill-health or injury in the last 12 months, as a result of cooking operations with traditional stoves. For more than half of the respondents, both women and children, mainly girls, were affected. Symptoms are the same and include: recurrent headaches, persistent cough, burns, and eye irritations.

5. Recommendation: 3 ICSs to be tested

When selecting the ICSs to be tested, it is important to keep in mind that the objective is not to completely replace the use of traditional stoves but to cover the most common uses in order to minimise smoke emissions and maximise the efficient use of fuelwood. Most studies report a simultaneous use of traditional and improved cookstoves (SHANKAR and al., 2020)[33]. Moreover, to overcome the strong constraints in rural areas, Dalberg Global Development Advisors

[32] NJENGA et al., 2019. *Innovative biomass cooking approaches for sub-Saharan Africa.* 22p.

[33] SHANKAR et al., 2020. *Everybody stacks: Lessons from household energy case studies to inform design principles for clean energy transitions*. 9p

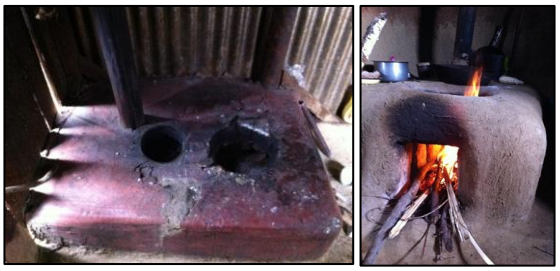
(2018) advocates encouraging and promoting the use of lower-cost options that meet the needs of rural HHs without the need to switch fuels.

By cross-referencing analyses of local and national markets and consumer habits, we first exclude the following ICSs mentioned in the long-list (see figure 4 in Part 2.1) for the following reasons:

- Charcoal/dual ICS: not readily available on the local market and does not meet HH needs since they rely mostly on fuelwood;
- TLUD: not readily available on the local market, complex use, have extra work of chopping wood into small pieces, and does not meet all the HH needs.

Second, we propose to test the following three ICSs:

5.1. Stove A: Brighter Communities

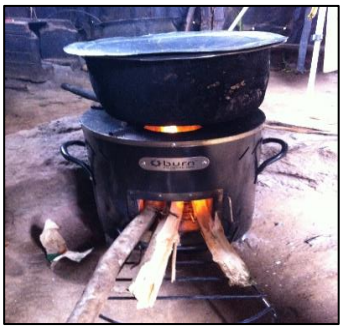


- Mud, bricks and clay stove;
- One inlet;
- One chimney;
- Two pots (one directly heated by the flame, the other by heat transmission);
- Estimated cost from local manufacturers: 5,000 KES/unit
- Locally available manufacturers (many trained by FOLK)

➔ Promoted by Brighter communities through FOLK since 2009

Figure 7: Brighter Communities ICS (ICS n°1 in section 2.1) (Kinyua Gitau, 2020)

5.2. Stove B: BURN Kuni Okoa



- Manufactured in Kenya by BURN Manufacturing
- One pot portable woodstove
- It reduces firewood consumption by a great margin compared to traditional three stone open fire
- Light weight
- Estimated cost from local retailers: 3,300 KES/unit
- Available within a week after order from BURN Office in Kericho County

➔ Promoted BURN Manufacturing, World Bank's "The Kenya Off-Grid Solar Access Project (KOSAP)", etc.

Figure 8: BURN Kuni Okoa (derivated from ICS n°5 in section 2.1) (Kinyua Gitau, 2020)

5.3. Stove C: Jiko fixed stove – 2 pots

- Clay liner fixed in mud mortar, two inlets, no chimney;
- Fits the local population uses (similar in appearance to the traditional stove);
- It addresses the issue of stability which was a concern for most of the HHs during the survey;
- Reported to use less fuel and smoke less (though data on how less is not available);
- Estimated cost from local manufacturers: 6,000 KES/unit (3000 KES for labour, and an estimated 3000 for the ceramic liner, to be confirmed).

