

### 1. Energy in Ethiopia

Ethiopia is a country of 94 million people in 18 million households with a total area of 1.1 million square kilometres. Its existing stock of infrastructure including energy is very low (even in Sub-Saharan Africa standards). Access to sustainable energy is also low where only 23% of the population and less than 5% of the rural population is connected to electricity. Access to sustainable sources of energy for domestic (such as cooking), productive (agriculture, rural enterprises), and social services is still very limited.

Ethiopia is a large, low income country with rapidly growing economy. Ethiopia's economy and population is growing rapidly; as a result its demand for energy is growing at even higher rates.<sup>1</sup> Although infrastructure expansion is a key agenda for the government and infrastructure investment has been sustained at high levels for the past decade there is still a large gap in terms of meeting demands.

Ethiopia depends on a limited set of energy sources to meet its energy requirements: electricity is generated mostly from large hydropower plants, transport is exclusively petroleum based, and cooking energy requirement in households is met mainly with biomass fuels. Limited diversity in supply exposes consumers to access risks. The hydropower dominated power system is exposed to climate variability, petroleum supplies are imported and suffer from international price volatility and foreign exchange availability, and access to biomass fuel supply for cooking has deteriorated due to declining biomass yields and stocks. Increasing diversity and improving sustainability is now given due attention: wind and geothermal energy are promoted for the power sector; electric railways are under development for transport; and cooking fuel alternatives, including liquid bio-fuels, are promoted for cooking.

Ethiopia's high dependence on non-sustainable source of energy, particularly biomass, for cooking has been a major concern over the past thirty years. The concern in the initial years was related to the potential contribution of biomass energy demand to deforestation and growing access problems to consumers (long collection distances and times). In recent years concern has grown due to the health

<sup>1</sup> According to the EEP, unconstrained electricity demand is growing at 2.1 times that of GDP, and demand for petroleum and other fuels is growing at high rates also.

impacts of cooking with biomass, and the contribution of non-sustainable biomass extraction to greenhouse gas emissions.

*Ethiopia is one of only three countries in the world with highest dependence of solid biomass*



Source: World Bank

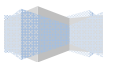
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### 2. Rationale for promoting ethanol as cooking fuel

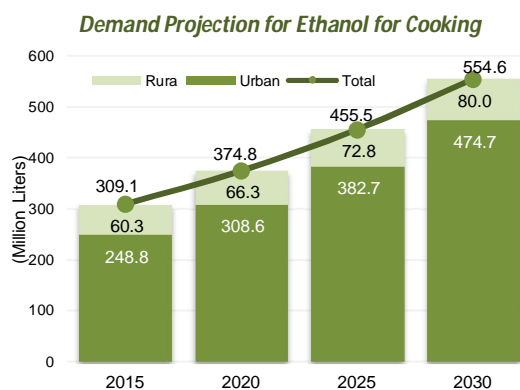
Meeting cooking energy requirements sustainably calls for actions in three directions: improving energy efficiency, sustainable management of existing sources of energy, and introducing new sustainable fuels. Considerable effort is going into improving energy efficiency and management of resources for biomass fuels; relatively less effort is directed towards providing new sustainable fuels for cooking. Ethanol is one of the new fuels that are considered viable in the Ethiopian context because it is a clean domestic fuel with growing availability at competitive prices.

Ethanol is produced from sugarcane molasses in Ethiopia. Domestic annual production from sugarcane molasses alone may rise to 350 million litres in the next five years due to the expansion of sugar production in Ethiopia.<sup>2</sup> In addition to sugarcane molasses, Ethiopia has other potential feedstock for ethanol production including sugar crops, sweet sorghum, and crop waste (fruits, vegetables, sugar crops) which may increase potential output to 500 million litres or more annually. Ethanol can be locally produced at small, medium or large scale. Small scale production enables localization of the ethanol production process, increasing the domestic content of ethanol produced in Ethiopia. Ethanol has a high energy to volume ratio which makes it ideal for transport (its storage and transport also does not require expensive equipment, unlike LPG for instance).

