Scaling up clean cooking in urban Kenya with Bio-ethanol

Using technology and business model innovation to promote sustainable cooking fuels

4th December 2019

Prepared for COP25, NDC Partnership Pavilion
The urban Kenyan cooking fuel market is estimated at USD 600m – USD 800m per annum, and remains dominated by dirty fuels.

The majority of Kenyans currently paying for cooking fuels live in urban Kenya:

- Most fuel used in rural areas is gathered and not purchased (e.g., 84% of households use firewood as their primary fuel).
- Market-driven approaches for expanding the use of modern fuels are unlikely to take hold in these areas in the short term.
- In urban areas, on the other hand, over 80% of households are already purchasing cooking fuel and are prime targets for modern fuel use.

Within modern fuel options, Bio-ethanol and LPG are the most feasible today; Bio-ethanol is the least understood:

- LPG is well-understood, already promoted by the Government, and enjoys strong consumer recognition.
- Bio-ethanol is relatively unexplored and has achieved lower penetration thus far.
- Electricity will become increasingly important to the overall cooking mix; however, for now, only higher income consumers can afford the expensive but efficient electric stoves that are needed to make electric cooking viable.
Continued dependence on dirty cooking fuels poses serious health, environmental, and food insecurity risks for Kenya

Impact of using biomass fuel for cooking

**Health**

- **Indoor air pollution**: 728k Disability-Adjusted Life Years (DALYs) and 16.6k deaths annually, *8-10% of early deaths* in Kenya\(^1\), likely a substantial underestimate of the full disease burden as many negative cooking health effects have not yet been quantified (e.g., burns, eye diseases, physical injuries from carrying firewood, etc.)

- **Lower respiratory tract disease** is the third largest contributor of deaths in Kenya while pneumonia is a major cause of death to children under the age of five, largely due to indoor air pollution\(^1\)

**Environment**

- **Deforestation and forest degradation**: Kenya loses *10.3 million m\(^3\) of wood from its forests* every year from unsustainable charcoal and wood fuel use, a major contributor to the 0.3% per year deforestation rate\(^2\)

- **GHG emissions**: Household fuel use in Kenya contributes *22-35 million tonnes of CO\(_2\) eq* each year, which is equivalent to *30-40% of total Kenya GHG emissions*\(^2\)

**Food insecurity**

- **Food insecurity**: deforestation, resulting from the use of dirty fuels, exacerbates food insecurity and harms the agriculture sector. Kenya's five forest water towers feed filtered rainwater to rivers and lakes and provide *over 75 per cent of the country's renewable surface water resources*\(^3\)
Bio-ethanol for cooking
Source of Ethanol for Cooking

Feedstock processing

- Sugarcane farming
  - Cane processing
    - Sugarcane juice
      - Molasses
      - Sugar production
  - Chip processing

Ethanol processing

- Fermentation & separation
- Distillation
- Mixing
- Dehydration
- Packaging

Ethanol for cooking
KENYAN PARTNERSHIP OVERVIEW

1. Ethanol is sourced from Kenyan and global suppliers
2. Ethanol is trucked to urban service stations
3. Ethanol is stored in dedicated tanks at urban service stations equipped with Smart Depot Systems
4. Smart MicroTankers undertake last-mile deliveries to a dense network of KOKOpoints
5. KOKOpoints are cashless Fuel ATMs, located in urban shops, that refill Smart Canisters
6. Customers return home and safely dock their Smart Canisters in their KOKO Ethanol Stove
7. KOKO tracks fuel levels and technical health, arranges customer and agent service, and automates payments across the supply chain

KEY: Ethanol Fuel | KOKO Technology | Vivo Energy

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V2.0 innovations mean that Bio-ethanol can be delivered at scale to the customer at a price up to ~40% less than the V1.0 approach.

Supply chain margins for Bio-ethanol (% of total cost)

<table>
<thead>
<tr>
<th>Component</th>
<th>V1.0</th>
<th>V2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landed supply cost</td>
<td>0.35</td>
<td>0.29</td>
</tr>
<tr>
<td>Bulk storage &amp; transport</td>
<td>0.35</td>
<td>0.20</td>
</tr>
<tr>
<td>Marketer</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Distribution</td>
<td>0.56</td>
<td>0.29</td>
</tr>
<tr>
<td>Retail</td>
<td>1.48</td>
<td>0.85</td>
</tr>
<tr>
<td>Taxes</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Distribution</td>
<td>0.10</td>
<td>0.07</td>
</tr>
<tr>
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Bio-ethanol V2.0 costs are significantly lower than those of Bio-ethanol V1.0

- Leveraging existing downstream infrastructure can cut down bulk storage and transport costs by ~90%
- Technology-enabled distribution can reduce combined distribution and retail costs by ~45%
- Aside from landed supply cost, taxes drive the retail price of Bio-ethanol V2.0

Source: KOKO networks, expert interviews.
The cost at which Bio-ethanol can be sold to customers is inflated by high import taxes and VAT, which drive ~25% of the retail price.

