PGI Discussion: Reaching Market Scale, Tapping Existing Alcohol Markets, and Efficiency of Microdistilleries

1. Scale – Are there economies of scale for large-scale distillation or for clusters of microdistilleries? Can single installations of micro-distillation compete?

Single microdistilleries operating as discreet business units can compete in a local or regional stove fuel market if the system is closely tied to a feedstock source that is competitive and if the processing unit is both energy efficient (economizing on fuel) and process efficient (possessing a distillation unit that efficiently separates ethanol from water). Feedstock represents the largest cost in making ethanol; after feedstock, either labor or energy represents the next largest cost. If a microdistillery is able to exploit the opportunities offered by its small size to economize on feedstock, labor, and energy, then the potential exists for the microdistillery to produce ethanol at a competitive price.

Large-scale distilleries achieve substantial economies as a result of the following:

- ✓ Advanced equipment that recovers ethanol efficiently, recycles heat efficiently, and employs energy-saving equipment like efficient boilers and molecular sieves
- ✓ Industrialized operations that produce more sugarcane per hectare
- ✓ Access to ample inputs (fertilizers, irrigation, etc.)
- ✓ High degree of mechanization both in the fields and the factory and thus higher rates of materials-handling with much lower labor costs

Microdistilleries should not necessarily be measured against industrial distilleries to judge their utility or practical efficiency. They may serve an entirely different purpose. They achieve gains in this way:

- ✓ They are situated close to or within the resource to be converted (adjacent to fields or in fields).
- ✓ They can be sized to cost-effectively use the resource. Small resource supplies cannot support large and expensive plants, yet small and geographically-concentrated resources typify the kind of resource that is available for management and exploitation for biomass fuels in most African economies. Charcoal is manufactured on a very small scale. Both farms and woodlots are generally small-scale. In many, if not most, African settings, crops for bioethanol production can be produced on a small scale when they cannot be produced on a large scale. The benefit of the microdistillery is that it enables ethanol production to be carried out on the same scale in which most other biomass energy is procured – on a very small scale.

- ✓ Because the microdistillery can be supplied with small feedstock streams, it can exploit feedstocks which might otherwise be considered to have no value. These include agricultural co-products and residues, market wastes and processing wastes. They may even include unusual feedstocks like poultry manure or wild, gathered feedstocks like prickly pear cactus and mesquite pods.
- ✓ Microdistilleries may use simplified and inexpensive equipment which nevertheless produces ethanol efficiently. Potentially all of this equipment can be locally manufactured. Capital cost per unit output can actually compare favorably with industrial-scale plants.
- ✓ Microdistilleries serve a local market. There may be no need for a wholesaler in the fuel supply chain, which can therefore be short and economical.

2. Tapping the Alcohol Beverage Market for Fuel-Grade Ethanol

The fuel market is potentially very large while the beverage market is small and constrained, so only a certain amount of distilled spirits can be sold into the beverage market. A fuel market will quickly surpass the beverage market in size and importance. Without the beverage and fuel markets being regulated, there is a risk that the beverage market could be undercut by the fuel market, with artisanal distillers put out of business. There is also the risk that the beverage market could remain a barrier to the early development of the fuel market if ethanol fuel, which should be regulated from point of production, is black marketed into the clarin market. A few million liters of annual production of fuel-grade ethanol, if inappropriately diverted, would entirely displace the clarin market.

It is not difficult to regulate industrial production of ethanol for fuels and chemicals, and to keep this production separate from production for beverage use. Obviously, producing fuel ethanol on a small, distributed basis will require new regulations to be written and implemented. What may be more difficult is regulating the clarin business, from production to sales. This should be done. Possibly the introduction of fuel ethanol to the Haitian economy offers the opportunity to bring the clarin industry into the formal economy.

Outfitting Distillers of Clarin to Make Fuel Ethanol

For those farmers or artisans who run a distillery and believe that they could increase capacity and sell fuel ethanol, two approaches seem possible:

1. They could sell their ethanol-water mixture to a better distillery for further distillation, or
2. They could upgrade their own equipment to produce fuel ethanol cost-effectively.

The latter could offer significant environmental gains. The former represents business-as-usual. Artisanal stills require a lot of energy, usually firewood, and the distillation is crude and inefficient. Creating a program to upgrade artisanal stills and bring them into compliance with environmental regulations would offer advantages, both in fuel production and in the reduction in the use of fuelwood. Strengthening the better operators would help to put the less-good operators out of business. A schedule of fees and taxes could be put in place to raise money for the new regulatory program.

