HOLISTIC FEASIBILITY STUDY OF A NATIONAL SCALE-UP PROGRAM FOR ETHANOL COOK STOVES AND ETHANOL MICRO DISTILLERIES (EMDs) IN ETHIOPIA

REVIEW OF NATIONAL POLICIES, STRATEGIES AND PROGRAMMES

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1. Introduction

1. The production and utilization of ethanol fuel in substitution for imported petroleum fuels and solid biomass addresses three key energy policy objectives of energy security, environment, and rural development. However, experiences of the countries that have succeeded in the development of their ethanol industry (Brazil and the USA) demonstrate that much of their success owes to government policies and regulations. The expansion in ethanol plant capacity in Brazil and the USA are directly linked to government regulations. The future of ethanol fuel in Ethiopia will greatly depend on policies and regulations. This report provides review of policies, strategies and programmes in Ethiopia that are relevant for the development and utilization of Ethanol fuel for cooking.

2. The report is structured as follows. The following section provides the context for development of ethanol for cooking in Ethiopia. This is followed by review of relevant policies and strategies in section 3. These are the draft Ethiopian National Energy Policy 2013 (draft), Biofuels Development and Utilization Strategy (2007), the Government's Growth and Transformation Plan (2010-2015), Fuelwood-Efficient Stoves Investment Plan (2012-2016), and Ethiopia’s Climate Resilient Green Economy (CRGE). Finally, Section 4 provides some of the conclusions and recommendations. Annexes include Review of ProAlcohol Programme in Brazil.

2. Background

3. Like most Sub Saharan countries, a marked feature of Ethiopia’s energy sector the high dependence on biomass (firewood, charcoal and crop residues). According to the Ministry of Water, Irrigation and Energy (MoWIE)\(^1\), in 2007, approximately 89% of the total final energy consumption was derived from bio-energy (see Figure 1). Firewood and charcoal combined accounted for 74% percent and agricultural residues (dung and crop residues) for 15% percent.

4. Petroleum and electricity play a less important role in the national energy supply system. Their share in total consumption is 11% (8% petroleum fuels and 3% electricity).

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According to a recent survey by the Central Statistics Agency (CSA), 96% of Ethiopian households (15.5 million households in 2011) used biomass fuels as their main sources for cooking. At country level, about 81.4 percent of the households use firewood, around 11.5 percent cook with leaves/dung cakes and only 2.4 percent use kerosene for cooking. The majority of rural households use firewood (84.4 percent) and few of them (12.7 percent) use leaves/dung cakes (see Figure 2).

The use of modern source of cooking fuel such as butane gas, electricity and kerosene for cooking is uncommon in the rural areas (0.4 percent). Use of kerosene in urban areas stands at 13.8 percent following firewood (65.4 percent). Charcoal (7.7 percent), electricity (2.4 percent) and leaves (5.3 percent) are also used rarely by urban households. On the other hand, only 0.2 percent of the households in rural areas are observed to use charcoal for cooking. In the previous surveys, however, no household was reported to use charcoal as source of cooking fuel.

Cooking fuels use in the urban areas change quite frequently due to changes in prices and availability of fuels. A significant change has taken place between 1996 and 2004 where the number of households who reported kerosene as their primary cooking fuel has declined in both relative and absolute terms. Households that would have used kerosene as their primary cooking fuel have switched to other fuels by 2004. The reduction in kerosene users is accompanied by an increase in the number of households cooking with fuelwood. This suggests a large proportion of kerosene users may have shifted to fuelwood or moved from using mostly kerosene to using mostly fuelwood. Such a shift towards a less convenient and efficient fuel suggests price may have been the main driver.