Granting industrial Bio-ethanol imports a VAT-zero rating and eliminating associated tariffs could reduce Bio-ethanol retail prices from $0.85 /L to $0.64/L.

### Taxes on Bio-ethanol Relative to Those on Other Fuels in Kenya

<table>
<thead>
<tr>
<th>FUEL</th>
<th>Effective duty</th>
<th>Effective VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>LPG</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Kerosene</td>
<td>9%¹</td>
<td>0%</td>
</tr>
<tr>
<td>Denatured technical Bio-ethanol</td>
<td>25%</td>
<td>16%</td>
</tr>
</tbody>
</table>

### Taxes on Bio-ethanol Relative in Kenya Relative to in Other Countries

Duty and tax burden on imported denatured Bio-ethanol; subset of 21 SSA nations, reflecting duties + taxes, %

- **Kenya**
  - Import tariff: 49%
  - VAT: 43%

The chart shows the duty and VAT burden for various fuels, with Bio-ethanol having a 25% duty and 16% VAT compared to charcoal and LPG, which have no duty and VAT. Kerosene has a 9% duty and 0% VAT. Denatured technical Bio-ethanol has the highest duty and VAT burden among the fuels listed.
Granting Bio-ethanol a VAT-zero rating and eliminating tariffs would make it the cheapest cooking fuel option for Kenyans

Average annual fuel expenditure by fuel type to meet 3,500 MJ fuel diet of a typical Nairobi household\(^1\), USD / year

<table>
<thead>
<tr>
<th></th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>$0.40/kg</td>
</tr>
<tr>
<td>Kerosene</td>
<td>$0.82/L</td>
</tr>
<tr>
<td>Bio-ethanol</td>
<td>$0.79/L</td>
</tr>
<tr>
<td>LPG</td>
<td>$1.70/kg</td>
</tr>
</tbody>
</table>
| Bio-ethanol after tax reduction | $0.64/L

(1) Average fuel diet taken from survey data; average size of household in Nairobi assumed to be 3.2
(2) Recent price spike in charcoal price reach $0.5/kg and continue to rise; this is due to a ban on illegal logging introduced by the government in addition to the expected upswing during the wet season
(3) Assumes V2.0 model and using imported Bio-ethanol

Source: Renetech 2017; TERI 2016; Kenya institute for Public Policy Research and Analysis 2010; KOKO Networks consumer research; Dalberg Analysis
A transition of all kerosene / charcoal users in Nairobi to Bio-ethanol could result in ~2mn tonnes GHGs, 200K DALYs, and 1,500 deaths averted p.a.

A full transition of kerosene and charcoal users to Bio-ethanol in Nairobi alone would help towards achieving the Sustainable Development Goals ~200,000 DALYs and 1,500 deaths averted\(^3\)\(^4\) over a three year intervention period

- **3 Good Health and Well-Being**: ~200,000 DALYs and 1,500 deaths averted\(^3\)\(^4\) over a three year intervention period
- **5 Gender Equality**: Time savings from collection, cooking, and cleaning will accrue to women
- **7 Affordable and Clean Energy**: USD 60mn in annual consumer savings\(^4\)
- **13 Climate Action**: Reduction of 2mn tonnes of CO2eq emissions\(^1\)
  This represents 2-3% of Kenya’s annual GHG emissions and 10% of Kenya’s 2030 GHG reduction goal\(^2\)
Bio-ethanol presents potential opportunities for strengthening the Kenyan economy

1. **Tax revenue**
   - Domestic Bio-ethanol production has the potential to increase tax revenues in the long-run as formal, income tax-paying jobs are created in the domestic Bio-ethanol industry.

2. **Trade balance**
   - In the future, **domestically produced Bio-ethanol could replace imported kerosene**, improving the trade balance.
   - With enough investment into domestic production, Kenya could one day be a regional net exporter of Bio-ethanol (vs. imports from Sudan, Mauritius, and Pakistan).

3. **Jobs**
   - Domestic Bio-ethanol industry will deliver **better-paying, formal jobs** along the Bio-ethanol value chain, from farmers to distributors.
   - Depending on business models adopted, an industry serving 500,000 customers could create 40-70K new jobs, generating USD 17-35mn in incremental incomes.

4. **Food security**
   - Reducing charcoal use could enhance food security.
   - ~90% of charcoal for cooking is harvested from non-renewable forests, driving food insecurity through negative impacts on water cycles and land degradation.
The way forward
Kenya Ethanol Cooking Master Plan

- Understanding demand for ethanol cooking fuel
- Supply of ethanol cooking fuel
  - CAPEX
  - Additional revenue streams
- Employment, income, environmental, & health benefits of a transition to ethanol cooking fuel
- Recommendation and Implementation Roadmap
Creating awareness - Chuja Anthem
Thank you