EPA WINROCK INTERNATIONAL

Cook Stoves & Indoor Air

Promoting Clean and Efficient Cooking in the Developing World

Cooking with Ethanol: Benefits, key challenges, and lessons learned
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Speakers:

- John Mitchell, **U.S. EPA, Webinar Facilitator**
- Gaston Kremer, **Green Social Bioethanol**
- Hilary Landfried, **Project Gaia Inc.**
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Q1: Is there a comprehensive inventory/analysis of feedstock options, viability of feedstocks and quantity required?

A1: There are several feedstocks available for ethanol production. They can be divided into 3 groups:

1. Sucrose (sugar cane, sweet sorghum, sugar beet),
2. Starch (cassava, sweet potato, corn, broken rice), and
3. Cellulose (biomass).

The easiest route is to convert sucrose to ethanol, simple fermentation. Starch requires conversion into fermentable sugars prior to fermentation. And the last, cellulose, which has the greatest potential for ethanol yield due to its abundancy, is still in research, and is just now starting to be implemented commercially. Cost of production is 60-80% the feedstock cost, but viability depends on other various points, such as sales price, labor cost, enzyme and freight cost, among others. In our projects one of the best scenarios is a micro distillery of 3,500 liters per day using sugarcane/sweet sorghum as feedstock due to its low production price. Ethanol produced from grain/tubers starch has the advantage to also produce Dried Distiller's Grains with Solubles (DDGS), an animal feed sold at high prices, when there is a market for it. Cellulosic ethanol has the lowest cost of feedstock since it can be produced from biomass residues, but the cost to convert it to ethanol is the highest, and demands more technological equipment, susceptible to specific maintenance. Based on our experience, it is not feasible to produce cellulosic ethanol in small scale with the technology available at the moment.

With that said, each region will have its own best scenario. For instance, it is important to note the circumstances of the communities in Sub-Saharan Africa, where maintenance must be as simple as possible, requiring robust, but still efficient equipment.

Q2: What's the turnaround time for installation and full operation of a micro-distillery? And what is the cost (purchase and installation)?

A2: A micro distillery takes 2-3 months to be produced. Add another 2 months for sea freight, installation, and training. So, in 5 months from the order date, a micro distillery can be produced, shipped and installed, and ready for full operation. Several local points should be addressed during that time, such as warehouse building, an outsourcing agreement for constant supply of feedstock, and preparation for commercialization of ethanol as a cooking fuel. The cost of a 3,500 liter per day micro distillery from sugar cane is priced at approximately USD $450,000 (purchase, freight and installation), payback is less than 2 years.

Q3: The presenter mentioned a microdistillery might cost anywhere from $300-500k USD investment. Please clarify for what capacity that figure represents.

A3: Please refer to A2. We prefer to analyze specific projects to build the most suitable scenario. Please, do not hesitate to contact us (*Green Social Bioethanol*).

Q4: Can ethanol be produced via pyrolysis (as is being done for diesel and gasoline)? Could require less time and require lower cost hardware, and produce charcoal as co-product.

A4: We have just been informed about biodiesel production via pyrolysis. If you have more info on this please share with us (*Green Social Bioethanol*).

Q5: Safety as an adoption challenge was not listed. What is the experience with fear or real safety concerns?

A5: As ethanol is a new fuel for households, Gaia and partners always implement a safety training and fuel handling workshop. In the refugee camps we also employ community mobilizers who are trained in the operation of stoves and fuel. To date, in over 15 million stove use days in the Ethiopian refugee camps, we have never had a single stove accident. The stove is very safe (non-pressurized, easy to operate, etc). The safety concern is more related to fuel. Ethanol fuel is flammable and should be stored away from the stove or any open flame. Ethanol should never be used to prime a charcoal or wood stove (i.e. poured onto the fire). It is imperative that users understand the safety concerns of proper fuel storage and use. So, in our experience the safety issue is less about the stove, and more about the misuse of ethanol fuel. We also have signs and markings on the bottles and jerry cans on how to use and not use the stove. We have safety manuals with photos which go with every stove. The ethanol fuel is denatured with a bittering agent so that the fuel cannot be consumed.

Q6: How well did people accept ethanol as a fuel, since it can also be an abused substance?

A6: We denature all the ethanol cooking fuel with a bittering agent (denatonium benzoate) so that it renders the fuel undrinkable. We also dye the fuel blue to mark it a different color. We are now working to create standards for stove + appliance fuel so that countries and governments can adopt regulations

related to stove fuel vs. beverage alcohol. For more detailed information, you can see our denaturing protocols here on the Project Gaia website.

