CLEANING UP COOKING IN URBAN KENYA WITH LPG AND BIO-ETHANOL

Introduction

Today in Kenya, the majority continue to cook with dirty fuels - kerosene, charcoal, and firewood - which cause significant damage to health at a household level and the environment at large. In recent years, clean modern fuels, which significantly reduce these adverse health and environmental impacts, have become increasingly available and cost-competitive in Kenya**. Liquified Petroleum Gas (LPG)** penetration has increased rapidly over the past five years, especially in Nairobi. More recently, **Bio-ethanol** has emerged as a scalable cooking solution with comparable potential to meet the needs of lower income Kenyan households. While Bio-ethanol and LPG are both more available than before, there are awareness, affordability and accessibility barriers which need to be addressed to drive greater adoption.

In our study, commissioned by the Climate and Development Knowledge Network, we assessed Bio-ethanol and LPG across economic, health, and environmental criteria to understand the impact potential of replacing traditional fuels. The study provides an impact evidence base for Bio-ethanol and LPG, and then takes a deeper dive on policy recommendations to promote the adoption of Bio-ethanol (given lesser focus compared to LPG to date) as a cooking fuel in Kenya.

Overview of the Kenyan Cooking Fuels Market

Dirty fuels continue to dominate in urban Kenya, notably charcoal (22%) and kerosene (29%). Along with LPG (28%), these are the principal "primary" household cooking fuels.[1] However, fuel stacking (i.e. the use of secondary and/or multiple fuels by the same household) is widespread; therefore, charcoal and kerosene use is much higher than primary cooking fuel data indicates. Nairobi is distinct from the rest of urban Kenya, with a higher share of households using LPG (44%) and kerosene (47%) as primary cooking fuels.[2] So, while progress has been made – especially with LPG – the problem is still large.

Continued dependence on dirty fuels poses serious health, environmental, and socio-economic costs for ordinary Kenyans. The data indicates that:

- **At least 727,689 disability-adjusted life years (DALYs) and 16,566 deaths annually** are currently attributable to indoor air pollution (IAP), and many thousands more Kenyans lose their lives due unquantified consequences of IAP and other harms like kerosene burns and poisonings;
- Kenya loses **10.3 million m^3 of wood** from its forests every year from firewood and charcoal consumption, a major contributor to the country's **0.3% annual deforestation** rate;
- Wood and charcoal fuel use, including Black Carbon emissions, contribute **25 million tonnes of CO2 eq. each year**, approximately **~40% of Kenya's total GHG emissions;**

[1] Kenya National Bureau of Statistics (2018)
[2] Source: Household Fuel Consumption Based on Multiple Fuel Use Strategies: A Case Study in Kibera Slums (Yonemitsu et al, 2014); Household Air Pollution: Sources and Exposure Levels to Fine Particulate Matter in Nairobi
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- Wood and charcoal cooking lead to **0.8-1.3 and 0.3-0.4 hours lost** for women (in time spent cooking and cleaning) respectively each day per urban households and **4+ hours for rural wood collectors**; an avoidable time burden with efficient and clean cooking fuels

Kerosene and charcoal remain dominant in urban Kenya because of the affordability and relative availability of these fuels and the stoves used for cooking with them. Kerosene is currently the lowest cost cooking fuel in urban Kenya. Charcoal bought in small amounts (i.e. tins) is the most expensive cooking fuel, but charcoal bought in bulk by middle class consumers (i.e. in 40 kg bags) can be a relatively affordable though increasingly expensive option.

In terms of accessibility, kerosene and charcoal are widely available in urban Kenya – there are over 1,500 kerosene dispensing points in Nairobi alone and we estimate that most people in Nairobi live within a 50-200-metre walk from a charcoal vendor.

FUEL	Affordability & availability assessment
Wood	• Abundant and largely free in rural areas for collectors, though 20-30% of rural HHs buying at least some of their firewood • Firewood is increasingly scarce and expensive in urban Kenya, particularly Nairobi (e.g., >$0.50 / kg), but still fairly low cost (e.g., $0.15 / kg in Kisumu, $0.10-0.15 / kg in most rural and peri-urban Kenya) • Traditional and moderately improved firewood stoves are free or very low cost <$10)
Charcoal	• Widely available in urban Kenya (e.g., 50-150m to charcoal for average HH in Nairobi) • Increasingly expensive as forests recede (prices rose from $0.10/kg to $0.35-0.50 / kg in Nairobi in past decade, doubling in just past 3-5 years) • Major poverty premium – 20-30% higher cost from buying charcoal in 4kg tins vs. 40kg bags
Kerosene	• Widely available throughout mass-market neighbourhoods at hyper-local distribution points (e.g., 1500+ points in Nairobi alone) • Most affordable and lowest cost fuel in urban Kenya currently • Often only truly affordable option for poorest urban residents (e.g., kerosene is primary fuel for 70-80% of slum households in Nairobi)