➔ Promoted by GIZ

Figure 9: Jiko fixed stove – 2 pots (ICS n°3 in section 2.1) (GIZ)

Annexe 1. HH questionnaire

District/ Sub-country/ Village/ Name of the respondent/ Telephone number/ Age of the respondent/Gender/
How many people regularly live and eat in the household? Are all household members ages 6 to 12 currently in school? Can the (oldest) female head/spouse read and write with understanding in any language? What type of material is mainly used for construction of the walls? What type of material is mainly used for construction of the roof and dwellings? What type of toilet facility does the household mainly use? How many mobile phones do members of your household own? Does any member of your household own a radio? Does every member of the household have at least one pair of shoes?
Type of kitchen/ if Indoor, is the kitchen ventilated? Do you always cook in the same area? Most used pots: diameter/type/picture What do you use the stove for? How many times do you cook during the day? When cooking for BREAKFAST/LUNCH/DINNER, how many fires do you use simultaneously? When cooking BREAKFAST/LUNCH/DINNER, how long do you usually cook for? What are the 3 main dishes you cook on a daily basis?
How many stoves do you use on a daily basis? Type of stove/description/picture What is the condition of the stove? How did you acquire the stove? What are your main purchasing criteria? Since when did you start using this stove? What are the main advantages of the stove? What are the main disadvantages of the stove? When do you plan to change the stove? Are you going to buy/build the same model in the future? If not, which type of stove would you like to acquire?
What type of fuel did you use in the last 12 months? Estimated fuelwood/charcoal/crop residues/animal residues consumption per WEEK/MONTH How do you supply fuelwood/charcoal? If you COLLECT AND BUY fuelwood, how much is bought and how much is collected? Distance from house to point of collection for fuelwood How many times per week do you collect fuelwood? Where does the fuelwood collected come from? How long does it take to go from your house to the edge of the main fuelwood collection area and back, and to collect fuelwood, in hours? Who usually collects fuelwood in the household? What form is fuelwood sold in? What is the price you pay for one unit? Are there any challenges to collect woodfuel?

Do you know about improved cookstoves? If Yes, which type of stoves do you know?
Do you own an improved cookstove? If No, why don't you use one?
How did you first here about ICS?
What do you think are/would be the main AVDVANTAGES of ICS?
According to you, what is THE MOST IMPORTANT advantage (from the list above)?
What do you think are/would be the main DISADVANTAGES of ICS?
According to you, what is THE MOST IMPORTANT disadvantage (from the list above)?
How much would you be willing to pay for an ICS?
During the last 12 months, did any household member suffer from ill-health or injury as a result of fuelwood or charcoal burning?
Which were the symptoms?
Did you know indoor smokes/air pollution was dangerous for your health?
Did you do something to prevent it?

Annexe 2. Household survey data & graphs

"Koitamaa" mud stove			
Main advantages	**%**	**Main disadvantages**	%
Ease of ignition	**80%**	**Generates a lot of smoke**	**95%**
Rapid cooking	**70%**	**High fuel consumption**	**75%**
Home-made from locally available materials, free of charge	**30%**	**Needs frequent repairs**	**45%**
Fuel economy	25%	**Unstable**	**35%**
Possible to repair oneself	25%	**High heat exposure**	**30%**
Fuel does not need to be sized/chopped	20%	Cannot be moved	15%
Can use any type of fuel	15%	Dangerous for children	10%
Little smoke	5%	Fire needs tending	5%
It does not occupy much space	5%	Does not retain heat long after cooking	5%
		Hard to clean pans	5%
		Ash gets in the food	5%
		Extra work to dig for building the stove	5%
		High risks of injuries	5%

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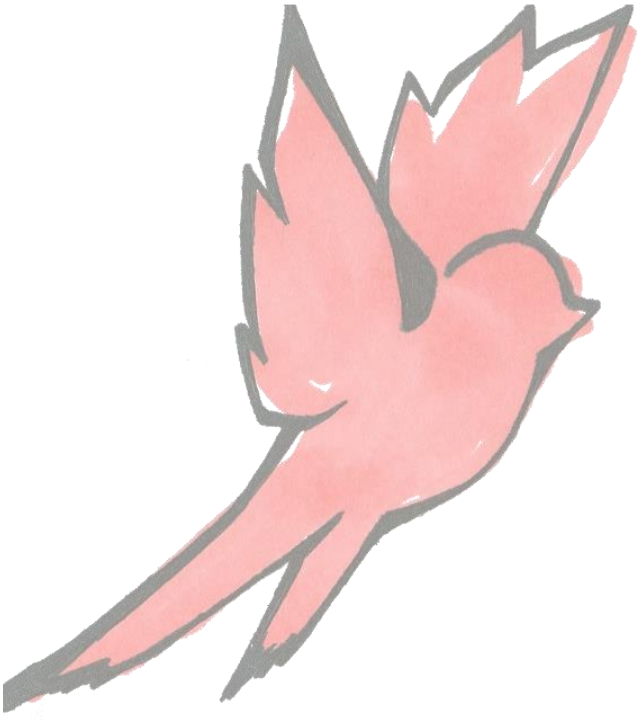

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