COOKING FUELS USED IN KENYAN HOUSEHOLDS

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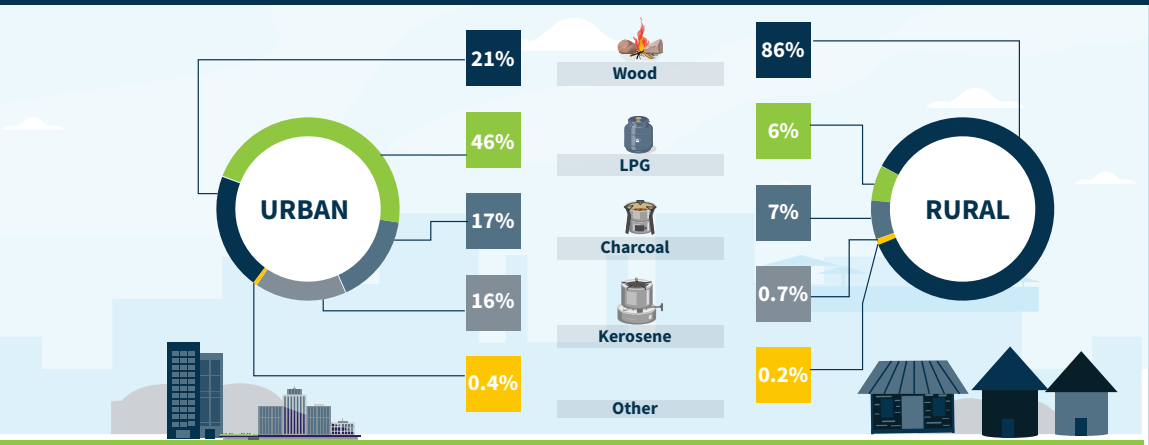
Primary Fuels Used by Households



The cooking patterns vary significantly in urban and rural areas with urban areas having higher penetration of Liquefied Petroleum Gas (LPG) and rural areas heavily reliant on woodfuel.

NATIONAL

75% of households in Kenya are using woodfuel (charcoal and firewood) which is a dirty fuel.

Cooking Fuel Stacking in Kenya

	Secondary stove → / Primary stove ↓	A No 2nd stove (%)	B LPG (%)	C Electric (%)	D Kerosene (%)	E Charcoal (%)	F Wood (%)	G Other (%)	Total (%)
1	LPG	6.6	1.3	0.3	2.2	6.5	2.0	0.1	19.00
2	Electric	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.20
3	Kerosene	3.3	0.2	0.0	0.0	1.9	0.2	0.0	5.60
4	Charcoal	4.9	2.0	0.0	1.1	0.3	2.0	0.0	10.30
5	Wood	34.5	5.4	0.0	0.8	22.9	1.1	0.0	64.70
6	Other	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.10
Total		49.40	9.00	0.30	4.10	31.60	5.40	0.10	99.90

PRIMARY FUEL

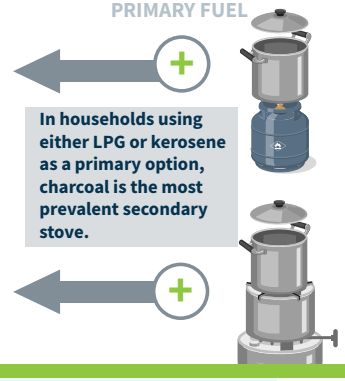
4.3 MILLION PEOPLE rely solely on wood for cooking.

Among those households that named a secondary option, the most common pairing is wood and charcoal.

SECONDARY FUEL

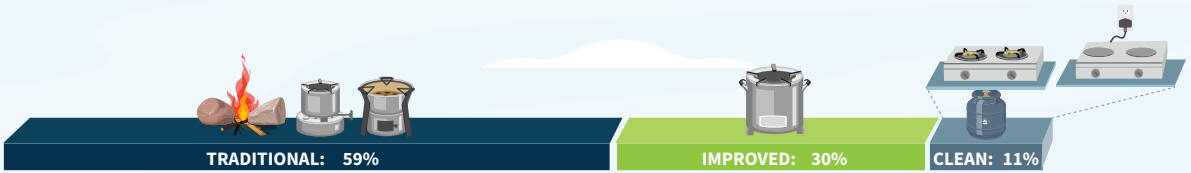
Charcoal still plays a major role in Kenya's household energy mix as a secondary fuel for a substantial fraction of the population in both rural and urban areas.

