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

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.

Cooking Fuel Stacking in Kenya

<table>
<thead>
<tr>
<th>Secondary stove</th>
<th>No 2nd stove (%)</th>
<th>LPG (%)</th>
<th>Electric (%)</th>
<th>Kerosene (%)</th>
<th>Charcoal (%)</th>
<th>Wood (%)</th>
<th>Other (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 LPG</td>
<td>6.6</td>
<td>1.3</td>
<td>0.3</td>
<td>2.2</td>
<td>6.5</td>
<td>2.0</td>
<td>0.1</td>
<td>19.00</td>
</tr>
<tr>
<td>2 Electric</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.20</td>
</tr>
<tr>
<td>3 Kerosene</td>
<td>3.3</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
<td>5.60</td>
</tr>
<tr>
<td>4 Charcoal</td>
<td>4.9</td>
<td>2.0</td>
<td>0.0</td>
<td>1.1</td>
<td>0.3</td>
<td>2.0</td>
<td>0.0</td>
<td>10.30</td>
</tr>
<tr>
<td>5 Wood</td>
<td>34.5</td>
<td>5.4</td>
<td>0.0</td>
<td>0.8</td>
<td>22.9</td>
<td>1.1</td>
<td>0.8</td>
<td>64.70</td>
</tr>
<tr>
<td>6 Other</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.0</td>
<td>0.10</td>
</tr>
<tr>
<td>Total</td>
<td>49.40</td>
<td>9.00</td>
<td>0.30</td>
<td>4.10</td>
<td>31.60</td>
<td>5.40</td>
<td>0.10</td>
<td>99.90</td>
</tr>
</tbody>
</table>

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).

Cooking Technologies in Kenya

- **Traditional**: 59% - Three Stone Fire, metallic charcoal stoves and kerosene wick stoves
- **Improved**: 30% - Improved charcoal and wood stoves
- **Clean**: 11% - LPG, biogas and electricity based cooking solutions

**REFERENCE**: Kenya Clean Cooking Sector Survey 2019
Clean cooking will contribute to the realization of Kenya's forest cover goals and improve food security.

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

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

Household air pollution (HAP) in Kenya causes more than 21,560 premature deaths annually 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.

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

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.

Kenya's productive labour force is affected by premature deaths related to HAP and the related public health burden.

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

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Mean</th>
<th>Median</th>
<th>Mean</th>
<th>Median</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerosene</td>
<td>200</td>
<td>245</td>
<td>105</td>
<td>142</td>
<td>100</td>
<td>231</td>
</tr>
<tr>
<td>Charcoal</td>
<td>200</td>
<td>270</td>
<td>200</td>
<td>229</td>
<td>200</td>
<td>246</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>250</td>
<td>342</td>
<td>250</td>
<td>489</td>
<td>250</td>
<td>256</td>
</tr>
<tr>
<td>LPG</td>
<td>188</td>
<td>200</td>
<td>113</td>
<td>137</td>
<td>128</td>
<td>176</td>
</tr>
</tbody>
</table>

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

**Proportion of respondents owning their most preferred stove**

- Three stone open fire
- Kenya Ceramic Jiko (KCJ)
- LPG stove (multiple burner)
- 6kg complete LPG cylinder
- Mixed LPG-electricity stove
- Improved charcoal stove

**Factors limiting stove ownership**

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

**Accessibility**

Are there adequate distribution channels for the fuels?

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

**Divisibility**

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

**Acceptability**

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

- 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.

**REFERENCE:** Kenya Clean Cooking Sector Survey 2019
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 CO2 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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REFERENCE: Kenya Ethanol Cooking Fuel Masterplan 2020
**Global Goals**

**Sustainable Energy for All**
- 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.

**Good Health and Well-being**
- Reduce greenhouse gas (GHG) emissions by 30% by 2030 relative to the baseline.
- Reduce household biomass related deaths from 40% of total deaths to 20%.

**Climate Action**
- Boost the capacity of the financial sector to 100% by 2022.
- Increase the forest cover by 10% by 2022.

**Decent Work and Economic Growth**
- Ensure inclusive and sustainable economic growth, full and productive employment, and decent work for all.

**Industry, Innovation and Infrastructure**
- Ensure access to affordable, reliable, sustainable, and modern energy for all.
- Ensure healthy lives and promote well-being at all ages.

**Promote Export-driven Manufacturing**
- Promote inclusive and sustainable economic growth, full and productive employment, and decent work for all.
- Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

**Kenya’s Nationally Determined Contribution (NDC)**
- Reduce greenhouse gas (GHG) emissions by 30% by 2030 relative to the business as usual.
- Reduce the use of charcoal to increase water availability and reduce food security.

**National Climate Change Action Plan 2018-2022**
- Reduce greenhouse gas (GHG) emissions by 30% by 2030 relative to the business as usual.
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**Kenya Vision 2030**
- Promote export-driven manufacturing.
- Investment in the ethanol industry will provide a significant boost to manufacturing, with the potential to export into new markets.

**Global Goals**
- Good health and well-being
- Affordable and clean energy
- Climate action
- Decent work and economic growth
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- Investment in the ethanol industry will provide a significant boost to manufacturing, with the potential to export into new markets.
Currently, ethanol is exclusively produced through molasses feedstock, a by-product of sugar production. However, a national shortage of molasses is affecting production level.

Best agro-ecological zones for feedstock in Kenya:

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?

Feedstock production: the molasses-based pathway allows for two industries & two revenue streams, both ethanol and crystal sugar. Ethanol processing: Kenya has 71 years of experience in molasses-based ethanol production and can leverage technical knowledge and existing production facilities. It reduces waste of byproducts i.e. molasses. 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.

Advantages and disadvantages of the different pathways to produce ethanol:

- **Molasses**
  - **Advantages**
    - It allows for the use of bagasse to generate energy that can be used to fuel the plant and supply the national grid.
  - **Disadvantages**
    - 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.
  - **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**
    - 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.

The most likely sources of ECF in Kenya include:

- **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.
ESTABLISHING SUPPLY OF BIO-ETHANOL IN KENYA

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.

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

The total CAPEX required over 10 years to expand the distribution network is estimated at KES 1.4 Billion.

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 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

REFERENCE: Kenya Ethanol Cooking Fuel Master-Plan 2020

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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.

### 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.