THE REALITY OF METHANOL USE AS A COOKING FUEL IN DEVELOPING COUNTRIES

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> ***History has demonstrated that, when alternatives are available and affordable, consumers opt for more modern energy carriers. As incomes rise and opportunities for using better technologies become available, consumer preferences shift to more efficient, convenient, cleaner energy systems. That is, consumers move up the energy ladder. (UNDP World Energy Assessment, 2000)***

1. Purpose

The purpose of this paper is to bring home to the readers the **reality of a simple consumer use for methanol in a large volume market that can be reached gradually without disrupting the supply-demand balance of methanol or requiring distress pricing to be economically feasible.** Referenced is a simple but elegant **non-pressure alcohol stove** that is in **use today in boats, RV's and camping** and that is being adapted to a developing-country market. This is the Dometic ORIGO stove, manufactured by a Swedish company.

2. Background

Many people in the global methanol industry are concerned with either producing or selling methanol and think in terms of ship cargoes of 50 million liters or barge loads of two million liters. **How could the use of one liter per day to cook two or three meals a day for a family of five possibly result in any significant volume of sales?**

To answer this, consider the parallel example of the family sedan in the US where gasoline is relatively cheap compared to many countries. Take a medium sized new car with very good average gas mileage; let's say 27 miles per gallon. It is apt to be driven 10,000 miles in a year. It will use on average a little over four liters of gasoline a day. How could such cars using such a small amount per day ever create real volume use of gasoline? **The answer is - there are a lot of them**. In the US alone, roughly a million tons of gasoline is consumed each day.

There are **at least 500 million families** in the developing nations of the world that **seriously need a better fuel for cooking**. **If only 10%** of them end up **with methanol** stoves that would each consume about one-third ton a year of methanol for fuel, they would **consume**

40,000 tons of methanol per day, 365 days a year. That is eight 5,000-ton-per day plants producing **over 14 million tons per year.** This amount would increase present methanol markets by almost 50%. If we could eventually reach **20% market penetration** it would almost **double the size of today's global methanol demand.** With proper support from the natural resource industries (big oil and gas), the methanol industry, financial and environmental groups and federal and local governments, this can be **accomplished relatively quickly and seamlessly.**

Another comparison will complete the picture. Suppose **fuel cell vehicles** significantly **come** on the market in **2013** costing in 2003 dollars **US$30,000**. Such vehicles might use **1.5 tons** of **methanol** a year. The investment is therefore **US$20,000 per ton per year** of methanol use. The **Origo stoves** will sell in volume for **US$35 and use 0.3 tons of methanol per year** with an investment of about **US$100 per ton per year** of methanol use. If a company had to bet its future on one or the other of these two potential markets, which should be chosen to pursue? This question can't be answered as yet but by the time this complete article is read it will become much more apparent.

3. Why Methanol as a Cooking Fuel?

Methanol is a nearly perfect fuel for cooking. It cannot form soot on burning because its one carbon atom is preoxygenated. It can only add more oxygen and become carbon dioxide, releasing heat in the process. The molecule also contains net hydrogen that burns to water. If methanol is burned with air in an open flame, as in our stove**, it burns without any byproducts**. Even NOx is at negligible levels.

In a properly designed stove, which we have (it is a unique, patented design), methanol **can be burned under no pressure** with a heat delivery per burner **comparable** to an **LPG stove** (2 kW). **Methanol** literally is a fuel that **handles as a liquid but burns like gas**. **The stove**, which is shown in Figures 1 and 2, can ultimately be **sold for US$35** retail in volume. It is made of **heavy stainless steel** to allow heavy pots to rest on it and to last indefinitely with reasonable care. If it lasts 10 years, the cost per day of the stove is about one cent. The **fuel methanol** would be in **20 liter** returnable and deposit-refundable **plastic jerry cans** sold at current fuel (LPG or kerosene) outlets, local markets, convenience stores, etc. The **cost of the stoves** could be amortized through a slight **cost increase of the fuel**. A **bitterant** would be added to the methanol to render it **undrinkable,** as well as a **substance** to provide a **luminous flame**.

We intend to introduce the **fuel at not over 35 cents per liter** retail. We expect, as volume grows, to bring this price down to 20-30 cents per liter. Now, those who think in price per ton may find it hard to visualize what this price per liter means. It means selling methanol retail initially for US$441 per ton. The beauty of this is that the **retail price** can **remain rather stable** as global wholesale methanol prices will continue to fluctuate rather wildly. Also, fuel methanol at these prices will **tend to disassociate** from the vacillating **crude oil and liquids markets**. When the methanol industry finally rationalizes its production around large plants and low cost gas, it will, as in the past, average a delivered cost (not market price) of about US$100 per ton or about US$75 – 80 per ton net back. **Integration forward can**

make money. Major oil companies have finally realized this and now make money on retailing whereas at one time they broke even or took a loss on retailing to gain market share. This is no longer the case.