PRIMARY FUEL



In households using either LPG or kerosene as a primary option, charcoal is the most prevalent secondary stove.

Cooking Technologies in Kenya



Three Stone Fire, metallic charcoal stoves and kerosene wick stoves

Improved charcoal and wood stoves

LPG, biogas and electricity based cooking solutions

The Mobilising Investment for NDC Implementation (MI) programme is supported by the German Government's International Climate Initiative (IKI). In Kenya, the programme aims to accelerate public and private investment in clean cooking ; a priority sector in the realization of Nationally Determined Contributions (NDCs).

REFERENCE: Kenya Clean Cooking Sector Survey 2019

IMPACTS OF USING TRADITIONAL COOKING FUELS IN KENYAN HOUSEHOLDS

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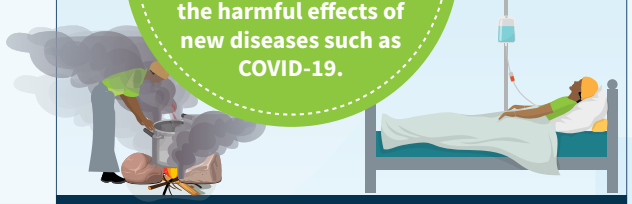
HEALTH:

Household air pollution (HAP) in Kenya causes more than **21,560 premature deaths** anually while leaving thousands of mostly women and children with respiratory diseases. Recent studies indicate that COVID-19 is more severe and has a higher mortality rate when associated with prolonged exposure to HAP.

Investing in clean cooking will reduce the disease burden arising from HAP and is a proactive way to mitigate the harmful effects of new diseases such as COVID-19.



ENVIRONMENT:

With **8.1 million** households using wood as a primary fuel, deforestation is rife. Deforestation is costing Kenya an annual loss of **10.3 million metric tonnes** of wood thereby exacerbating climate change impacts such as drought leading to food insecurity.

Clean cooking will contribute to the realization of Kenya's forest cover goals and improve food security.

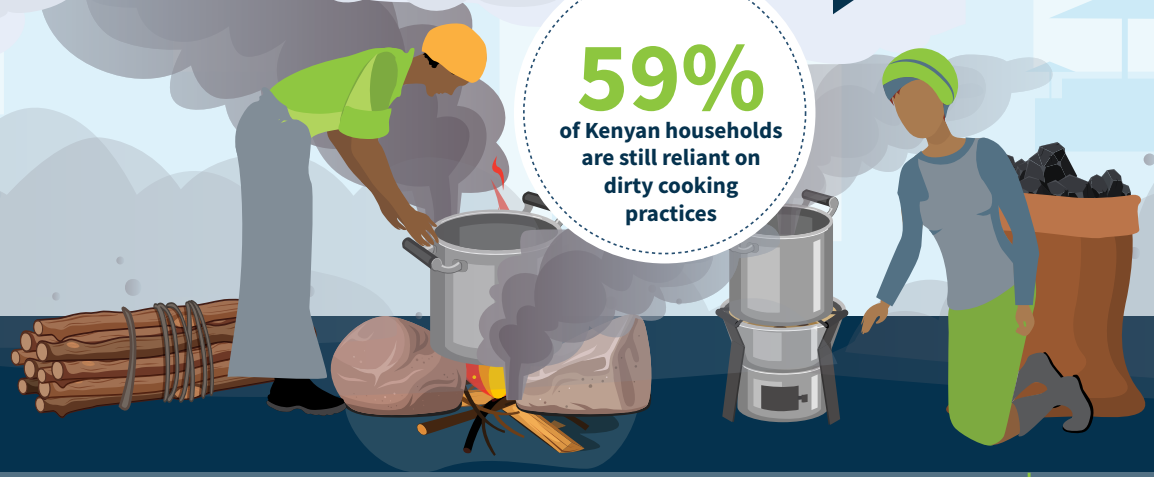
SOCIO-ECONOMIC:

The gendered nature of cooking has women and young girls spending more time sourcing firewood and losing out on productive use of time.

- Women and young children are more affected by HAP as they spend more time in food preparation areas.
- Kenya's productive labour force is affected by premature deaths related to HAP and the related public health burden.