The consequences of the prevailing energy supply and consumption pattern include:

- Growing demand and biomass resource over-exploitation has increased households' costs of energy acquisition and eroded household welfare;
- Loss of human availability for productive work due to time spent on collecting firewood. Over 70% of households collect firewood and about 25% travel at least 5
kilometers.\(^2\) Many children, especially girls, are withdrawn from school to attend to domestic chores related to biomass use, reducing their literacy and restricting their economic opportunities;

- Exposure to indoor air pollution from solid fuels leads to premature deaths. In Ethiopia 56,460 deaths per year are directly attributable to indoor air pollution from the use of solid fuels, more than 90% of them children under five years of age\(^3\);  
- Deforestation and general environmental degradation;  
- Reduction in agricultural production and productivity due to the use of valuable soil conditioners and organic fertilizers and animal fodder (dung and crop residue) for fuel; and  
- With decline in biomass resource availability, the livelihood of millions of people who depend on the biomass energy value chain is threatened.

9. Ethanol fuel offers substantial opportunities for substitution of solid biomass and kerosene consumption in Ethiopia. The development of Ethiopia’s bio-ethanol sub-sector has been hampered by a combination of factors including poor institutional framework and lack of a comprehensive study on the economics of ethanol for cooking as well as on the technical and economic viability of small-scale ethanol production. In order to address these challenges, Gaia Association in partnership with the Ministries of Water, Irrigation and Energy; and Environment and Forest; the Horn of Africa Regional Environment Centre and Network (HoAREC&N); and Project Gaia Inc., has initiated the present “Holistic Feasibility Study of a National Scale-up Program for Ethanol Cook Stoves and Ethanol Micro Distilleries (EMDs) in Ethiopia”. The Project is financed by DIFD’s Strategic Climate Institutions Programme (SCIP).

10. The overall objective of the “Holistic Feasibility Study of a National Scale-up Program for Ethanol Cook Stoves and Ethanol Micro Distilleries (EMDs) in Ethiopia” is to contribute to the development of the bio-ethanol sub-sector in Ethiopia by analyzing the feasibility of ethanol micro distilleries and ethanol fuel for cooking and articulating an action plan. The Project is expected to improve energy access, enhance the contribution of bio-ethanol towards income and employment generation/diversification in the rural areas, and contribute towards a low-carbon energy path in Ethiopia.

11. The Project components are: (i) review of policies and strategies, investment opportunities in the ethanol sub-sector in Ethiopia; (ii) economics of large and small-scale ethanol production including assessment of alternative feedstock; review of technological options and industrial manufacturing capacity for EMDs and ethanol stoves (stove standards); (iii) analyses of the market for ethanol for cooking (households, commercial, social services): a national energy market survey and (iv) a Comprehensive Feasibility Study and proposed Action Plan.

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3. **Review of Relevant Policies, Strategies and Programmes**

3.1. **Ethiopian National Energy Policy 2013 (draft)**

1. The draft Ethiopian National Energy Policy was completed in 2013 by the Ministry of Water, Irrigation and Energy (MoWIE) following a participatory process involving a large number of stakeholders. The main energy policy objective is to “ensure the availability, accessibility, affordability, safety and reliability of energy services to support accelerated and sustainable social and economic development and transformation of the country”. The main energy sector issues that the updated energy policy aims to address include:

   - Energy poverty;
   - High dependence and unsustainable use of biomass resources;
   - Wasteful and inefficient energy production, transportation and utilization;
   - Low institutional, human and technological capacity;
   - Low private sector participation;
   - High dependence on imported petroleum fuels’
   - Climate change impacts on national development and energy sector;
   - Weak enforcement of Standards and Regulations; and
   - Inadequate transfer of technology and localization.

2. The key bio-energy sub-sector issues outlined in the chapter on bio-energy include:

   - High degree of dependence on biomass resources;
   - Unsustainable use of biomass
   - Difficulties in biomass production, transportation and utilization;
   - Lack of regulations and standards;
   - Lack of reliable and up to date data;
   - Lack of distribution system e.g., ethanol use in the domestic sector;
   - Low technological transfer and localization
   - Low participation of investors e.g., in forestry, biofuels development; and
   - Lack of access to financing.