Clean, modern cooking fuels are increasingly available in Kenya, but have not yet overcome consumer awareness, affordability and accessibility barriers necessary to become scalable and fully replace traditional fuels. While the Government of Kenya has made substantial progress in electrification, electric cooking is not viable today for most Kenyans due to the high consumer electricity tariffs and the high cost of highly efficient electric cookstoves.

LPG is well-understood and increasingly prevalent in urban Kenya; significant investment in upstream capacity is required to increase penetration further, as well as innovation in last-mile distribution.

Bio-ethanol has now emerged as a comparably attractive option which can leverage existing fuels infrastructure; for now, however, the cost remains higher than a number of the other options due to unfavourable tax and tariff treatment.

FUEL	Affordability & availability assessment
LPG	• Fuel availability constrained outside of Nairobi, but access fairly widespread in capital (>40% use LPG as primary fuel, >60% have LPG stove), but overall urban accessibility projected to grow – Kenya Pipeline Company (KPC) plan to more than double LPG storage capacity by 2020 • LPG is largely unaffordable as primary fuel for bottom 50-70% of urban Kenya population and prices have been unstable ($1.25 to 1.75 / kg over course of 2017) • High upfront stove/cylinder costs (>$100 for 2-burner)
Electricity	• Not widely available: residential grid provisioned for lighting only; major capex investment required • Electricity costs far too high to make electric cooking mainstream (uptake ~5% in Nairobi, ~2% in urban Kenya) • Efficient electric stoves are priced uncompetitively (>$200) for stoves that bring costs of electric cooking within realm of other fuel alternatives
Bio-ethanol	• Denatured technical Bio-ethanol* for cooking currently only available from a handful of providers that are all currently at nascent or pilot scale (i.e., KOKO Networks, Leocome, Safi International), but about to scale quickly – e.g., 1000 KOKOpoints going live across Nairobi in late 2018 • Cooking with lowest cost Bio-ethanol on Kenya market is slightly more expensive than kerosene, on par with LPG, and below cost of 4kg tin charcoal -- would be lowest cost option if tax and tariff regime was equal to other fuels • Bio-ethanol stoves are fairly low cost ($30 - 70) compared to alternatives like LPG ($45 – $110)

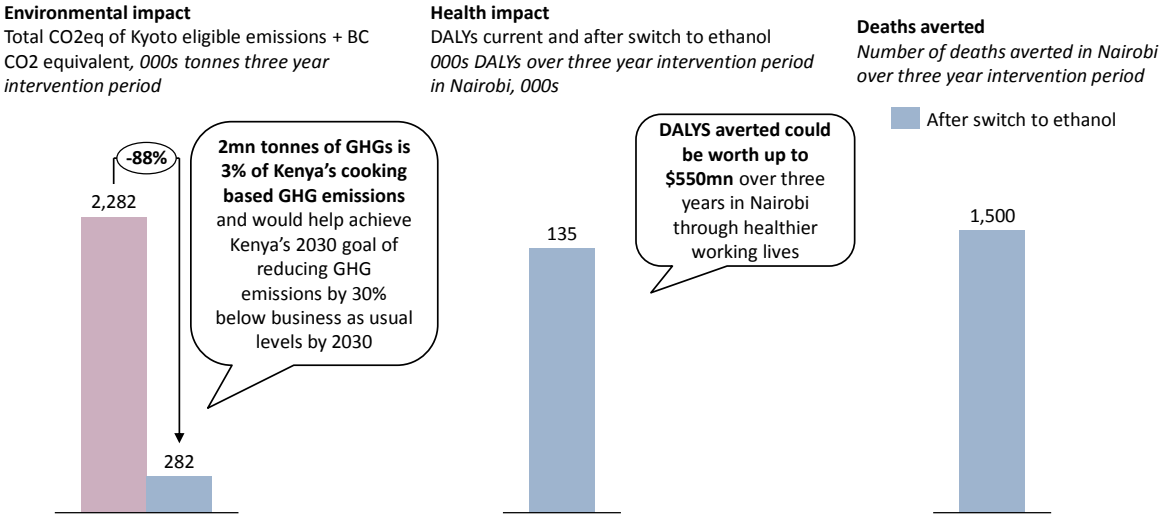
Potential of Bio-ethanol for Cooking in Kenya

Bio-ethanol is being used increasingly around the world as a clean and efficient alternative to traditional cooking fuels. In Western countries, it has primarily been used for camping and in recreational vehicles. It was adapted for use in refugee camps in East Africa in the early 21st Century and first commercially-piloted in Mozambique in 2013, with cooking Bio-ethanol enterprises currently active in multiple countries including Kenya, Mozambique, Madagascar, Ethiopia, Nigeria, and Haiti.