Clean cooking will avert premature deaths while allowing women to take part in more socio-economic activities thereby contributing to the economy.

59%
of Kenyan households are still reliant on dirty cooking practices



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BARRIERS TOWARDS UPTAKE OF CLEAN COOKING IN KENYA

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What influences the choice of cooking fuels and technologies in Kenya?

Affordability

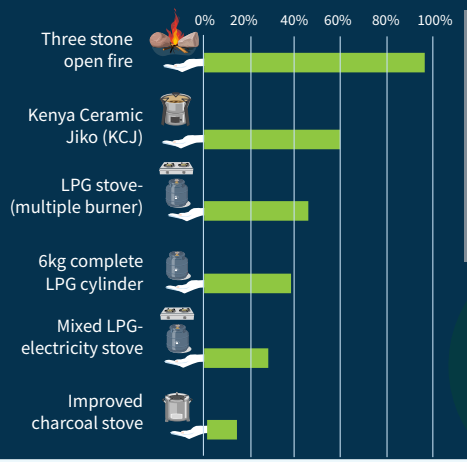
The price of the fuel and cookstoves are key factors influencing the uptake of improved cooking solutions.

Weekly average and median expenditure on cooking fuels (KES/Week)

	Urban		Rural		National	
Fuel	Median	Mean	Median	Mean	Median	Mean
Kerosene	200	245	105	142	200	211
Charcoal	200	270	200	229	200	246
Fuelwood	250	342	250	409	250	396
LPG	188	200	113	137	138	176

Note: Prices accounted for different energy content values of fuel and stoves' thermal efficiencies.

Proportion of respondents owning their most preferred stove



Purchased woodfuel, the cheapest fuel per kilo, is the most expensive in terms of energy delivered due to its low energy content and poor energy conversion efficiency.

Kerosene is the cheapest fuel in terms of energy delivered and most accessible fuel in terms of distance consumers must travel to acquire it. Despite these factors, more people use charcoal or LPG either as primary or secondary cooking options.

LPG is the costliest fuel on a mass basis and is marginally more expensive than kerosene charcoal and purchased woodfuel.

Factors limiting stove ownership

Fuel unavailable	Safety concerns	Other factors	Expensive fuel	Stove is unavailable
3.4%	5.4%	6.8%	6.9%	7.3%

The stove is expensive

70.1%

The cost of stoves is the leading factor limiting ownership of clean cooking technologies. Innovative financing models that can advance affordability of stoves are key in promoting clean cooking.

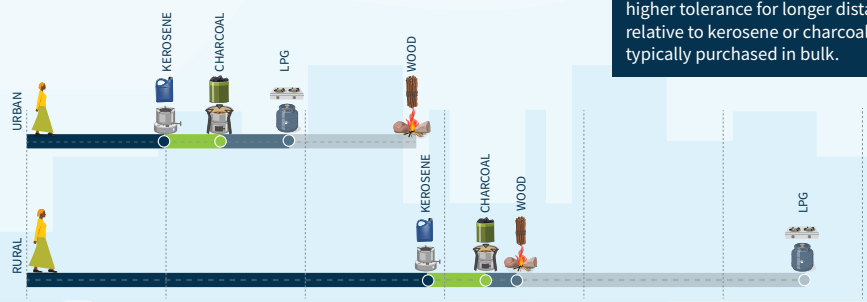
Accessibility

Are there adequate distribution channels for the fuels?

Kerosene is the most accessible commercial fuel source for both rural and urban households with well-developed distribution channels.

The well-developed kerosene distribution networks can offer learnings for upcoming clean cooking fuels such as bioethanol.

The average distance to a LPG purchase point is almost double the average distance to a kerosene outlet. LPG purchase is more infrequent as it is commonly sold in bulk quantities. This means that users could have a higher tolerance for longer distances for LPG relative to kerosene or charcoal which are not typically purchased in bulk.