Q7: Are there any market studies to determine if a consumer will actually pay more for the ethanol compared to charcoal?

A7: SEI has done a lot of research into consumer choice and acceptability of ethanol as a household fuel. While the price of ethanol per liter vs. charcoal is variable on the country/city/neighborhood level, there are some discussion briefs, which may provide some additional information:

- ✓ Ethanol: towards a viable alternative for domestic cooking in Ethiopia
- ✓ Will African Consumers Buy Cleaner Fuels and Stoves? A Household Energy Economic Analysis Model for the Market Introduction of Bio-Ethanol Cooking Stoves in Ethiopia, Tanzania, and Mozambique.

Q8: Does Project Gaia have any reports or studies showcasing best practices from their stove programs?

A8: On the Project Gaia website under the "Resources" section, you can find a number of reports from pilot studies. These are organized by country. You can also see a link under the Madagascar tab to a 3 year World Bank report done in conjunction with Practical Action, University of Liverpool, Berkeley Air and others which is quite comprehensive. We also have a number of Briefs available under the "Resource" Tab. Under the press and other resources you can see reports published by other groups – I would encourage you to read the two reports done by SEI linked above in A7. Additionally you can find indoor air pollution monitoring data as well as videos and other media on the Resources tab. If you are looking for something in particular, feel free to email us.

Q9: Gelled ethanol has been considered a possible solution because it doesn't run or potentially cause house fires, and is easier to transport. Is that still considered a solution?

A9: We did not select a gel fuel stove for our work because it is not really a suitable stove for heavy-duty family cooking. Moreover, gel fuel is or can be expensive- to make, to handle and to ship. In contrast, ethanol ships easily and conveniently, like any liquid fuel. Because liquid ethanol fuel burns more easily and efficiently than gel fuel, it produces less CO. Indeed, the CO or carbon monoxide production is very low, superior to all other fuels except LPG, to which it is very close. Gel fuel was promoted as a solution mainly because it got around the safety issues for handling fuel. However, when you gel fuel- you lose a lot of efficiency and thus it takes much longer to boil water or to cook meals than if you had used that ethanol in a liquid fuel. We have overcome the safety issue of containing the fuel by using the CLEANCOOK stove, which has the adsorptive fuel canister. In our user acceptability tests with gel fuel vs. liquid fuel, consumers also found the refilling of gel and the "stickiness" of the gel to be bothersome in cleaning (and sometimes clogging) the stove. In summary, while gel fuel was widely promoted (For instance, the World Bank's Millennium Gel Fuel Initiative) we have found that liquid fuel is ultimately cheaper, more fuel efficient and more user-friendly in the long run.

Q10: If you compare the cost of LPG is it almost equal to ethanol? In El Salvador 25 lbs. of LPG cost $12 USD and last for about 4 to 5 week depend how big the family is.

A10: Yes, we often say that LPG is our second favorite fuel. On a per day – or a per meal basis, LPG is very comparable to ethanol. However, the advantage we find to ethanol over LPG is that ethanol can be purchased in very small quantities. For example, a family could purchase .5 liters of ethanol, which may

be all they can afford that day. In places where people have to travel far to purchase their fuel, LPG can be prohibitive – carrying the canister on public transportation or walking. Ethanol can mimic the supply chain of wood/charcoal/kerosene, which is the advantage of ethanol over LPG, even if the cost of cooking per meal/day is comparable. The other issue with price of ethanol vs. price of LPG is that LPG will always be tied to the world oil prices. Ethanol can be produced locally on a small scale or imported from around the world. In this case, the market for ethanol – we feel - is more sustainable, especially for very vulnerable countries (like Ethiopia- which is landlocked and has to import all its fossil fuels, but produces millions of liters of ethanol every year). For both LPG & ethanol, policies can make or break those markets. We have seen what happens to consumers when LPG subsidies are removed – they switch back to wood and charcoal. At the same time, policies can greatly affect the price of ethanol (for example by charging a VAT tax or not).

Q11: Are the emissions from ethanol stoves lower than LPG stoves? Has there been any study conducted comparing ethanol and LPG emissions?

