Securing America's Future Energy

Intelligence Report

"Connecting the Dots on Energy Issues"

July 1, 2008 – Vol. 1 Issue 5

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The Truth About Biofuels

SUMMARY

- Biofuels may offer a renewable, domestically-produced liquid fuel for transportation. But there are drawbacks as well as advantages, and not all biofuels offer the same benefits.
- Not long ago, corn-based ethanol was touted as a possible answer to oil dependence, but in recent years, its limitations—including a negative impact on food prices—have become clearer.
- Second generation biofuels alleviate some of the disadvantages of corn ethanol, and are close to commercial viability, but they also have some of the same limitations. Third generation biofuels are much further away from being commercially available, but may offer a stronger case as a substitute for gasoline and traditional diesel.
- Ultimately, we may turn largely—or entirely—away from liquid fuels in order to power our transportation sector. In the meantime, however, they could still offer a valuable bridging technology.

ANALYSIS

Perpetual motion. Cold fusion. In so many ways, they represent what so many secretly hope for: the perfect, easy answer. But you cannot get something for nothing. There are no easy answers—like the idea that we can grow ourselves out of our energy problems.

Corn Ethanol: Not the Silver Bullet Some Had Hoped?

It was not long ago that many politicians and policymakers on both sides of the political divide were praising corn ethanol as the obvious—and easy—solution to our dependence on oil. It is easy to understand the appeal of corn ethanol. At first glance, it appears to be everything that oil is not. It is renewable. It is domestically produced. It is clean (or cleaner, at least). But it has become increasingly clear to even casual observers that, like perpetual motion, what looks good on the surface may in fact be just a mirage.

First, corn ethanol, simply put, is not the same as gasoline. Introducing significant volumes of ethanol into the fuel supply will involve significant changes in infrastructure. Ethanol

cannot be transported in gas pipelines or stored in gas tanks. Blends constituting more than 10 percent ethanol require modifications to traditional gasoline engines. Moreover, a gallon of corn ethanol contains only 2/3 as much energy as a gallon of gasoline. That effectively reduces the range of any car running on fuel containing a significant amount of ethanol, such as E85 (85 percent ethanol and 15 percent gasoline), the highest-concentration blend used in the United States. In other words, consumers who use high-concentrate blends of ethanol are forced to fill their tanks more often, an inconvenience that many may choose not to undergo.

There are other factors to consider as well. Increased production of corn ethanol can have unintended consequences. Production in 2008 may reach 8 billion gallons, versus less than 2 billion gallons in 2001. That means that in 2008, roughly one-third of the entire U.S. corn crop will be channeled to ethanol production. Not incidentally, corn prices have spiked from $2.50 a bushel to approximately $7.50 a bushel in the last five years. Of course, increased demand for corn is not the only input driving up food prices. Oil prices affect transportation and the costs of fertilizers, and improving economies in the developing world are leading to improving diets—and increased demands for food. Nevertheless, ethanol-based demand for corn is a contributing factor, and it is attracting attention. In October 2007, the UN special rapporteur on the right to food, Jean Ziegler, referred to biofuels as "a crime against humanity." Ethical concerns have already led to an announced review of biofuels policy in the EU.

Ultimately, the real question about corn ethanol is whether the investment is worth it. The federal government supports ethanol production with a renewable fuels standard established in 2005, a 54 cent-per-gallon tariff on ethanol imports into the U.S., and a 51 cent-per-gallon "blender's credit." With all of that money, and with production of 8 billion gallons a year, corn ethanol is only currently displacing approximately 350,000 barrels of oil a day—this in a nation that consumes 21 million barrels a day. And the production of corn ethanol itself requires significant energy inputs: as much as 0.8 Btu of conventional oil, gas, or coal energy as input is needed to gain 1.0 Btu of ethanol as output. Many therefore question the return on our billions of dollars in investments. Is this the most efficient and most effective way to address our energy security vulnerabilities?