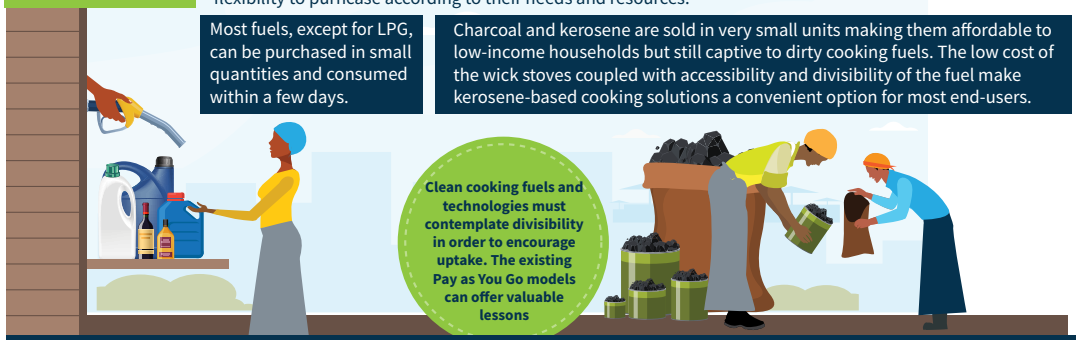


Divisibility

Ability to purchase small portions of the fuel makes it more affordable and gives the consumer flexibility to purhcase according to their needs and resources.

Most fuels, except for LPG, can be purchased in small quantities and consumed within a few days.

Charcoal and kerosene are sold in very small units making them affordable to low-income households but still captive to dirty cooking fuels. The low cost of the wick stoves coupled with accessibility and divisibility of the fuel make kerosene-based cooking solutions a convenient option for most end-users.



Acceptability

Is the design of the stove appropriate and acceptable to the consumer?

Some of the improved cookstoves are limited in terms of their design, specifically stability and diameter of the cooking space. Small diameters make it hard for large families who want to use bigger cooking pots. Some manufacturers have introduced new stove models to address these concerns.

Ease of stove operation addresses technological barriers. These includes factors such as ease of lighting the stove, ability to systematically regulate heat and fuel use, partial fuel refill and ability to detect fuel level. Cookstoves that address these factors are highly desired by end-users.

Charcoal cookstoves do not address most of these factors and this may explain why approximately 10 % of the population uses charcoal stoves as their primary stove. This may also explain why kerosene is still prevalent among households and LPG is the most desired cooking fuel.

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REFERENCE: Kenya Clean Cooking Sector Survey 2019

CLEAN COOKING: THE CASE FOR BIOETHANOL IN KENYA

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What is Ethanol Cooking Fuel (ECF)?

ECF is a liquid biofuel that can be produced from a variety of feedstocks including sugary materials such as sugar cane, molasses; starchy materials such as cassava, potatoes, or maize; or cellulosic material such as wood, grasses, and agricultural residues. ECF is denatured alcohol making it unfit for human consumption.

Benefits of ECF across the value chain

ECONOMIC IMPACT

Jobs:

Up to
370,000
jobs
(with the majority in feedstock production)

Income:

Up to
KES 51 BILLION
with additional income of up to KES 180,000 per year for smallholders

ENVIRONMENT IMPACT

Switching to ECF will reduce reliance on wood fuel and mitigate climate change impacts:

Deforestation will be averted:

Up to
54 MILLION
trees saved

Greenhouse gas emissions will be reduced:

Up to
13.5 BILLION KGS
of C02 equivalent

SOCIAL IMPACT

The main benefit is improved health which translates into better quality of life and aversion of premature deaths negatively affecting livelihoods.

Deaths averted:
3,700 DEATHS
could be averted

Disability-adjusted Life Years (DALYs) averted:
Up to
507,000
DALYs

Economic value of deaths averted and DALYs saved:
KES 372 MILLION
in lost wages

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HOW ECF ALIGNS TO LOCAL AND GLOBAL GOALS

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The Big Four Agenda

Food security

Achieve 100% food security; to reach 1 million farmers and unlock 150,000 acres of uncultivated land

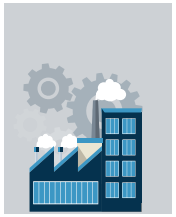
Investment in cassava and sugar cane will boost yields, providing feedstock for ethanol as well as food for consumption.

The potential 54 million trees to be saved can protect the country's renewable surface water resources.