A family of five can cook for a year for about US$130, perhaps US$100, if they are careful with their consumption of fuel. When we bring the price down, **their cost will be under US$100 a year.** It is not uncommon to see per capita income of $1 per day in developing countries or US$1,800 for a family per year. Thus **the expenditure for fuel is a reasonable fraction of income.** If they **gather their own wood** taking six hours a day for travel, cutting and splitting, this, at a value of 25 cents per hour, is equivalent to **$1.50 per day**—**far above the 30 to 35 cents required to purchase methanol fuel**.

We'll review briefly what cooking appliances and fuels are typically available to families in the developing world. **In Africa, 98% of families depend on biomass—leaves and sticks, dung cake, wood and charcoal.** This is at the **bottom rung** of the energy **ladder.** Even in oil rich states in Nigeria, the rate of dependence on biomass fuels remains at 98%. African families use a fire ring of stones or a substitute, for example a tire rim with a cut out. A typical arrangement is the **"three stone fire", a triangle of stones used to support a griddle or pot** (Figure 3). Charcoal is burned in a vessel with a grate. If it is made of sheet metal, it will have a clay liner (Figure 4).

The next most frequently seen stove is a **kerosene wick stove** (Figure 5), which is the **next step up** the ladder. Most of these stoves are manufactured in the Orient and sell for just a few dollars. **They are a great killer; actually "Molotov Cocktails", responsible for many tens of thousands of burns, injuries and deaths each year in Africa and indeed throughout the developing world.** When a family has moved from biomass to a more modern fuel, kerosene is usually the next step.[1] Kerosene is much in use in India, where it is heavily subsidized, at great cost to India's national economy**. In Nigeria** it is currently **selling** for the equivalent of **above $1.00 per liter**.

The next step up the energy ladder is to a pressure kerosene stove or to an LPG stove (Figure 6). These latter two stoves are reserved for the wealthier families of the developing world; less than one percent of families. The World LP Gas Association is aggressively seeking to expand the number of LPG stoves in use in the developing world, **but LPG supply would quickly run short** even if they were only modestly successful.

Electricity in theory sits **atop the energy ladder as the best cooking energy.** The amount of electricity needed to supply cooking energy to the developing world almost defies conception. Less than 20% of African households are served by electricity. Average production continent wide is 650 kWh per person with most African nations below 100 kWh per person. **Africa's electricity** needs to be used for **lighting and to power** electronics such as computers. Where it is **used for cooking, only the top one percent in income can afford it.**

[1] This concept was first introduced by the Office of Technology Assessment, OTA-E516, 1992.

Table 1: Recent Cost Comparison of Stoves and Fuels in an African City Compared with a Target Price for Methanol in the Origo Stove

	Cost per day per family	Typical cost of stove	% Efficiency of stove
Purchased Fuel wood	$1.00	0 to $5.00	10%
Charcoal	45¢	$3.50 to $12	20%
Kerosene	25¢ (subsidized)	$5–$15 (one burner)	25%
LPG	58¢	$50 (+ tank, hose, regulator)	55%
Electricity	$1.25	$60–$100 (two burner)	60%
Methanol/Origo stove	25¢	$35 (two burner)	55%

Electricity is not even a **cooking option for most people in developing countries**. The appliances are simply too expensive. And there are few ratepayers, for there are so few who can afford to pay the rates. **So the entire system**, grid, power plant, pipeline, etc. **have to be bought and built** by the developed world through the World Bank or some other financing agency, **at enormous cost**. **Compared to electricity, methanol wins hands down on cost and sustainability.**

Table 2: Change Motivators Pushing Consumers Away From Existing Stoves to the Origo Alcohol Stove—African Urban Case Study

Market Sector	Electric	LPG	Kerosene	Charcoal	Wood	Dung	Leaves
Upper Income	**A**	**A**		**A**			
Middle Income	**AE**		**QSAE**	**CAE**	**QCAE**	**QCA**	**QC**
Lower Income			**QSAE**	**CAE**	**QCAE**	**QCA**	**QC**

Q* = *Quality of stove/fuel performance
C = *Convenience* of stove and/or fuel, including purchase/gathering, transporting, storing
S = *Safety* of stove and/or fuel
A = *Availability* of fuel; easy to buy or in short supply?
E = *Economy* of stove and/or fuel; are they affordable?