The health, environmental, and social impacts of transitioning from more traditional fuels are well documented. While LPG has enjoyed more visibility and promotion in Kenya, the potential benefits of transitioning customers from dirty fuels to Bio-ethanol are comparably significant at a household level:

- Bio-ethanol and LPG have **average PM2.5 emissions much lower** than those of traditional fuels (24-48 hr PM 2.5 emissions of 30-50 ug/m³ under laboratory conditions)
- Switching from charcoal to either Bio-ethanol or LPG could save **up to 30 trees and reduce 3-5 tonnes of GHG emissions per household, including the effects of Black Carbon** (~0.5 tons CO2eq annually vs. 5-7 tons CO2eq for charcoal cooking by an urban household in Kenya, including fuel production emissions)

- Transitioning all kerosene and charcoal users in Nairobi to Bio-ethanol could result in **up to 2 million tonnes of GHG emissions and 135,000 DALYs** averted annually. This transition would also counteract deforestation and its negative effects on agricultural yields and food insecurity.



Under this full transition to ethanol, 690,000 consumers from the poorest income segment (<$200/month) switch to ethanol, 350,000 consumers from the middle income segment ($200-$500) switch to ethanol and 99,000 consumers from the upper income segment (>$500) switch to ethanol, for a total of ~1.1mn new ethanol customers

Bio-ethanol can also deliver additional economic benefits. As local demand is proven, and the necessary investments are made, the existing local technical alcohol industry could be expanded to serve this demand, creating tens of thousands of jobs across the value chain. These jobs would be formal, generally higher-quality and better-paying than jobs in the charcoal value chain, and potentially taxable.

	Charcoal	Kerosene	LPG	Ethanol (Central Bottling)	Ethanol (New Decentralised Model)
Fuel retail price	**$0.30 - $0.45** / kg	**$0.75 - $0.85** / L	**$1.70-1.75 /** kg for 6kg, 13kg cylinders, **>$3.00** / kg for PAYG LPG	**$0.90 - $1.10** / L with small volumes of Kenyan ethanol **>$1.48** at large scale with imported ethanol	**$0.85** / L sustainable at scale with imported ethanol, including **$0.21** / L of VAT and import tariffs
Annual cooking cost for average Nairobi household	**$207 - 249**	**$224**	**$233**	**$234 – 297** (at pilot scale w/ domestic ethanol) **$308** (at pilot scale w/ imported ethanol)	**$220 - 230**

Stove retail price	**$7 KCJ,** **$25 - 35** Burn/ Envirofit	**$6 - $20**	**$40-50** for 1-burner, **$100-120** for 2-burner (incl. hose, regulator, cylinder deposit)	**$50 - $70** for 2-burner stove (SAFI, Dometic)	**$45** for 2 burner and **$30** for 1-burner (KOKO)

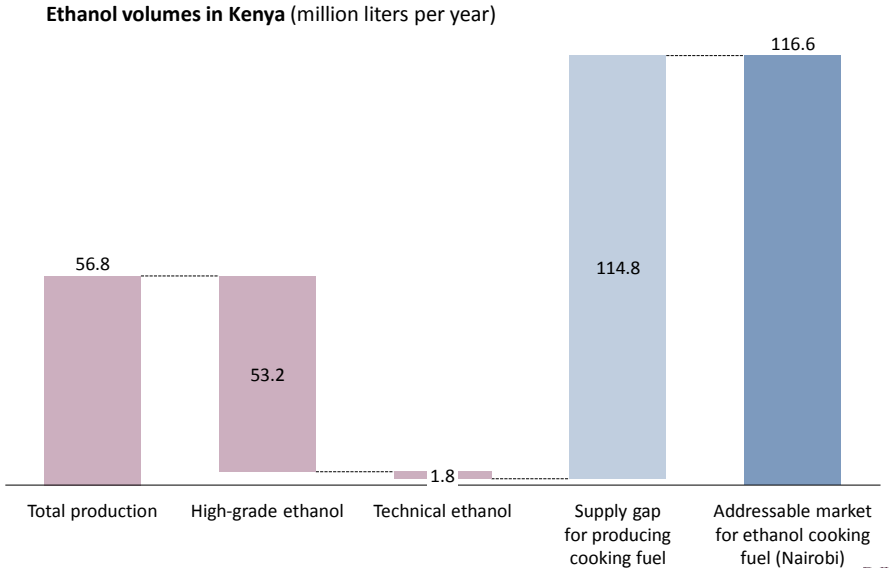
Bio-ethanol is now becoming cost-competitive and scalable as a cooking solution for urban Kenya, given innovations that leverage localised distribution technology and existing downstream infrastructure. Traditional cooking Bio-ethanol business models currently being pursued by players like Safi International and Leocome in Kenya involve a centralized bottling approach, with a variety of distribution innovations for delivering bottled ethanol to consumers. This model has demonstrated some successes in urban settings to date, but also faces a number of challenges at scale.