3. The updated draft Energy Policy clearly stated the need for developing renewable energy resources and substitution of fossil fuels and traditional energy use in the household and other sectors of the economy. The delivery of alternative energy supplies would help increase the national energy supply mix and also reduce the burden on the biomass resources.

4. The policy identifies supply and demand side policy objectives and policy instruments for the bio-energy sub-sector. The policy instruments to enhance diverse and efficient bio-energy production as stated in the document include:

   - Promote improved bio-energy conversion technologies including agro-industrial waste;
   - Introduce small and medium scale bio-fuel processing technologies;
   - Promote technology transfer for second generation bio-fuel processing;

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4 The draft Policy updates the National Energy Policy formulated in 1994. The rationale for the policy update is to “align energy sector development strategies to the current national development strategies, and also to give emphasis to the development and utilization of renewable energy sources and support the climate resilient green economy strategy of the Country.”
• Provide a favorable environment for private investor in bio-energy production such as land, tax, infrastructure, security, and legislative support;
• Encourage the development of local capacities for bio-energy equipment and appliance manufacturing;
• Strengthen and promote market based private sector participation in biogas development;
• Involve all stakeholders including NGOs and CBOs in small and large biodiesel development activities in rural villages and in remote locations;
• Support private sector involvement in productions of bio-energy technologies;
• Facilitate the establishment of centre of excellence for bio-energy system production and know-how; and
• Strengthen R&D in the bio energy sector.

5. The policy instruments to ensure bio energy supply security include:

• Develop awareness for commercial farms and homesteads to grow and use their own bio-fuels;
• Developing and strengthening standards to increase bio-energy production;
• Regulate the distribution of bio-energy;
• Promote the sustainable exploitation of wood resources such as bamboo;
• Diversify and promote use of indigenous energy resources;
• Promote bio-diesel for household energy use; and
• Promote use of bio-energy by establishing processing, distribution, transportation and marketing infrastructure.

6. The development and utilization of ethanol fuel for cooking will contribute to the achievement of the national energy policy objectives: improve energy supply mix, enhancing supply reliability and security, increases development and utilization of indigenous renewable energy resources, helps improve energy efficiency in use, and, increases local dependency for the supply of modern energy sources. Small scale ethanol development encourages participation of local communities and the private sector in the energy sector development program of the country. The updated draft energy policy clearly identifies the policy instruments to the development of bio-energy (including ethanol) resources.

3.2. The Biofuels Development and Utilization Strategy of Ethiopia

7. Ethiopia is already implementing biofuel strategy since October 2007. The overall objective of the strategy is to facilitate adequate production of biofuel from indigenous resources so as to substitute imported petroleum and export excess products.

8. The strategy was formulated based on principles that development of biofuels should not have unintended consequences on food security, land access, the environment, cultural values and the economy. The strategy has also clearly outlined the need for participation of local communities (farmers, pastoralists and the private sector) in development of biofuels so that they can be beneficiaries of the development.

9. The biofuels strategy document identified some energy crops such as sugarcane, Jatropha, castor and palm trees as potential feedstock for ethanol and plant oil production for energy use. Other appropriate feedstock can also be considered as long as they fulfill the
sustainability criteria emphasized under this strategy and the general environmental policy of Ethiopia.

10. The driving factors of this Strategy are

1. **Economic:** the country is spending the largest proportion of foreign exchange earning to import fossil fuel. The cost of petroleum fuel is increasing at an increasing rate and there is no sign that it will go down. This led to the drafting of the biofuel strategy for sustainable inclusion of biofuel into the economy as renewable and alternative fuels. These fuels are becoming more and more important in the world market.

2. **Political:** as a land locked and net importer of petroleum, Ethiopia would like to be energy secure. Any problem that affects the transaction of petroleum into Ethiopia has the potential to disrupt the entire economy. It is to this extent that the country likes to be energy secured.

3. **Natural Resources:** Forest depletion and soil erosion is a widespread phenomenon particularly in the highlands. With the increase of population, the need for construction, furniture and fuel wood accelerates the depletion of natural forest. Increase in human and livestock population exerts enormous pressure on land and water resources. It is expected that alternative energy source to fuel wood would improve the quality of life, natural resources regeneration and soil fertility enormously.