<u>What This Table Demonstrates:</u> Electricity, LPG, kerosene, charcoal, wood and dung are often scarce and difficult to obtain (A for Availability). While affordability is not an issue for upper income consumers, electricity, kerosene, charcoal and even wood are expensive for middle and lower income consumers (E for Economy). Kerosene and wood/dung are considered low quality fuels. Kerosene is seen as dangerous. The change motivators concentrate at kerosene and wood for middle and low income consumers. These become the primary target for displacement by the methanol-fueled Origo stove (shaded boxes).

Methanol cost per day is comparable to kerosene purchased in many or most free markets and **may be less than kerosene in time**. But the difference in quality is like night and day. **The kerosene stove is more dangerous, smoky and less efficient (Figure 3)**. **Methanol will beat LPG costs in a free market**. **Methanol cannot be expected to compete with state-subsidized fuels or electricity.**

When we look at these facts, we tend to wonder **why in the world has it taken so long to realize that methanol is the answer to home cooking in developing countries?** It has taken so long because no one has been looking for new uses, especially not in the consumer market and especially not in developing countries. **In general, the methanol industry has not developed many of the new uses itself but has tended to react to them when others have found them,** such as the case with MTBE with refiners and environmentalists and acetic acid with chemical companies**.**

4. The Need to Monetize Gas and Help Local People

It is ironic that **Nigeria,** with about the ninth largest oil and gas reserves in the world and nearly 130 million people, is **flaring gas** while **people cut down trees to cook with**, literally in sight of the oil rigs. It is estimated that **Nigeria flares about 80% of its associated gas and the country is responsible for approximately 40% of the flared gas in the world.** There has to be a way to correct this situation for the benefit of the people, especially in the oil and gas rich areas. That is the goal of a project we are working on and this objective is in sight. Obviously, Nigeria will eventually become a methanol producer. If a 5,000-ton methanol plant existed today, selling initially in export markets, it would be enormously profitable with a cash margin before tax and debt service of about US$150 per ton at today's world price. But no one has seen this opportunity yet.

If a large, modern **methanol plant existed in Nigeria** serving the **cooking needs of six million families or about one quarter of the potential market**, virtually all of the **wealth created would remain in the country**. If we assume foreign capital and we give the investors US$50 per ton for debt service and equity, then at our leveled out large volume retail price of 25 cents per liter, **about US$265 per ton would stay in Nigeria** and this would be roughly **a half billion dollars a year**. Nigeria is used as an example in this case but it can also apply to any of the other developing nations.

The reduction in flare gas would be 56 BCF per year with a gross **reduction in greenhouse gas emissions at the flare of about four million tons per year**. If this **emission reduction** were valued even **at US$5 per ton**, it would be a **US$20 million bonus**. There could also be emission trade offs. The Nigerian Government requires that no more gas be flared by the year 2008 or it will cause a stiff penalty.

5. The Greenhouse Gas Issue

Today all decisions made on energy production and use must incorporate and deal effectively with the greenhouse gas issue. Wood is 50% carbon and methanol is 37.5% carbon. The efficiency ratio in working use is at least a factor of five in favor of methanol. The wood is being "mined", that is to say, **the trees are being cut down and not replaced in most developing countries.** When we put all this together, including the CO_2 emissions from the methanol plant itself, **a family using methanol in place of wood will reduce net CO_2 -equivalent emissions by about three tons per year.** If these emissions eventually become worth US$35 per ton, **this would nearly pay for the fuel.** Estimates of the cost to produce CO_2 credits in the future range as high as US$50-100 per ton based on capture and sequestration costs. Common sense tells us that these costs will be high, as they will have to cover scrubbing, liquefaction, pipeline transmission and underground sequestration.

The trees not cut down continue to absorb CO_2 from the air. If the gas used to make methanol were flared, its CO_2 emissions would have been as much as 1.4 times that corresponding to burning pure methanol completely. That is because some methane escapes the flare and there are higher hydrocarbons present also. For simplicity sake, we have not included these two sources of additional CO_2 emissions reduction credits.

Today we have the technology to grow forests, cut down the trees and make methanol from them. Even the harvesting, hauling and wood grinding equipment can all be operated on methanol as the fuel for engines. Thus we eventually can have renewable methanol with virtually no net CO_2. This would create an enormous amount of employment in the process. What could be more ideal for developing countries than such a use for methanol?