Universal healthcare

Delivering 100% universal health care (UHC)

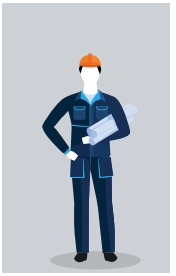
In 2013, 1.66 million DALYs (on average) were lost in Kenya due to ill-health, disability, and early death as a result of household air pollution. With up to 507,000 DALYs saved by switching to ethanol, UHC will become more attainable



Boost the manufacturing industry

Increase the manufacturing sector's share of GDP from about 9% in 2017 to 15% in 2022

Investment in the ethanol industry will boost manufacturing, by creating a new industry



Create jobs for young people within manufacturing

The government plans to create 1.3 million manufacturing jobs by 2022

Up to 3,480 jobs can be created in ethanol manufacturing depending on the extent of local production and the production pathway chosen

Kenya Vision 2030

Promote export-driven manufacturing

Boost the capacity and local content of domestically manufactured goods

Investment in the ethanol industry will provide a significant boost to manufacturing, with the potential to export into new markets

Increase forest cover

Increase the forest cover by 10% by 2022

Reducing the use of charcoal will increase the forest cover, which will in turn increase water availability and reduce food security

Kenya's Nationally Determined Contribution (NDC)

Reduce greenhouse gas emissions

Reduce greenhouse gas (GHG) emissions by 30% by 2030 relative to the business as usual

Up to 13.5 billion kgs of CO2 could be saved cumulatively over a ten-year period by switching to ECF

Sustainable Energy for All Initiative – Kenya Action Agenda

Increase the penetration rate of clean fuels

Increase the penetration rate of clean fuels to 100% by 2028

The development of a domestic ECF industry will contribute to the objective of increasing the uptake of clean fuels in Kenya

National Climate Change Action Plan 2018-2022

Promote the transition to clean cooking

Reduce the number of household biomass related deaths from 49% of total deaths to 20%

The development of a domestic ECF industry will contribute to the objective of increasing the uptake of clean fuels in Kenya

Global Goals

3 GOOD HEALTH AND WELL-BEING

Good health and well-being

Ensure healthy lives and promote well-being at all ages.

~3,700 deaths could be averted by households switching to ECF from other cooking fuels

Up to 507,000 DALYs could be saved over ten-years

7 AFFORDABLE AND CLEAN ENERGY

Affordable and clean energy

Ensure access to affordable, reliable, sustainable and modern energy for all

With the removal of VAT on ECF salesand potentially lower costs from domestic production, ECF will be the cheapest cooking option

13 CLIMATE ACTION

Climate action

Take urgent action to combat climate change and its impacts

Up to 54 million trees could be saved over a 10-year period from households switching from charcoal to ECF

Up to 13.5 billion kgs of CO2 eq could be saved cumulatively over a ten-year period by switching to ECF

8 DECENT WORK AND ECONOMIC GROWTH

Decent work and economic growth

Promote inclusive and sustainable economic growth, full and productive employment and decent work for all

Up to 370,000 jobs can be created by a domestic ethanol market depending on the extent of local production and the production pathway chosen

Up to KES 51 billion can be generated in new income by a domestic ethanol market, with potential new income of up to KES 180,000 per year for smallholder farmers

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Industry, innovation, and infrastructure

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

The investment in ethanol manufacturing and distribution will boost industry and innovation in Kenya

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SOURCES OF ETHANOL COOKING FUEL IN KENYA

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The most likely sources of ECF in Kenya


Molasses


Sugarcane juice


Cassava

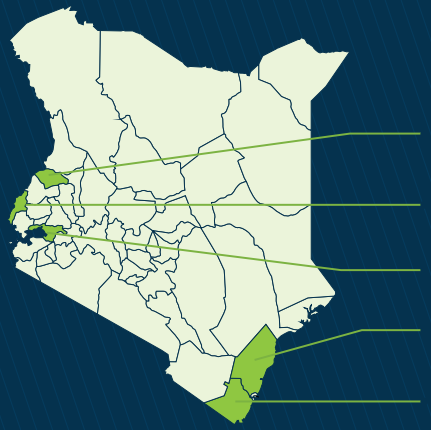
Currently, ethanol is exclusively produced through molasses feedstock, a by-product of sugar production. However, a national shortage of molasses is affecting production level.

1. **Availability** of the feedstock: this refers to the current level of production in Kenya.