4. **Climate Change:** Fossil fuel or petroleum increases the accumulation of carbon dioxide and toxic gases in the atmosphere. The increase of carbon dioxide increases temperature in the atmosphere known as commonly the greenhouse effect.

5. **Rural Development:** During the last ten years, the local as well as international market of biofuels is expanding. Hence, there is a good opportunity to export biofuels creating employment and business opportunity for rural poor.

11. In the Ethiopian context biofuels includes biodiesel and bioethanol. Biodiesel is obtained from *trans-esterification* of vegetable oils such as from palm, castor, and physic nut. In this report the part of the policy and strategy on bioethanol is assessed.

12. Bio-ethanol has been blended with fossil fuel at 5% and available to gas stations in and around Addis Ababa since 2009. According to the MoWIE, a total of 4.7 million liters of ethanol was blended with gasoline and more than US$ 37 million was saved by displacing gasoline. Although to-date ethanol has been used for blending, the Strategy stresses the use of bioethanol for cooking to replace kerosene.

13. Ethiopia has 0.7 million hectare of suitable land for sugarcane production. Furthermore, if this all the land is fully utilized, the amount of ethanol that can be produced on this land is estimated at one billion liters. Currently, there are two private and nine government sugar estates with a total potential land holding of 342,000 ha. In addition, this amount can be supplemented with other crops such as sweet sorghum and sugar beets.
14. The general and specific objectives of the Strategy stress on the substitution of imported petroleum products by renewable sources and support the economy through import substitution and export, climate change mitigation, employment generation and support agro processing sector. The values and principles of the strategy are;

- Production will not compete with food production;
- Production will not compete with grazing and farm lands as well as water;
- Will include broad participation of small scale farmers and pastoral and agro-pastoralists;
- Production will not threaten biodiversity an environment;
- By-products have no harm to the environment and shall be utilized for various economic benefits; and
- Will be implemented in line with international agreements and protocols.

15. The strategy encourages participation of the private sector in feed stock production as well as biofuels processing and research towards development and manufacture of bio-ethanol stoves for household purposes. In addition, it is indicated that the possibility of manufacturing stoves locally has a paramount importance.

16. The scaling up of bioethanol micro distillers and cooking stoves are miscible and complementary to biofuel policy and strategy due to the following factors:

1. **Environment factor:** the bioethanol cooking stoves saves forests by reducing the amount of fire wood. It also contributes significant reduction on greenhouse gas emission that could come from burning of kerosene.

2. **Food security factor:** In many instances the major constraint for decline of soil fertility is that crop residues and animal waste are used as fire wood. Bioethanol cooking stoves improves soil fertility by increasing the level of organic matter, organic carbon and nitrogen to the soil. Improving soil fertility increases food crop production particularly those in homesteads such as *enset* and coffee. Food security cannot be improved by crop production alone.

3. **Employment and business factor:** bioethanol micro distillers and cooking stoves can generate employment opportunity in urban and rural areas. First, production of feed stocks involves participation of the rural poor. Second bioethanol could generate business opportunity in retail market similar to Kerosene and cooking oil.

4. **Economic factor:** Bioethanol substitutes kerosene that requires foreign currency to import.

5. **Health factor:** Bioethanol stoves do not have smoke and smell that affects the health of mothers and children. Bioethanol does not emit carbon dioxide, carbon monoxide, sulfur dioxide, sulfur monoxide, nitrous oxide etc. rather it creates health environment at home as compared kerosene, charcoal and fire wood.

6. **Social factor:** Bioethanol cooking stoves decreases the time and effort wasted by women and mothers to gather fire wood. Some could use charcoal who can afford it but is likely expensive and hazardous. The availability of bioethanol cooking stoves saves enormous time and effort for mothers and increases their time to spend with their
children. In addition, the time wasted by children to gather firewood could be spent on their school matters.