<sup>2</sup> Potential ethanol production from government owned sugar factories alone is estimated at 350 million liters annually. The amount that will be available for cooking will be 250 million liters (setting aside 100 million liters for gasoline blending). This is enough to meet the cooking (excluding baking) energy requirements of 0.6 million households (i.e., 3% of all Ethiopian households).



At current market prices ethanol is a cheaper cooking fuel compared to kerosene and LPG; it is slightly more expensive than biomass; and much more expensive than electricity. However, social valuation of ethanol and the alternatives makes ethanol a cheaper cooking fuel compared to both petroleum and biomass fuels. The health and environmental benefits of ethanol compared to petroleum and biomass fuels further improves its competitiveness against petroleum and biomass cooking fuels



### 3. The national policy framework for promoting ethanol as cooking fuel

Ethiopia's vision for 2025 is to become a middle income country in a climate- resilient and green economy path. Climate resilience and green growth are promoted because of the vulnerability of the economy to climate variability (e.g. agriculture), resource limitations of continuing the current development path (e.g. expansion of cropland, increased livestock numbers), the financial risks of depending on traditional technologies (e.g. petroleum imports), and to reduce greenhouse gas emissions (CRGE, 2011).

Protecting and re-establishing forests is one of the four pillars of the green economy plan. Introduction of ethanol as a domestic renewable cooking fuel meets the aim of reducing forest degradation (replacing biomass fuels) and at the same time reduce the financial risks to the economy of dependence on imports (replacing petroleum fuels).

The Draft National Energy Policy (2013) identifies ethanol as a domestic renewable fuel that will improve the security and reliability of energy supply (as transport and cooking fuel). The policy identified the two barriers that have limited scale-up of ethanol as cooking fuel in Ethiopia as inadequate distribution system, and the high cost of purchasing ethanol stoves. The policy recommends increasing ethanol production and improving marketing and distribution for wider adoption of ethanol as cooking fuel.

The policy stressed the need for a systematic value-chain development approach to establish ethanol as a true alternative cooking fuel in Ethiopia. Actions

spanning from research and development in technologies to investment and marketing need to be undertaken by government and private enterprise to achieve this goal.

The mission of the Science, Technology and Innovation (STI) Policy (2012) is stated as "creating a technology transfer framework that enables building national capabilities in technological learning, adaptation and utilization through searching, selecting and importing effective technologies in manufacturing and service enterprises." The current effort to manufacture components of ethanol distilleries (micro and small scale) and ethanol stoves are in line with the STI policy.

### 4. Issues that have inhibited the large scale adoption of ethanol for cooking in Ethiopia

The potential market for ethanol as cooking fuel is half a million or more households by 2025. The current market size is about 3,000 households, i.e., less than 0.5% of the potential. Although it has been ten years since ethanol has been introduced as a cooking fuel in Ethiopia its market is essentially limited to very few households in Addis Ababa. The market for ethanol as cooking fuel has not grown because of availability constraints, rising price for ethanol, inadequate public awareness and marketing, and limited distribution infrastructure and services.

- a. **Availability of supply:** availability of ethanol for cooking has been uncertain since the introduction of the fuel for cooking ten years ago. This has inhibited existing distributors from investing in distribution and also on marketing the fuel. Uncertainty about long-term availability of ethanol in large volumes has also inhibited potential new entrants (such as petroleum companies) from entering the market. Although supply availability has improved recently with special allocation for cooking, however, the market was already depressed because of supply uncertainties in the past, the sharp price rise and distributors could not sell as planned. Investment requirements for ethanol distilleries are high at both large and micro scale. Large distilleries require several hundred millions ETB<sup>3</sup> while micro distilleries require relatively smaller amounts. For instance, a 1,000 litres/day distillery plant costs around ETB 5 million. Investment constraints from the public sector may be addressed by promoting private and foreign investment in ethanol distilleries. Private and foreign investment in ethanol distilleries will depend on competitive supply of sugarcane molasses from government sugar factories and also competitive pricing of ethanol for consumers.
- b. **Alternative options for ethanol feedstock production and processing:** alternative feedstock that are viable in Ethiopia including sweet sorghum, sweet potato, sugar beet, cassava, prickly pear cactus, vegetable and fruit waste, have not been sufficiently explored as possible sources of ethanol production. Small and micro scale processing of feedstock with small and micro scale ethanol distilleries has also not been given sufficient attention in the past. Feedstock production and processing at small scale by private enterprises or cooperatives could supplement large scale production and processing by the public sector.