2. Is the feedstock a **staple food?** Using maize as a feedstock can cause food security concerns.

3. **Stability** of the feedstock: Is the yield reliable? Is the feedstock climate-resilient?

Best agro-ecological zones for feedstock in Kenya:



Most conducive areas for establishing these plants due to existing sugarcane or cassava production and high yield in the coastal areas.

Advantages and disadvantages of the different pathways to produce ethanol

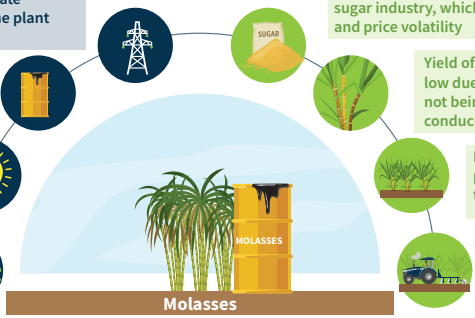
Molasses

ADVANTAGES

- It allows for the use of bagasse (fibrous residue from sugarcane) to generate energy that can be used to fuel the plant and supply the national grid
- It reduces waste of byproducts i.e. molasses
- Ethanol processing: Kenya has 71 years of experience in molasses-based ethanol production and can leverage technical knowledge and existing production facilities
- Feedstock production: the molasses-based pathway allows for two industries & two revenue streams, both ethanol and crystal sugar

DISADVANTAGES

- Supply of molasses is dependent on the sugar industry, which results in shortages and price volatility
- Yield of sugarcane in Kenya is currently low due to poor quality crops and crops not being planted in the most conducive areas in the country
- Hectares allocated to sugarcane production is too small to support the increase of production
- Deficit of investments in large-scale mechanized sugarcane farms



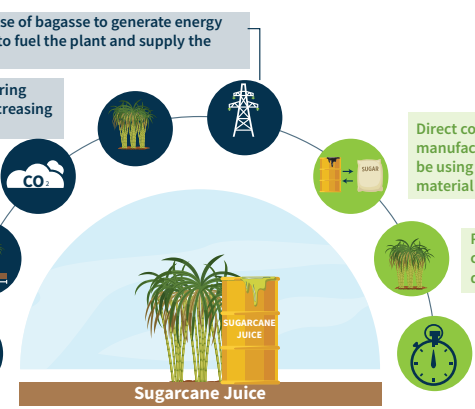
Sugarcane Juice

ADVANTAGES

- It allows for the use of bagasse to generate energy that can be used to fuel the plant and supply the national grid
- Potential to cultivate faster-maturing varieties of sugarcane, further increasing annual productivity per hectare
- It generates less greenhouse gases (GHG) than the molasses pathway
- It requires far fewer hectares than the molasses-based model since the conversion ratios are greater with sugarcane juice
- The sugarcane juice-based production requires less sugarcane than the molasses-based model, which in turn means less CAPEX spent on farming & feedstock production

DISADVANTAGES

- Direct competition with the sugar manufacturing industry as both would be using sugarcane directly as a raw material
- Productivity of sugarcane is currently low in Kenya with poor quality crops
- Sugarcane juice's shelf life is only 24-48 hours which could result in losses



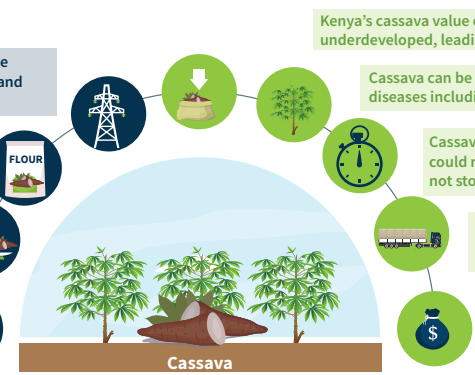
Cassava

ADVANTAGES

- It allows for the use of bagasse to generate energy that can be used to fuel the plant and supply the national grid
- Cassava-based ethanol plants allows for the production of other ancillary products such as flour
- Cassava has a potential for higher yields than sugar under optimal conditions
- The cassava value chain is relatively new in Kenya and does not have the same legacy issues as the sugar value chain

DISADVANTAGES

- Kenya's cassava value chain is currently underdeveloped, leading to low yields
- Cassava can be damaged by several diseases including the brown streak virus
- Cassava roots rot quickly (24-48 hours) which could result in significant losses if roots are not stored and processed efficiently
- The bulkiness of cassava roots could result in additional transport costs
- The treatment costs for effluent are higher for cassava-based plants than other plants



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ESTABLISHING SUPPLY OF BIO-ETHANOL IN KENYA

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Land required for feedstock production

Molasses-based production requires the most land, ranging from

64,000 to 292,000 HECTARES

driven by the need for the sugarcane produced to support both the sugar and the ethanol industries.