A11: Ethanol and LPG emissions (CO & PIC) are comparable – extremely close. LPG is pressurized (unlike ethanol) so it achieves slightly better air mixing. However, it is important to note that ethanol stoves are not pressurized - and therefore have no risk of exploding. One good resource is the Berkeley Air Monitoring Stove Inventory Performance Report. In the next few months, there will be a detailed testing report published by the USEPA, which will have more information and details on emissions data for a number of stoves including ethanol and LPG. Two other resources:

- ✓ http://www.sciencedirect.com/science/article/pii/S0973082610000311
- ✓ http://www.mendeley.com/research/fuel-emissions-performance-fifty-cooking-stoves-laboratory-related-benchmarks-performance/

Q12: How can you overcome the distorting effects of fuel subsidies so that the market can make the appropriate decision about fuel and fuel choice?

A12: Good question. We don't advocate for subsidizing ethanol as a fuel. We have seen firsthand what happens when LPG or kerosene subsidies are removed from fuel - most often consumers switch back to charcoal and wood. We would advocate not subsidizing ethanol as a fuel, but also advocating policymakers not to tax ethanol unfairly. Often, renewable fuels and renewable clean technologies are not supposed to be taxed, but since ethanol and ethanol-powered cookstoves are often new technology, it may take extra effort to ensure that these products are receiving fair tax treatment. It is also imperative to understand the true cost of fuels in the market, and which fuels are receiving subsidies and/or preferential tax treatments. If governments want to provide a subsidy to encourage ethanol as a household fuel and to make it more available to consumers, we advocate subsidizing the stove (as a one-time purchase) but leaving the fuel at its true cost.

Q13: What is the per meal price?

A13: This is also greatly variable depending on the country and price of ethanol per liter as well as what kind of cooking is taking place. The average amount of fuel used per day across our projects is 0.5 liters to 1 liter. Often this includes 5 cooking activities: 3 meals +coffee/tea. In Ethiopia, the cost of ethanol is 14 birr per liter ($0.67 USD per liter). Families are using .5 liters per day ($0.33 per day). If they are cooking breakfast, lunch, dinner (and usually coffee/tea at least once): this is very cheap at $0.11 per meal (excluding tea/coffee) and probably a little bit less if you count the ethanol used to make hot drinks or

warm food. Note that this price per liter also includes a 15% VAT. The cost of kerosene is 16 birr which has no VAT and is still slightly subsidized.

Q14: How does one get to distribute Dometic ethanol stoves? Do you source stoves and fuels in South Africa?

A14: To potentially distribute the Cleancook stoves please contact us through our web site www.cleancook.com and you will be guided through the process. We produce our stoves outside Durban in South Africa and source the fuel where available at the right quality and most cost efficient depending on the target market.

Q15: How much do those stoves cost to produce (vs. retail prices that were provided in the webinar slides)?

A15: This information is, as I am sure you understand, not public.

Q16: The presenter listed prices for the ethanol stoves. Are those prices wholesale or retail, and what margins are you offering distributors at that price point?

A16: We do not dictate end customer prices since we believe an open market will regulate this. We work with serious partners who, like us, want to reach a wide customer base and thus keep the margins low. Since our partners also distribute the fuel for the stoves they can daily earn a small margin on the fuel as well.

Q17: On what basis do you assert that ethanol could replace LPG?

A17: Ethanol is cost competitive with LPG and has the extra advantage to be sold in very small quantities. Also ethanol can be produced in many more countries than LPG and is not tied to the global world oil prices. We have seen that consumers who are used to using LPG (such as in our Brazilian studies) showed a willingness to switch to ethanol if the fuel price was comparable and if the ethanol was as accessible as LPG. We also find favor in consumer willingness to pay for ethanol over LPG due to safety concerns. In many places (like Nigeria) we have found widespread fear of LPG & kerosene stoves, due to explosions. Ethanol is not pressurized (like LPG & kerosene) and cannot explode when used in the CLEANCOOK stove. If there were to be a fire, ethanol has the added advantage to be put out with water. See A10 for more information.

Q18: Has anyone ever worked with a hybrid alcohol - TLUD operation? This could lower cooking costs as char can be sold. Also can greatly increase turndown ratio (TDR) and (probably) should clean up emissions.

A18: This could be very tricky and dangerous, requiring a complex stove. A fireproof fuel reservoir for the alcohol would be needed and if not, there would be a risk of explosion. Ethanol is a great fuel (if contained in the correct way). We have done a lot of work on the stove side to ensure that the ethanol once charged into the canister is safely stored. Alcohol could certainly add octane to wood burning, but we are unsure of how this would be safely contained.