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INVESTING IN OUR PLANET

THE ROLE OF BIOENERGY IN THE CLEAN ENERGY TRANSITION AND SUSTAINABLE DEVELOPMENT

LESSONS FROM DEVELOPING COUNTRIES

4

LIQUID BIOFUELS – THE ALCOHOLS

4.1 Introduction

Liquid fuels are the most portable of fuels; they are an efficient and affordable way to transport energy to distant areas. Liquid biofuels are produced from organic matter through one of several physical, biological or thermochemical processes, including fermentation, pyrolysis, gasification and catalytic conversion or direct extraction and transesterification. Liquid biofuels are also produced by anaerobic digestion and direct partial oxidation or gas synthesis. Fuels produced by the recombination of hydrogen and carbon are referred to as synthetic fuels or synfuels. The most developed liquid biofuels are ethanol, methanol and biodiesel.

Liquid biofuels are traded globally and have been historically used in transportation, lighting, heating, cooking and electricity generation. They lost currency with the rise of petroleum fuels and were displaced by kerosene, gasoline and diesel fuel. However, they have regained popularity for fuel blending and flex-fuel engines. For example, in Brazil and the United States, the production and use of bioethanol was supported by forward-looking policies, including the National Alcohol Program (ProAlcool) in Brazil, 1975, and the Renewable Fuel Standard (RFS) in the US, 2005.

Ethanol and methanol, the two simplest alcohols, have begun to emerge from under oil's dominance for compelling reasons. These include their environmental benefits, such as their potential to be renewable and to recycle waste, the fact that they burn cleanly, are biodegradable, and are low-carbon fuels. Their socioeconomic benefits include their ability to be produced at low cost, through well-established pathways with relative ease, on a large or small scale. Liquid biofuels also have significant health benefits over other fuels, including wood and kerosene, as their use for cooking has been discouraged by the World Health Organization (WHO).

The three case studies presented next illustrate the opportunities created by bioethanol production and use. The focus on this liquid biofuel is based on its widespread application. It is produced in almost every country, including DCs and LDCs. In addition, the capital cost of very small plants is relatively low and competitive when compared with ethanol production costs in large plants. These smaller plants are micro distilleries, which are defined as producing up to 5,000 liters of ethanol per day. Ethanol is produced most easily from sugar and starch feedstocks, which are often by-products or wastes of other agro-industrial processes, such as sugar, food and beverage production.

4.2 Case Study #1: Tanzania bioethanol cooking program – a stove and fuel delivery facilitation project

Selling cook stoves at a local market. (Source: Project Gaia Inc.)

4.2.1 Project background

UNIDO, in collaboration with the Vice President's Office, Division of Environment, of the United Republic of Tanzania, is implementing a five-year GEF-funded project to promote the use of bio-ethanol as a clean, alternate fuel for cooking in Tanzania's largest city, Dar es Salaam. They are working together with partner institutions, including the TIB Development Bank. The project is spearheading an innovative approach, the Market Enabling Framework (MEF) – a private sector-driven market model with a target of 500,000 households adopting ethanol cookstoves by 2024, and to set up a fuel supply chain that sources, delivers and retails ethanol fuel to cookstoves in the Dar es Salaam market. The approach harnesses GEF and European Union funds to facilitate a rapid switch in cooking habits in households primarily reliant on charcoal and fuelwood for cooking. It also sets up, through the TIB Development Bank, a Private Sector Guarantee Fund (PSGF), to assist with financing infrastructure needed for an ethanol cooking fuel economy.

4.2.2 Supply and value chain

The MEF is a unique project design. The goal is to induce households to switch to a modern ethanol cook stove, priced competitively compared to traditional stoves.

The MEF assists the distributor to place a stove in the hands of the consumer at a competitive price. The distributor also sources and delivers the fuel. Thus, the MEF provides facilitation on the demand side, with a small subsidy on cook stoves. It also offers extensive business and technical support to the distributor. Moreover, the MEF seeks to build capacity within the policy and regulatory bodies of Tanzania and facilitate the adoption of standards, both for ethanol cooking fuel and ethanol stoves. It seeks to establish a supportive policy framework for the use of ethanol fuel. It also seeks to share knowledge with appropriate institutions engaged in research and development. UNIDO is working with the Tanzanian Bureau of Standards (TBS) and with private sector stakeholders, such as the Tanzanian Private Sector Foundation (TPSF), to support the collaborative process of developing standards. It is also working with the Sokoine University of Agriculture and the University of Dar es Salaam to build and share knowledge.

On the supply side, it offers financial support through the PSGF, which is designed to catalyze commercial lending for infrastructure development for producers by reducing lender's risk. The MEF team networks with sugar producers to encourage the use of molasses, an often-wasted by-product of sugar production, for distillation to ethanol fuel, thereby ensuring principles of circular economy.

Tanzania has 11 sugar factories around the country, large and small. Currently, the country produces just under 28 million liters of ethanol annually. Yet, based on its sugar production, it could be producing 365 million liters annually. Tanzania is a sugar-deficit country, importing sugar to meet its domestic needs. Therefore, it is likely that Tanzania's sugar sector will continue to expand. In addition, the UNIDO/GEF project also seeks to encourage the development of micro distilleries to process smaller agricultural waste streams. Examples of these are cashew apples, the sugary waste from cashew nut harvesting, and sisal boles, a waste in the sisal industry. Other agricultural feedstocks are of interest as well, most notably cassava. The MEF seeks to accomplish delivery through the private sector after years of planning, stakeholder consultations and a pilot study of 150 stoves from 2014 to 2015 in Zanzibar.