Second Generation Biofuels: Closer, But Not Perfect

So if corn ethanol has shortcomings, then where can we turn for liquid fuels? Today, cellulosic ethanol—derived from woody or fibrous plants material, including crops, trees and forest matter; agricultural residues such as cereal straws; and dedicated "energy crops" like switch grass—is on the cusp of commercial availability, with large projects by several companies moving forward in both Canada and the United States. Cellulosic ethanol—considered a '2nd generation biofuel'—has distinct advantages over corn ethanol, but it is not perfect. The end product of cellulosic production is chemically identical to corn-based ethanol, meaning that it also has a lower energy concentration than traditional gasoline, and that it faces the same infrastructure challenges. In addition, some of the crops suitable for 2nd generation biofuels can become invasive species if introduced to certain regions. For example, jatropha is not a problem in its native India, but it can be an invasive weed in other areas, hindering agriculture later.

The advantages of cellulosic ethanol, however, are not insignificant: cellulosic production can make use of non-food-grade crops and waste forest materials. These materials can often be grown on land that is not suitable for agricultural production, thereby avoiding competition with the food economy. In addition, use of the entire plant can increase per acreage ethanol yields, potentially lowering costs. And cellulosic ethanol requires 0.2 to 0.4 Btu of fossil fuel

input to derive 1.0 Btu of ethanol output—roughly two to four times as attractive as conventional corn ethanol on an energy balance basis.

Third Generation Biofuels: The Real Solution?

So, cellulosic ethanol has distinct advantages over corn ethanol—but also still faces genuine challenges. That is why investors and energy analysts alike are looking forward to the next step. The true prize may very well go to those who can create commercially viable liquid biofuels that combine the low cost of cellulosic feedstock with an output that can be transported and distributed using current pipelines and tanks, and burned in conventional engines.

DuPont and BP entered into a partnership in 2006 to develop biobutanol, or butyl alcohol, a molecule with a better energy profile than ethanol. Company officials expect commercialization within five to seven years. Amyris Biotechnologies is planning to begin construction of a 'no compromise' biofuels pilot scale facility in Oakland, California, this fall. Amyris also recently announced a partnership with Brazilian sugar and ethanol group Crystalsev to produce and sell the first commercial diesel made from sugar cane instead of oilseeds like soy or canola. In addition to cellulosic ethanol investments, Royal Dutch Shell PLC announced earlier this year a research initiative with Wisconsin-based Virent Energy Systems Inc. to develop biofuels that could be used in existing fuel distribution systems and engines. Company officials reportedly say they are several steps away from a decision on commercial-scale production.

All of these investments are designed to test fuel technologies that appear successful at the lab scale but have unanswered questions about cost and scalability for commercial use. It appears increasingly likely that some strong alternatives to cellulosic ethanol may appear on the market well before ethanol production reaches the scale of requiring substantial new infrastructure and engine modification investments.

Of course, even these advanced biofuels will not necessarily address all of our energy security vulnerabilities. Introducing additional supplies of biofuels into the liquid fuels market can place downward pressure on prices, but it will not necessarily address other fundamental problems, including price volatility. Liquid fuels prices tend to track each other, and biofuels have their own unique volatilities built in: for example, recent severe weather in the corn-growing regions of the Midwest could have a significant effect on the price of corn ethanol and other biofuels.

But the importance of biofuels should not be underestimated. The EIA's recently released International Energy Outlook posits that a quarter of the growth of our demand for liquid fuels by 2030 will need to be met by biofuels and unconventional oils. Current events bear out their predictions. Biofuels are the single largest source of fuel growth in non-OPEC nations. The 350,000 barrels of oil a day displaced by U.S. corn ethanol production is not nearly enough to mitigate our energy security vulnerabilities, but it and other biofuels provide an important supply at the margin of a tight market.

Ultimately, policymakers may need to consider the benefits of moving away from not just oil, but all liquid fuels for transportation. The electrification of the transportation system—with advanced biofuels providing critical bridging technology—may be the true path to energy security. Electrification, however, just like biofuels, carries with it costs as well as benefits. There are no easy answers. Until a perpetual motion machine is invented, we will need to continue weighing every option with an eye to all of their consequences, positive and negative.