17. The scaling-up of bioethanol micro distillers and cooking stoves is on the top of the Government’s energy policy and strategy. The Biofuels strategy stresses on the participation of the private sector including small scale farmers in feed stock production, bio-ethanol processing, stove manufacturing and retail.

18. The biofuel strategy empowers the private sector participation through financial assistance and provision of technology and scaling up. Public institutions namely the Ethiopian Agricultural Research Institute, the Research and Training Directorate of Sugar Corporation and Universities are supplied with finance to carry out research on feed stock production and bioethanol processing technology. Right now all recipes for sustainable utilization of bioethanol micro distillers and cooking stoves in Ethiopian economy are in place.

19. To ensure sustainable development and utilization of biofuel, the Government of Ethiopia released the biofuels development and utilization strategy. The Biofuels strategy provides an implementation guideline in order to ensure the achievements of the national energy policy objectives while avoiding unintended consequences.

20. In the price structure of fuels, kerosene is exempted from value added tax while ethanol is not. This will affect the market development effort for ethanol in the household sector. Hence, price setting for ethanol for cooking fuel use should be consistent and in support of the policy.

3.3. The Growth and Transformation Plan

21. Biofuels development and utilization is given due emphasis in the Government’s five year (2010-2015) Growth and Transformation Plan (GTP). Regarding development of ethanol the GTP target to increase production to nearly 200 million liters at the end of the planning year.

22. The strategy plan envisages development of large scale sugar industries by the government and the private sector which would also produce the targeted amount of ethanol. As an implementation strategy the GTP also promotes distributed production of bio-fuels at farmers scale in rural areas.

23. Ethanol is primarily considered for transport fuel in the plan but it is also inferred from the plan that it can be one of the alternative sources of cooking energy which would reduce deforestation, indoor air pollution and also contribute on saving working time of women and children wasted for searching, collection and transportation of cooking fuels.

3.4. Fuelwood-Efficient Stoves Investment Plan (IP)

24. As the GOE identified fuelwood-efficient and fuel-shift stoves as one of the immediate priorities to the development of Climate-Resilient Green Economy (CRGE), this Investment Plan has been formulated. The aspiration and focus of this initiative has two horizons i.e. (i) in the long term (2030) deploying 31 million fuelwood-efficient stoves in rural and urban areas, and (ii) in the short term (2015), 9 million stoves in rural areas.
25. The Investment Plan (2012-2016) targets to disseminate 9 million improved cookstoves by improving activities across the entire value chain of stove production and bundles these activities in improvement programmes. In this context the IP addressed most of the potential barriers that hinders large scale dissemination of ICS especially in the rural areas.

26. For successful implementation of ICS projects/program that adopts commercialized approach for the sake of sustainability, there is a need to devise a strategy that address the 5 Ps marketing mix (Product, Price, Place, Promotion, and People). Getting the right product that is needed by the people and has the required solution, with affordable price that make them believe that they paid for the value that they are looking for, at the right place where they can access it, by conveying the right promotional message that the consumers would like to hear and say about it. More over the consumers that love the brand of the product are also expected to be our promoter to the other people that we intend to serve and supply our product.

27. When we review ICS intervention in different countries the main reasons for not achieving large scale dissemination of ICS is lack of having the marketing mix properly in place. There is either lack of awareness about the ICS that required to be promoted, if at all there is awareness; lack of access to the stoves and/or lack of finance (at users as well as producers level), etc. are the main challenge for the success of the intervention.

28. Looking at the Promotion and distribution programme of the Investment Plan (IP), these major bottlenecks have been well addressed and strategies have also been formulated. This section covers three main activities:

- Increase awareness of high-efficiency stoves;
- Create distribution channels for stoves in rural areas; and
- Introduce smart-subsidies in non-viable market environments.