A new decentralised approach, currently being pioneered by KOKO Networks (www.kokonetworks.com), a hardware and software technology company which enables the last-mile distribution of Bio-ethanol fuel starting with the Kenya market, has reduced logistics costs between the landed cost and final price to customer, with taxes now driving ~25% of final price. KOKO partners with fuel majors to safely and efficiently add Bio-ethanol to their existing downstream infrastructure. By leveraging this existing fuel infrastructure, KOKO's model requires significantly lower upfront capital expenditures than those required for scaling alternative clean cooking fuels. Using decentralised sales points, and mobile and cloud technology, KOKO's model delivers Bio-ethanol fuel closer and more cheaply to customers and Bio-ethanol fuel can be sold to customers at $0.85 per litre, even using imported ethanol, and despite associated taxes and tariffs.

Policy on Bio-ethanol for Cooking Fuel

Bio-ethanol is a scalable clean fuel option – especially using latest technologies – but taxation is affecting customers' ability to access Bio-ethanol fuel at the lowest possible cost. The rationale for high tax on imports is to promote local industry. However, demand in Kenya for Bio-ethanol as a cooking fuel needs to be built up first, which requires more competitive pricing.

Given limited local production, imports are necessary to meet this demand as it is built up in the medium term. Only 1.8m litres of technical Bio-ethanol are produced in Kenya versus a potential demand of ~120m litres for cooking in Nairobi alone.



In the long run, Bio-ethanol could be produced locally after first proving demand using imports. Scaling the local industry will require a phased approach as potential investors (i.e., those likely to provide the project finance to build more dedicated ethanol plants in Kenya) will want to see a track-record of demand. As proved in many other contexts all over the globe in the energy sector and beyond, once this local demand is proven with a reliable supply of imports, domestic production will follow to serve it.

Technical Bio-ethanol faces 16% in VAT and 25% in duties compared to 0% for most other fuels (apart from kerosene, which faces a 9% excise duty); this inflates the cost at which Bio-ethanol can be sold to customers. Kenya ranks below other sub-Saharan African countries in terms of Bio-ethanol-friendly policy, with combined duties and VAT of 41% for Bio-ethanol, versus an average of 33% for 21 sub-Saharan African countries for which data was available. As previously mentioned, these taxes and tariffs now drive ~25% of ethanol retail price.

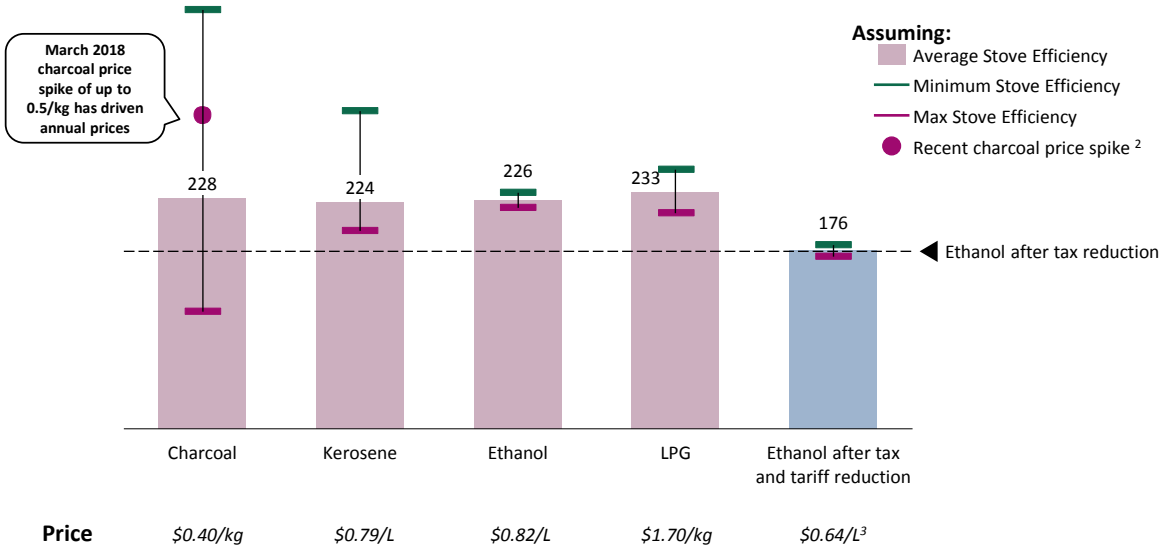
Cooking fuel	Effective duty	Effective VAT
Charcoal	N/A	N/A
LPG	0%	0%
Kerosene	9%[1]	0%
Denatured technical ethanol	25%	16%