The two most important improvements for artisanal distilleries would be a distillation column to replace the alembic or pot still and an improved furnace to fire the boiler. Different sizes of distillation columns could be built locally for sale. Instructions and training could be provided to operators on how to build a better furnace. A furnace with a grate and good air circulation could burn bagasse. These furnace designs could come from the same experts who have designed better stoves. Plans already exist that could be adapted to local capacity.

Another important improvement for the artisanal distiller would be to provide a hand-operated cane crusher to improve juice extraction from cane.

Yet another opportunity to increase productivity would be provide training and seeds to produce hardier sugarcane and diversify to sweet sorghum where possible.

A substantial improvement over these upgraded artisanal operations would be provided by installing an integrated microdistillery sized to achieve some economy of scale. The examples we have looked at suggest better unit capital cost numbers beginning at 1.000 to 1.500 liters per day. The front end of the microdistillery is sized correctly to provide a steady supply of beer to the distillation column for continuous processing, even in batch mode. If the microdistillery is receiving feedstock from many small farms in its area, presumably the feedstock supply will be adequate and reliable. Possibly the more successful distillers among the artisanal operations that seek to upgrade would become candidates for operating a more completely engineered distillery.

Supply Lines for Making and Delivery of Ethanol Fuel

In any biofuels production and sales, whether solid fuels like wood and charcoal, or in this case ethanol, the materials-handling and delivery to processing or sale is a major part of the price build-up of the fuel and its life cycle energy efficiency. Producing fuel ethanol in place of clarin and installing local, integrated microdistilleries to handle the production of many small farmers in an area, as an alternative to pot stills, changes the way in which feedstock is handled and the product is marketed.

Delivering cane from the fields to the distillery becomes a more extensive operation. Once cut, cane should be processed the same day to ensure minimal loss of sugar in the stalk. Therefore, the area from which the distillery can receive feedstock is defined by the delivery times and cost to bring the cane to the distillery.

It is presumed that all of the fuel ethanol would find a market in the surrounding towns. A large enough distillery might find a market for its fuel in a more distant town or city – for example, the regional capital – and transport its fuel to the city once per week or several times per month in a tanker truck. A standard kerosene tanker truck can be adapted to haul ethanol fuel.

3. Energy Efficiency of Distillation

The energy efficiency of distillation has been thoroughly studied and there is no mystery in how to build an energy-efficient distillery. The key points in the process that affect efficiency are as follows:

- ✓ Efficient cane-crushing to extract the juice from the cane
- ✓ Heating the juice to remove contamination and ensure successful fermentation
- ✓ Good production of alcohol in the beer during fermentation
- ✓ Efficient extraction of the alcohol from the beer in the distillation column, with the least amount of reflux required
- ✓ Recycling the heat used in the distillation to other parts of the process; heat from the boiler used to preheat the mash; heat from the ethanol vapor used to preheat the mash
- ✓ Efficient boiler to heat the beer; efficient firebox or furnace to heat the boiler
- ✓ A furnace or firebox that can burn bagasse and other residues in place of wood

Various levels of life cycle energy efficiency are reported for ethanol fuel from sugarcane and sweet sorghum ranging upward to a ten-to-one energy gain.[1] Microdistilleries are not likely to be as efficient as industrial distilleries in their process efficiency, but they have the opportunity to make up for this with shorter feedstock supply chains, shorter ethanol fuel delivery chains, and their ability to process materials that would otherwise be wasted. The energy gain achieved in using a feedstock that would have been wasted represents an absolute gain provided the energy used in converting it to fuel is less than the energy derived from the fuel.

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[1] A number of studies have been cited in the report. Here is a list of relevant reports.
Blume David. 2007. Alcohol Can Be A Gas—fueling an Ethanol Revolution for the 21st Century. International Institute for Ecological Agriculture. See Appendix A: Ethanol and EROEI.
Macedo, Isaias Carvalho. 1996. Energy Balance of the Sugar Cane and Ethanol Production in the Cooperated Sugar Mills, CT Brasil, Ministério da Ciência e Tecnologia Brasil, UNFCCC.
Lorenz, David and Morris, David. 1995. How Much Energy Does It Take to Make a Gallon of Ethanol? Institute for Local Self Reliance.