29. Moreover though this investment plan assumes the usage of Gonzyie and Tikikil stoves as technologies for baking and cooking stoves to calculate programme costs, it clearly stated that this is not a prescriptive decision on which technology must be used by producers. The only requirement the IP put is that fuelwood savings of the stove used is around 50%. Therefore in this regard there is a need to advocate that promotion of ethanol clean cookstoves will be a breakthrough as it fully replace the use of fuelwood and needs to be incorporated in the range of technologies that are stated as a fuel shift options.

30. There a need for further work on the strategy on issues of creating distribution channel for both the ethanol stoves and the ethanol fuel. Though it is clear that it is very important to focus on rural areas there is also a need to address the issue of creation of distribution channel for the urban areas too.

31. The importance of integrative effort with other development partners like Health and Agriculture sectors is also emphasized which is the key for sustainable intervention. In this regard it is also worth to incorporate Women's Affair offices as it has a very good extension structure that contributes for the success of the intervention, especially in promotion and marketing task through mobilization and awareness creation related tasks.
3.5. Ethiopia’s Climate Resilient Green Economy (CRGE)

32. Degradation of forest resources due to unsustainable harvest of biomass for cooking and clearing of forests for agriculture are the major problems identified in the CRGE. The household energy sector particularly cooking energy situation has been identified as an opportunity to make significant environmental and social impacts by reducing the demand for fuelwood which would, in turn, reduced emissions and unsustainable harvest of biomass resources.

33. To achieve this, the strategies devised are wide-scale dissemination of fuel efficient cookstoves and shift to other alternative cooking energy sources with less carbon intense fuels. Use of ethanol as cooking energy would address both efficient utilization of the resources and is also a shift away from fuelwood.

34. Improved cooking/baking technologies are well considered as a tool to reduce forest degradation as fuelwood consumption is considered as the main source of GHG emissions in Ethiopia. As most of the households, particularly in rural areas, use highly energy-inefficient technologies (e.g., open fire or three-stone technology) it is clear that there is a huge improvement potential of this inefficient use so as to address forest deforestation as well as reduction GHG emission.

35. The dissemination of improved technologies for efficient use of biomass resources and/or shifting to other less carbon intense fuels are considered as the main intervention area to address this issue. In this regard, the document underlines the importance of ethanol for cooking is to be included in the way forward.
4. Conclusions and Recommendations

4.1. Conclusions

36. The updated draft National Energy Policy addresses many of the limitations of the previous National Energy Policy (1994). Issues related to biofuels development are a recent development and were not properly addressed.

37. The updated policy highlighted the multifaceted importance of ethanol from energy security, green growth, affordability, and safety points of view and has clearly identified policy instruments that need to be adopted for development and widespread utilization of biofuels. The updated policy is generally supportive of the development and utilization of ethanol fuel for cooking. However, there remain gaps in policy implementation. The limitations observed are not in the policies and strategies, per se, but rather gaps in policy implementation.

4.2. Recommendations

38. The ethanol industry in Brazil owes much of its success to government policies and regulations. The expansion in ethanol plant capacity can be directly linked to government regulations. The future of ethanol fuel in Ethiopia will greatly depend on government support. The motivations behind the government support for ethanol are environmental, energy independence, and rural development. The recommendations below are for effective marketing and wide spread use of ethanol as a household cooking fuel:

a) **National Ethanol Programme.** The Government needs to adopt a national Ethanol Programme to articulate a clear long-term direction and coordinate actions.

b) **Awareness Creation and Promotional Campaigns** - Comprehensive consumer information campaigns to promote ethanol for cooking incentives and increase credibility of the technology.

c) **Duties and taxes.** Inconsistent treatment of renewable energy technologies is widely observed. Energy conversion technologies and end-use devices for solar and wind resources are benefiting from favorable import taxes\(^5\). Ethanol distilleries and ethanol stoves are not treated equally in the implementation of the policy. Ethanol fuel should receive similar treatment as solar energy technologies.

d) **Ethanol Pricing** - Differential pricing of ethanol fuel for blending and for cooking are under implementation. Therefore, the Government should rationalize its pricing policy. Also, the Government should rationalize its pricing policy for cleaner and renewable fuels against imported kerosene.