Tax concessions would accelerate unlocking the ethanol cooking fuel opportunity by levelling the playing field and making prices more competitive. Levelling the playing field by granting denatured technical alcohol a VAT-zero rating and eliminating related tariffs would make ethanol fuel the cheapest option, providing Kenyans with an affordable alternative to traditional fuels. Plans to increase taxes on kerosene and recent spikes in local Kenyan charcoal prices (localised pricing of above $0.50/kg seen in recent

months, making this some of the most expensive cooking charcoal in the world) due to local logging bans reinforce the need for cheaper alternatives for the lowest income users.

Average annual fuel expenditure by fuel type to meet 3,500 MJ fuel diet of a typical Nairobi household[1]

USD / year



Conclusions and Recommendations

It is clear that there are viable clean cooking fuel options that could serve the Kenyan population currently paying for their fuel – these users are concentrated in Urban Kenya. Bio-ethanol and LPG are indisputably cleaner and safer options than charcoal, kerosene, and firewood. The promotion of LPG has been successful in increasing its use in Kenya. Bio-ethanol too is now well-positioned to be a mass-market solution for urban Kenya. While the proactive efforts of the Government of Kenya and other stakeholders to promote clean fuels and stove usage are to be commended, there are opportunities to further eliminate barriers to drive adoption of clean fuels, notably Bio-ethanol, which has the potential to become an important part of the clean cooking energy ecosystem in Kenya and globally with appropriate policy support.

Bio-ethanol delivers comparable health and environmental impacts to LPG, and, as players continue to innovate around distribution and logistics, it can now be distributed at prices affordable to lower- and middle-income Kenyans. In order for the Bio-ethanol opportunity to be fully realized, there needs to be a level playing field for Bio-ethanol to compete with other cooking fuels. Specifically, we recommend that the Government of Kenya remove policy and tax barriers which are currently preventing Kenyans from purchasing safe and high-quality Bio-ethanol at the lowest prices possible. This can be achieved by the following policy actions:

1. **Grant technical Bio-ethanol a VAT zero-rating**
2. **Remove duties and other taxes on imports of technical Bio-ethanol for cooking fuel**
3. **Establish and enforce safety / quality standards for all clean modern fuels, including Bio-ethanol**

This document is an output from the Mobilising Investment project, an initiative of the Climate and Development Knowledge Network (CDKN) and Low Emission Development Strategies Global Partnership (LEDS GP) contracted through SouthSouthNorth (SSN). The Mobilising Investment project is funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), on the basis of a decision adopted by the German Bundestag. Delivery partners for the project include the National Renewable Energy Laboratory (NREL), Overseas Development Institute (ODI) and PriceWaterhouseCoopers UK (PwC). The views expressed are not necessarily those of, or endorsed by, BMU or any of the entities delivering the Mobilising Investment project, who can accept no responsibility or liability for such views or information, or for any reliance placed on them. This publication has been prepared for general guidance on matters of interest only, and does not constitute professional advice. You should not act upon the information contained in this publication without obtaining specific professional advice. No representation or warranty (express or implied) is given as to the accuracy or completeness of the information contained in this publication, and, to the extent permitted by law, the entities managing the delivery of the Mobilising Investment project do not accept or assume any liability, responsibility or duty of care for any consequences of you or anyone else acting, or refraining to act, in reliance on the information contained in this publication or for any decision based on it.

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