The projected size of land required for **cassava-based** productions range from

17,000 to 56,000 HECTARES

The projected size of land required for sugarcane **juice-based** productions range from

10,000 to 32,000 HECTARES

For molasses-based production, the projected CAPEX is estimated to range from **KES 7.6 Billion to KES 25.3 Billion.**

CAPEX for cassava production is estimated to range from **KES 1.6 Billion to KES 5.4 Billion.**

The projected CAPEX for sugarcane juice-based production is estimated to range from **KES 1.1 Billion to KES 3.7 Billion**

Total CAPEX required to produce ethanol from molasses is significantly higher than the other two pathways since it also includes CAPEX for sugar production. For molasses-based production to be feasible both ethanol plants as well as sugar plants will have to be established. Some of these will be joint sugar-ethanol facilities, but several standalone sugar plants will also have to be set up.

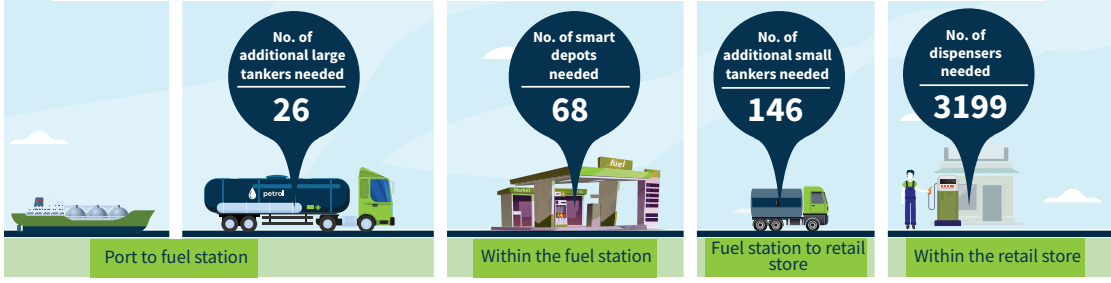
Creating supportive smallholder farmer ecosystem

To ensure that the economic opportunity of a local ethanol industry is fully realized, a supportive ecosystem for smallholder farmers, which is cognizant of vulnerability to climate change shocks, needs to be built. The infographic illustrates some of the complementary support that smallholder farmers will need to boost feedstock production.

CAPEX for ethanol distribution

To meet the projected demand for ethanol over 10 years, ethanol distributed will increase from **16 Million to 192 Million litres from Year 1 to Year 10.**

In order to expand the distribution network, several investments will be required at every stage of the distribution channel. Distribution from the port to the fuel station, distribution within the fuel station, distribution from the fuel station to the retail store and storage in the retail store.



The total CAPEX required over 10 years to expand the distribution network is estimated at

KES 1.4 Billion

The two major investments that will be required:

Setting up new dispensers in retail stores

~63%

of total CAPEX

Purchasing additional small tankers to distribute the ethanol to retail stores

~33%

of total CAPEX

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DEMAND FOR BIO-ETHANOL IN KENYA

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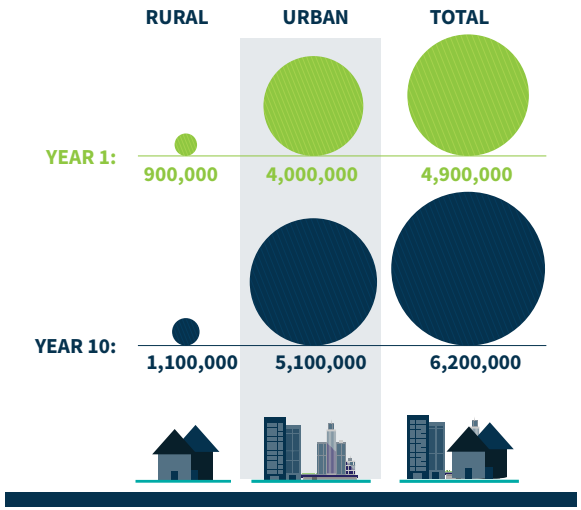
ECF demand