The distributor chosen for the first phase of the project was Consumer's Choice Limited (CCL), a logistics and wholesale company with experience in buying and selling ethanol. They will distribute up to 110,000 stoves under the GEF-6 subsidy program in an assigned sales territory in Dar es Salaam. During phase two, two or three more distributors will be selected to create competition in the market.

One of the first things that CCL had to do once they were selected was to choose an ethanol stove supplier on an open tender. The winning bid was from CleanCook, a Swedish company with manufacturing facilities in Durban, South Africa. CCL's next move was to build its supply chain and secure financing from its banker to import the cook stoves. They built a fuel supply depot and a semi-automatic bottling plant at their industrial premises in Dar es Salaam to bottle fuel in one-, two-, and five-liter returnable HDPE containers. They secured contracts for supply of ethanol fuel from their suppliers. They signed an agreement with the stove company to assemble the stoves locally, with an eye to eventual local manufacture, and set up a stove assembly workshop adjacent to their fuel bottling plant. The first stove shipments arrived in October 2019. CCL leveraged approximately USD 282,000 with the bank to import the first 12,870 stoves and spent USD 775,000 to build and supply their fuel storage, handling, bottling and marketing operations. Thus, slightly over USD 1 million has been invested commercially so far in the project.

CCL began selling stoves in earnest in February 2020. To date, they have sold approximately 1,000 stoves in their assigned territory in Dar es Salaam. Just as sales volumes were on the rise, the COVID-19 pandemic hit Tanzania and Dar es Salaam went into quarantine. As a result of a government request, CCL quickly adapted to the situation to produce hand sanitizer. They joined Tanzania's largest ethanol producer, Kilombero Sugar, in donating pharmaceutical-grade ethanol to the effort. This was an opportunity for CCL to remind the public about clean cooking with ethanol, sharing the message: "Clean Hands, Clean Fuel, Clean Air."

Twin burner cook stove in Tanzania. (Source: Project Gaia Inc.)

4.2.3 Project assessment: benefits, success factors, challenges [12]

The program targets and indicators have a strong focus on women's empowerment, cleaner production, low-carbon technology, inclusive livelihoods, health, access to finance and social services, and innovative partnerships.

By developing a market for ethanol cooking fuel in Dar es Salaam, the project achieves the following:

1. demand in the agricultural sector to produce fuel from agricultural residues and wastes;
2. opportunity for value-add investment in the agricultural sector;
3. economic stimulus to the rural economy, encouraging jobs and the benefits that go with cash earnings, including an economic multiplier effect that will impact many aspects of daily life; and
4. response to a fundamental, unmet need in the city, namely clean and convenient cooking, and pollution-free homes.

One liter bioethanol bottles ready for distribution. (Source: Project Gaia Inc.)

These achievements directly improve the health and well-being of women and children. As the program expands, it is expected to have significant macro-economic benefits for Tanzania. Fuel imports represent the greatest demand on FOREX earnings and have a considerable impact on Gross Domestic Product (GDP). As more fuel is produced domestically and less is purchased from abroad, this will place greater financial resources within Tanzania, a critical requirement for growth.

The benefits realized (clean air, saved time, increased productivity) and money earned, contribute to the domestic economy. By injecting limited financial support where the financial obstacles are, this approach unlocks local investment and entrepreneurship and encourages conducive government fiscal and regulatory policy. This approach to development requires a lower investment from OECD countries and allows the investment to go much further.

Various financing issues were overcome during the project. Firstly, CCL was slow to obtain financing from its commercial bank to guarantee the Letters of Credit required to import stove parts from South Africa, resulting in an eight-month delay in the start of sales. The PSGF, to be seeded in capital from the Government of Tanzania, should be in place during Phase 2 of the project, to help reduce commercial capital risk. Secondly, despite a USD 7 subsidy to the consumer and a USD 3 success fee to the distributor, the stoves were still too expensive (USD 17) for households to buy without a consumer loan. Economic difficulties associated with the COVID-19 pandemic have only exacerbated the problem. As a remedy, the MEF will propose increasing the subsidy on the stoves by an additional USD 4 to bring them down to a cost of USD 13 for the consumer. It will do so by reducing the distributor's allotment of subsidized stoves from 110,000 to about 75,000 stoves.

While the MEF was designed in an adaptable way to address such problems, the following barriers point to possible improvements of the model: (1) a loan guarantee mechanism to help leverage the always risk-averse commercial capital and (2) consumer finance to help with the purchasing of stoves. The latter will also stimulate more rapid sales of stoves. A third barrier is the value added tax (VAT) on ethanol fuel. The fuels with which ethanol must compete, charcoal and LPG, are not subject to VAT. Removal of VAT on ethanol fuel will reduce its cost by 20% and position it as the cheapest cooking fuel in the marketplace. The MEF team, along with the distributor, will engage with the government to help shape conducive policies, of which VAT is one.