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The Cost of Grain-Derived Ethanol

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My name is Robert Rapier. I am a chemical engineer working for ConocoPhillips in Billings. I am also an ardent supporter of developing alternative energy sources. But I do not believe grain-based ethanol poses a viable long-term solution to U.S. energy needs.

My experience with ethanol dates back to my graduate school studies at Texas A&M University from 1991-1995. I grew up on a farm, and I chose a school that would give me an opportunity to research issues that would benefit both farmers and the environment. I joined a research group concentrated on economically producing ethanol from agricultural waste products. As a part of our work, we conducted a number of economic studies and energy balances on ethanol production from various feed stocks. Our research consistently indicated that waste feed stocks were the key to economic ethanol, and even that would require some technical breakthroughs to become competitive.

The primary objection that I have to grain-derived ethanol relates to the energy balance (energy inputs minus energy outputs). There are those who suggest the energy balance is negative - that it takes more energy to produce ethanol than you get back from the ethanol[1]. On the other hand, there are those who claim that ethanol has an even better energy balance than gasoline. This issue is extremely important, because if the energy balance is zero or negative, then ethanol is not a renewable fuel. So what is the truth?

In a 2002 USDA study[2], ten corn ethanol energy balances from various studies were presented. Four of the ten energy balances were negative, and the average energy gain calculated from these ten studies was 5,885 BTUs per gallon of ethanol produced. To put the number in perspective, the energy inputs to gain 5,885 BTUs were in the range of 80,000 to 100,000 BTUs. For reference, one gallon of gasoline contains about 125,000 BTUs and 1 gallon of ethanol contains about 76,000 BTUs. In other words, taking the average energy balance from the ten studies means that 21 gallons of ethanol production at a net of 5,885 BTUs per gallon will be required to generate the 125,000 BTUs contained in 1 gallon of gasoline. Since the two large energy inputs for grain based ethanol – natural gas for fertilizer production and for fractionation – are mature technologies, significant improvements in the energy balance are unlikely.

I recently had an e-mail correspondence with the lead author of the USDA study, Hosein Shapouri, in which I pointed out my concerns over corn ethanol economics. In his response, Shapouri did not even attempt to defend corn ethanol as an economic option. He wrote "If we want to produce fuel ethanol from biomass and crop residues, then ethanol should compete with gasoline on the BTU bases. We do not have the technology yet. But in the future it is a possibility." His conclusion is the same one I came to in graduate school 10 years ago: Someday the technology may be economical for crop wastes, but as of now it is not[3].

Ethanol from crop residues, on the other hand, shows promise. A recent story in Business Week stated: "*Last December the bipartisan National Commission on Energy Policy released a report, **Ending the Energy Stalemate**, that analyzed the potentials of various alternative fuels, including both types of ethanol. Only cellulosic ethanol got a decisive thumbs-up. By 2020, the commission predicts, its production cost could be less than 80 cents a gallon. In stark contrast, after 20 years producing grain ethanol, it still costs $1.40 a gallon to produce -- roughly twice as much as gasoline*"[4].

You have probably seen claims from the pro-ethanol literature such as: "*Ethanol production is extremely energy efficient, with a positive energy balance of 125%, compared to 85% for gasoline*"[5]. If these claims were true, then one must wonder why we need ethanol subsidies. In fact, however, such claims are false. These claims are based on the use of two different accounting methods designed to show ethanol in a positive light. The energy balance for ethanol is calculated for the entire life cycle, and that for gasoline is calculated on the basis of a barrel of crude oil ready to be refined. We can calculate gasoline based on an entire life cycle to obtain a true apples to apples comparison. It takes only about 1 barrel of oil energy input to net 10-30 barrels of oil from the ground, depending on the source. So, this step has an efficiency of at least 1000%. Once the 85% energy efficiency is factored in for the separation of gasoline from the oil, the positive energy balance for gasoline ranges from 850% to well over 1,000%. That's why gasoline costs significantly less than ethanol on a BTU basis.

Let's now consider the magnitude of the subsidies involved. The federal subsidy for ethanol is presently $0.51 a gallon and the proposed state subsidy is $0.20 a gallon. The USDA's own estimate on the energy balance of ethanol was 21,105 BTUs/gallon produced. This means it takes 6 gallons of ethanol, using their numbers, to displace 1 gallon of gasoline. Therefore we will pay $4.26 in subsidies for each gallon of gasoline that is replaced. This also translates into a total subsidy of $33.81 per million BTUs of energy gained. In comparison, the cost of natural gas is about $7 per million BTUs, and the subsidy on wind power ($0.018/kWh) works out to around $5 per million BTUs. As you can see, the ethanol subsidy is extremely high, primarily due to the poor return on the energy input.

Since I am from a farming family, I am interested in issues that impact farmers. Therefore, I want to close with a personal appeal to refocus our energies in a different direction. The state of Montana ranks 5th in wind energy potential[6]. Wind is to Montana what corn is to Nebraska, yet we are not taking advantage of this abundant resource. States with much lower wind potential than Montana have many more megawatts of installed wind power. For example, a recent article in the Milwaukee Journal Sentinel stated that Wisconsin ranks 18th in terms of wind energy potential, but already has 53 megawatts of installed wind power[7]. In contrast, Montana has almost 20 times the wind potential of Wisconsin, yet has less than 1 megawatt of installed wind power[8]. There is enormous growth potential, and farmers stand to gain far more financially from wind power development than from ethanol mandates. Farmers can earn $2,000 to $4,000 for each turbine sited on their land, and each turbine takes up a fraction of an acre. If you want to provide new sources of income to farmers and develop a real renewable source of energy available in abundance in Montana, then wind power is the answer.

I would be glad to address any questions or comments. My office phone number is (406) 255-2553 and my e-mail address is robert.rapier@conocophillips.com. Thank you for your time.

REFERENCES

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[1] Pimentel, David. The Limits of Biomass Energy. Encyclopedia of Physical Sciences and Technology, September 2001.

[2] Shapouri, H., J.A. Duffield, and M. Wang. 2002. "The Energy Balance of Corn Ethanol: An Update". AER-814. Washington, D.C.: USDA Office of the Chief Economist.

[3] A small Canadian company called Iogen appears to have the lead in producing ethanol from crop wastes. http://www.iogen.ca/ If their claims are accurate, they would render corn-derived ethanol production obsolete.

[4] "Not Your Father's Ethanol", *Business Week*, February 21, 2005.

[5] This claim seems to have originated with the American Coalition for Ethanol, but can be found on a number of the ethanol advocates' information sheets.

[6] http://www.sustainableenergy.org/resources/technologies/windy_states.htm

[7] "Utilities See Winds Shift for Wind Power", *Milwaukee Journal Sentinel*, March 6, 2005.

[8] http://www.montanagreenpower.com/wind/mtinstallations.html