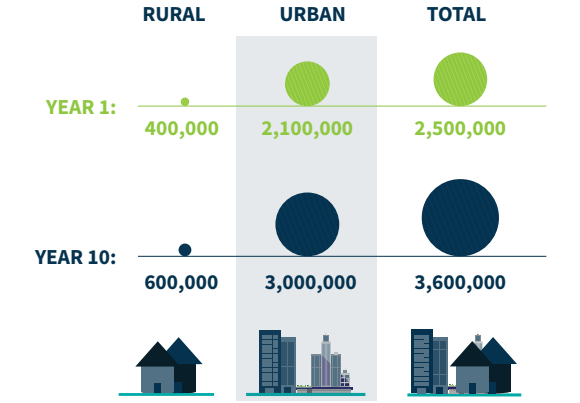
Year 1	Year 10
8 - 24 MILLION LITRES	115 - 268 MILLION LITRES

The rising demand is expected to be driven mostly by the urban areas, due to the dominance of firewood use in rural areas (which means that most households will be reluctant to pay for fuel) and the infrastructural challenge of supplying ethanol Cooking fuel (ECF) to the more remote areas of the country.

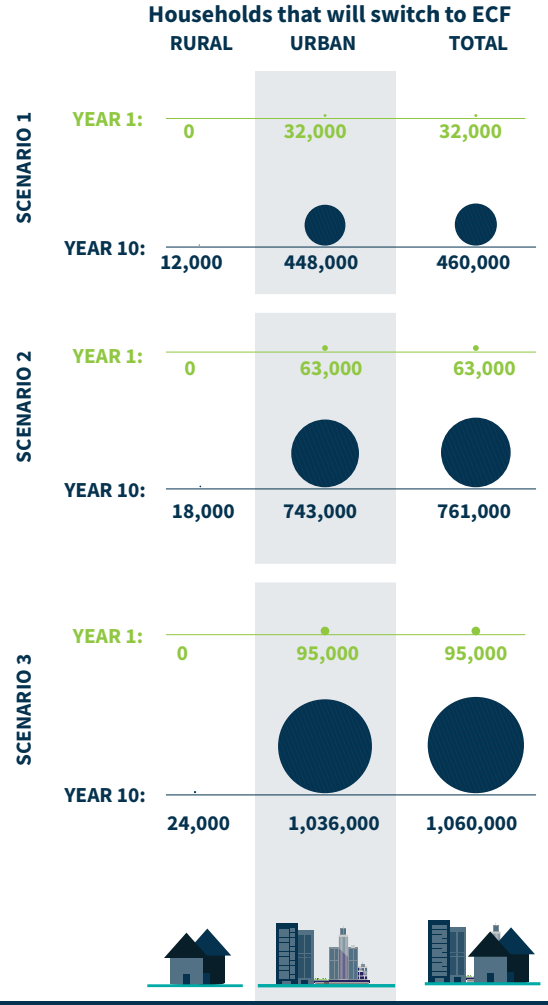
Potential target market for ECF in rural and urban areas



Households that can afford ECF year 1 vs year 10



Households that will switch to ECF



How to Boost ECF Demand in Kenya

Affordability

- Zero Rate VAT on ECF to make price competitive with LPG
- Short-term zero-rating import duty on denatured ethanol as local production grows
- Stove financing

Availability

Availability assumptions account for the constraints in access and distribution of ethanol which could vary widely, particularly between urban and rural areas. Availability is expected to increase rapidly in urban areas rising to 100% by year 5. In rural areas due to infrastructural challenges, access is expected to reach a maximum of 20% of households over the 10-year period.

Awareness

Creating awareness on the social, economic and environmental benefits of clean cooking as well as the detriments of using traditional cooking fuels and technologies.

The Mobilising Investment for NDC Implementation (MI) programme is supported by the German Government's International Climate Initiative (IKI). In Kenya, the programme aims to accelerate public and private investment in clean cooking ; a priority sector in the realization of Nationally Determined Contributions (NDCs).

REFERENCE: Kenya Ethanol Cooking Fuel Master-Plan 2020