e) **Standards** - Technologies that are either imported or locally manufactured should meet minimum required standard to ensure safety, efficiency and functionality. There are several types of cookstoves including ethanol stoves in the market place that are different in performance, usability and safety. Certification of alcohol stoves. Quality

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\(^5\) A directives for duty tax exemption for renewable energy technologies passed to Ethiopian Revenues and Customs Authority listed Solar and Wind technologies with the balance of system but not included technologies for biomass and biofuels. (Source: Directive for duty free exemption for Renewable Energy Technologies (RETs), Letter dated 07/04/2002 EC (16Dec2010), Ref. No. - ያሆ,30/47/1.)
ethanol cookstoves should clearly be differentiated from inferior products. Bad stoves can retard the introduction and uptake of good stoves. The Government needs to adopt quality standards for alcohol stoves. Necessary standards and quality control mechanisms for renewable energy sources/fuels and conversion technologies should be put in place so that the policy objectives would be maintained. Institutions established to set and regulate quality standards need the necessary capacity building support.

f) **R&D support** - The Brazilian ethanol development experiences revealed that investments in sugarcane agronomic research is pivotal for lowering production costs, and allowing ethanol producers to survive without government subsidies. Specific actions to develop new sugarcane varieties should be considered.

g) **Infrastructure Investments** - The draft national Energy Policy recognizes the importance of investments in bio-fuels infrastructure. The policy therefore focuses appropriately on investment in ethanol fuel storage and distribution facilities, and cooking appliances. Such investments will resulted in lower consumer prices and will greatly increase the uptake of ethanol fuel for cooking.
Annex 1
Brazil’s National Alcohol Programme (ProAlcohol)

1. Objectives

The ProAlcohol Programme was established as a response to the 1973 oil crisis and had three explicit objectives:

   a) Improving commercial balance by reducing the demand of imported fuel;
   b) Improving agricultural production; and
   c) Expanding the production of domestic capital goods through rising demand for agricultural and distillation equipment.

The Programme boosted ethanol use in the country through a variety of methods.

2. Measures Taken

Supply Side Measures - On the production side, the main incentives were agriculture and industrial financing, production acquisition guaranteed, and fixed subsidized prices. Measures included:

   • A yearly production quota for both sugar and ethanol produced by farmers and millers;
   • Production goals for ethanol (3.5 billion litres by 1980, and 10.7 billion litres by 1985);
   • Fixed prices aimed at parity between ethanol and sugar, despite more attractive international prices for sugar than for ethanol (competition subsidy).
   • Low interest loans to ethanol distilleries through the Bank of Brazil, and favorable credit conditions for mills to increase their production capacity.

Demand Side Measure - On the demand side, measures adopted by the government included:

   • Mandatory blends for ethanol in gasoline (progressively increased to 25%);
   • Subsidized and regulated prices for ethanol. A price cap guaranteed that ethanol prices; would not be higher than 65% of gasoline prices at the pump, increasing attractiveness for consumers;
   • Making the sale of ethanol at gas stations compulsory

R&D - The supply and demand side measures were supplemented by with the following R&D support:

   • Investments in sugarcane agronomic research were also pivotal for lowering production costs, and allowing ethanol producers to survive without government subsidies. The bulk of this agricultural research has been done by the public sector;
   • Research in agriculture, to develop new sugarcane varieties;
   • Investment in the fuel distribution infrastructure;
• Comprehensive consumer information campaigns to advertise the incentives and increase credibility of the technology.

3. Lessons learned

• State intervention through policies and the allocation of a large quantity of governmental subsidies, distributed to the ethanol producers, consumers and to the car manufacture industry were directly responsible for the success of the Brazilian Ethanol Programme.

• In particular, the government had a very important role in supporting the market in its enfant phase and during its crisis in the 1990s; (ii) investing in infrastructure; (iii) investing in R&D to reduce costs and increase efficiency; and, finally, and (iv) gradually reducing support and state intervention.