<sup>3</sup> USD 1 = 20.05 Ethiopian Birr (ETB) (10 December 2014)



- c. **Ethanol pricing relative to alternatives:** ethanol is in competition with wood, charcoal, kerosene, LPG and electricity. The price for ethanol has eroded its competitiveness with these fuels making it less attractive to consumers. The expressed interest of the government to promote the fuel for its economic and environmental benefits does not appear to have been considered in setting its price.
- d. **Public awareness and marketing:** the public is not aware of the existence of ethanol as a potential alternative cooking fuel. Very few households use ethanol for cooking, therefore, few have first-hand knowledge of ethanol as cooking fuel (they themselves using the fuel or seeing others use the fuel). There has also been no public awareness campaign to promote the fuel.
- e. **Distribution capability:** existing ethanol distributors have very limited distribution capacity both financially (to purchase and distribute in significant volumes) and physically (storage and distribution facilities). Existing distributors of ethanol for cooking are essentially small enterprises for whom ethanol distribution is a secondary business. Potential large scale distributors (such as petroleum companies) have yet to enter the market because of supply uncertainties.
- f. There are also inadequate **support for functions in the supply chain:** including technology adaptation (distilleries, stoves), R&D for feedstock, standards and regulations for ethanol fuel and stove, financing of investment and R&D.

## 5. Recommendations for large scale adoption of ethanol for cooking in Ethiopia

The commercial market for ethanol as cooking fuel is very small and limited to Addis Ababa. The market is not growing and probably shrinking because of uncertainties of supply and rising prices. On the other hand, potential availability of ethanol is high from state owned sugar factories (from public and private investment in ethanol distilleries from molasses waste). There is also potential to promote private investment in ethanol distilleries from a variety of feedstock including sugarcane, sweet sorghum, other sugar crops, and crop waste.

There is clear advantage in using ethanol for cooking rather than for other uses including as gasoline blend or export. Cooking can be the largest market for ethanol produced in Ethiopia; cooking with ethanol has multiple economic (at consumer level and nationally) and environmental benefits.

- **Household energy expenditure.** Households that are substituting ethanol will make savings on expenditure on ETB 136 per year and ETB450 per year on kerosene and charcoal, in their respective orders. The aggregate savings over the same period is estimated at ETB 5,131 million and the net present value 10.23% discount rate ETB 2,185 million.
- **Kerosene import substitution and foreign exchange.** The ethanol for cooking programme will allow the displacement of 1,747 million liters of imported kerosene. At the current import price of USD0.65/liter, USD1,135 million will be saved.
- **Avoided energy-related deforestation.** The Programmed will allow the substitution of fuel wood and charcoal amounting to about 33 million tonnes of Fuel wood Equivalent. At 75 tonne/ha of above-ground biomass, this is translated into an avoided deforestation of 441 thousand ha.
- **Job creation.** A total of 118 micro-distilleries of 1,000liter/day capacity will be required to fill the demand-supply gap. These will create approximately 17,200 new permanent jobs over the 15 year time horizon.
- **Green House Gas (GHG) emission reduction.** Over the 15 year period, the Programme will allow the avoidance of 65million tonnes CO<sub>2</sub> equivalent. Based on a market price of USD5.00/tCO<sub>2</sub>e, it could generate USD325 million in carbon revenues.