From this brief review we can see that **cooking with methanol is a very "green" activity** and of course all major **companies** today must be vitally concerned with the **"greenness" of their image.**

6. Commercial Development

We have so far run a trial for methanol-home cooking **tests in South Africa** with very **encouraging results.** We now have a **1000 stove pilot program underway in Ethiopia. 150** of these stoves are in **camps for Darfur refugees**. **They can get food but they have no reasonable way to cook that food.** Therefore, **they are clamoring for more stoves.** In just a few months, by the end of the **first quarter of 2005**, we plan to **initiate a 300+ stove test program in Nigeria**. Then we will be off to **Brazil and some Caribbean island nations.** We are confident that, after these tests are complete and the results known, **the global demand for better home cooking fuels and stoves will prove to be enormous** and that customers will choose the ORIGO stove, which is called the CleanCook stove for the African market. As mentioned above, the next major step is a **large pilot marketing program in Delta State, Nigeria,** the largest oil and gas producing state in Nigeria (and perhaps the richest local jurisdiction in oil and gas in the world—where 98% of its people still depend on gathered fire wood for cooking). The program is being supported by the Government of Delta State and numerous other **stakeholders who want to see gas used, the people helped and the destruction of forests halted.** These are lush tropical areas, and yet the forests are being so badly compromised that they cannot regenerate as before.

Back to Ethiopia. The 1000 stove pilot study recently launched was assisted **by funds provided by the Shell Foundation and assistance and facilitation from UN agencies, the Swedish Development Agency, the Ethiopian government, and other groups.** This pilot study uses ethanol produced from waste molasses produced by Ethiopia's sugar industry. There is enough ethanol to sustain 22,000 stoves, and potentially enough to support up to 65,000 stoves, if all of the waste molasses in the country were fermented to ethanol. When the demand for stoves outstrips the supply of fuel ethanol, there is another resource base awaiting the need—substantial gas reserves in the southeast of Ethiopia capable of producing sufficient methanol to support several millions of stoves or more. This will provide a comprehensive solution to Ethiopia's dire need for cooking energy that is now being met in the most unsatisfactory ways--costly petroleum fuels imports, and widespread deforestation from fuel wood harvesting and wasteful and dirty charcoal manufacture.

7. What Can Industries Do to Help?

This is a relatively **large potential market for methanol** that can be acquired with much less research and time than some other outlets. But it will **require strong initial support** not only of **governments and environmentalists**, but also from divisions of big oil companies. This could include the **natural gas producers to supply a reasonably priced and stable supply of feed stock, engineering and construction sections to build the required large methanol plants for the oil companies that should integrate downstream, fuel distribution outlets, etc.**

But first some "due diligence" and **study should be performed** to carefully examine the attributes of methanol as a cooking fuel, in order to be convinced that it makes eminent good sense. If anyone wishes to be briefed in more detail, we would be glad to do so. They can certainly contact us for more information and we would be very glad to share pilot study results with anyone as these results come in and are published. We can bring interested parties to one of our pilot sites to be an on-the-spot observer.

8. The Greater Implications of Methanol as a Household Energy Source

Another emerging **trend in energy management** is **distributed energy rather than centrally piped or wired energy.** Distributed generation has become the buzzword in developed countries but is even more important to developing nations.

Consider this. We are ready to put in the field a well developed **methanol fueled mantle lantern that is so designed that its waste heat can also be used for cooking.** This is true cogeneration on a small scale. This lantern **will generate about 400 watts of light**. It can be sold at affordable prices and **is already in production**. Beyond this there is the **heat-operated refrigerator** long used in rural homes, RVs and boats. Dometic AB, the stove producer, makes these devices and **has tested them with methanol with great success**. Dometic regards methanol as a superior fuel to ethanol for their alcohol appliances. There are also, of course, small generators, either internal combustion engine or fuel cells, that can produce enough electric current for radio, TV, computer and emergency lighting. These can operate on methanol. Methanol offers the answer to a **total household energy system** on a distributed basis. Methanol is **easy to deliver in tank trucks** and to **package for consumers to take home.** It can be stored safely and it remains stable. These additional uses could double or triple methanol use per home over cooking use alone.

The **Achilles Heel** of new energy markets for methanol has been **distribution at a reasonable consumer price.** Fuel distribution is mostly in the hands of big oil companies and they don't easily accept methanol as a competitive fuel to their petroleum products. **They don't like the "M" word**. The methanol industry failed on this score and lost the M-100 and M-85 markets, which could have dwarfed even the domestic fuel market. **Our** domestic cooking fuel **business plan** incorporates from the very start the **distribution** from bulk terminal **to the consumer package in a retail dealer's store.** This is the only way in which a consumer market can succeed. No matter how clever the device to use methanol, **if the consumer can't buy the fuel, the business will fail.** This alone should **provide a strong incentive for big oil to consider getting into methanol production,** the very first GTL (gas-to-liquid), **from their gas.**