Private enterprises distributing ethanol as well as the public institutions that produce ethanol and promote its use as cooking fuel agree market development to be the key goal. Sustainable market development requires suitable policies and regulations, investment in ethanol production and distribution, promotion and marketing. The following actions need to be taken for ethanol to become a viable alternative cooking fuel in Ethiopia:

- a. **Increase ethanol production and ensure long-term availability.**
  - Increase ethanol production from government sugar factories through both government and private investment. Government should promote private investment (local, foreign, joint) in ethanol distilleries for the new sugar factories. There is already such a plan by the government but this plan must be pursued strongly. Investors also seek competitive and stable prices for inputs (molasses purchases) and outputs (ethanol wholesale) and government must provide long-term price incentives to attract private investment.
  - Promote diversity of ethanol production feedstock (other than sugarcane molasses). Provide policy guidance for feedstock cultivation for ethanol production to increase and diversity ethanol production sources and to attract investment. The Bio-fuel Policy does not provide guidance on whether feedstock other than sugarcane molasses (and sugarcane) can be used as ethanol feedstock. Clear policy guidance on this will attract investment in ethanol distilleries.



- Ensure/secure/guarantee long-term (10 years) sustained supply of ethanol for cooking at growing levels from government ethanol distilleries. Guaranteed allocation of sufficient ethanol for cooking will increase market share for ethanol in urban areas. Allocation should be based on market demand assessment for the fuel.
- Increase R&D in ethanol distilleries and ethanol stoves to lower supply costs. Ethanol micro distilleries promote rural agro-industry. This is an area that is given high priority for investment by the government together with manufacture. Micro distilleries also promote rural commercialization which is a strategic focus for the agriculture sector. Investment in micro distilleries will therefore receive the investment incentives outlined above.

**b. Price ethanol competitively to increase its market share.**

- Implement social valuation of ethanol to ensure that non-financial benefits of ethanol are reflected in its price. Make rationale economic, social and environmental valuation of the benefits and costs of using ethanol for cooking, as gasoline blend or for export. Allocation and pricing of ethanol among the alternative uses should be based on such rationale valuation not on enterprise level decisions.
- Provide tax exemptions for ethanol if production cost for ethanol exceeds levels that make it competitive with other cooking fuels (this will of course depend on the economic/social price of ethanol).
- Provide long term outlook for price development for ethanol to ensure sustained engagement of investors in ethanol distilleries and ethanol distribution.

**c. Integrate ethanol as a clean cooking alternative in the National Improved Cook stoves (NICS) program of Ethiopia. Clean cooking with ethanol will then benefit from national efforts for public awareness and education, standards and their regulation, financing, and RET enterprise development.**

**d. Distribution capability: provide incentives to existing distributors and potential new distributors to invest in distribution of ethanol.**

- Attract large companies (e.g. petroleum distributors) to engage in ethanol distribution (through supply guarantees, attractive distribution margins)
- Provide alternative distribution models for ethanol (bottled ethanol, ethanol at the petrol pump)

- Provide investment incentives for ethanol distributors to invest in storage and distribution infrastructure; also provide low-cost safe designs for storage and distribution of ethanol.
- Develop and implement safe ethanol storage and distribution standards.

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Gaia Association is an Ethiopian resident charity organization established in 2005 to promote the use of renewable ethanol fuels for household energy in Ethiopia. The Gaia Association seeks to reduce household energy dependence on imported petroleum and hazardous solid bio-fuels, improve indoor air quality by preventing smoke-related health problems, and increase user safety and quality of life.

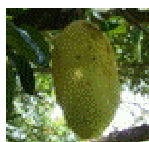
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**Alternative feedstock for Ethanol Production**



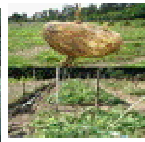
Sugarcane



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Cactus



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