ETHANOL

Corn Stalks

Sugar Cane

Cellulosic Material (corn stover)

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INTRODUCTION

So often now we hear people—politicians, environmentalist, journalists—warning of the negative consequences of our addiction to oil (though 'reliance on' may be a more apt descriptive). Nonetheless, the point remains: the inhabitants of the United States are the largest consumers of a finite and depleting energy source and resource. This is not news but as the price of a barrel of crude passed the $150 mark, it became a more pressing matter. Happily, as the price rose, the citizenry did in fact curtail their consumption. As reported on KYW news radio on November 19, 2008, AAA is expecting a decrease in 50-plus-mile driving this Thanksgiving season for the first time in seven years.

In a rather dramatic turn of events, though, not long after the record-setting prices for crude oil, the global markets underwent a financial crisis, which, in turn, brought about a $100-per-barrel reduction in crude, to an 18-month low of just under $50 a barrel. It will be interesting to see if consumption continues to decline or begins to creep upwards due to cheaper prices. Regardless, though, alternative forms of fuel have been gaining momentum over the past few years and are likely to remain ascendant, given the economic and environmental cost of continued petroleum consumption. These alternative fuels are known as biofuels and are derived from relatively recently dead biological material. Innovators and entrepreneurs and industrialists are experimenting with biofuels derived from everything from corn to sugar to sorghum to switch grass. The question is…are any or all of them viable or even sensible alternatives to petroleum?

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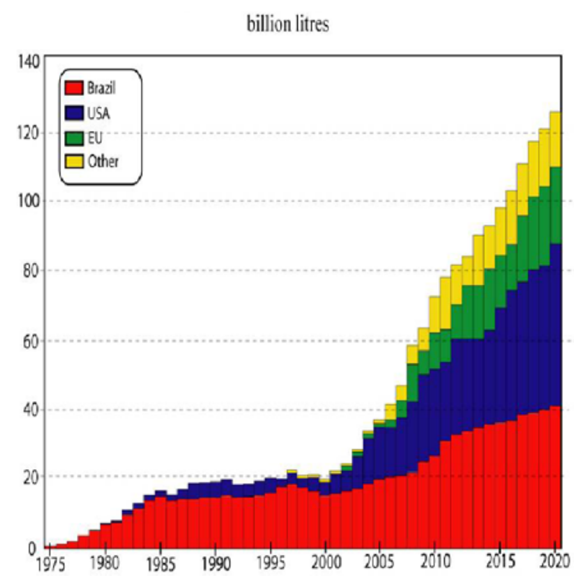
Ethanol is a biofuel, and therefore renewable, which is mainly used as a gasoline additive. It is, essentially, non-drinking grain alcohol. Produced by fermenting plant sugars, it can be made from various feedstocks, including cereals (rice, wheat, corn), sugarcane, and cellulosic materials, which are agricultural waste such as corn stalks, corn husks, wood chips, and the like.



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All over the world, countries are experimenting with, and investing in, ethanol fuel technologies. As of 2007, the top 10 ethanol-producing countries were the U.S., Brazil, the European Union, China, Canada, Thailand, Colombia, India, Central America, and Australia.[1] The chart above shows the estimated increase in ethanol production through 2020. Red represents Brazil; blue, the US; green, the EU; and yellow, other. Primary feedstocks used are corn, sugarcane, molasses, sugar beets, rye, and wheat.[2]

The two biggest producers of ethanol, by far, are the United States and Brazil. The two nations combined account for 70 percent of world production (Elobeid and Tokgoz, 2008). The primary source of ethanol in the U.S. is corn while Brazil's primary source is sugarcane. Cellulosic ethanol is a young upstart and leads ethanol production in no nation at this time. It may turn out to be, however, the ethanol of the future.

We will look at each of these processes and examine which is the most effective, efficient, and cost sensible.

ETHANOLS: SUGAR, CORN, CELLULOSIC

Government regulations and subsidies have been responsible for propelling the ethanol industries in both Brazil and the United States. Brazil began its push with the National Alcohol Programme, which was launched in 1975 (Elobeid and Tokgoz, 2008). The U.S.' latest push is the result of the 2005 Energy Policy Act, which mandates that roughly five percent of the nation's annual gasoline consumption come from renewable fuels by 2012 (Sedjo, 2007).

Since ethanol is produced by fermenting plant sugars, sugarcane has both a time and cost benefit because it is, at the outset, all ready one step ahead in the production process. Specifically, "the conversion of sucrose into ethanol is easier compared to starchy materials…because previous hydrolysis of the feedstock is not required since this disaccharide can be broken down by the yeast cells; in addition, the conditioning of the cane juice or molasses favors the hydrolysis of sucrose" (Cardona, 2007). To produce ethanol from corn, on the other hand, "it is necessary to break down the chains of this carbohydrate for obtaining glucose syrup, which can be converted into ethanol by yeasts" (Cardona, 2007). Simply put, sugarcane is cheaper to produce than corn because it does not need to be converted from carbohydrates to sugar. In fact, corn ethanol production in the U.S. costs two times that of sugar ethanol production in Brazil (Alonso-Pippo, et al, 2008).

Moreover, Brazilian sugar ethanol provides eight times the energy of the fossil fuels used to make it while corn ethanol provides only 1.3 times the energy of the fossil fuels used to make it. Sugar ethanol also reduces greenhouse gases more than corn ethanol (Friedman, 2006).

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[1] Source: F.O. Licht (http://www.ethanolrfa.org/industry/statistics/#E)
[2] Source: F.O. Licht (http://www.bioenergywiki.net/index.php/Top_ethanol_producing_countries)

Specifically, compared to gasoline, corn ethanol provides an 18-40 percent reduction in greenhouse gases, depending on the source (Dale, 2007; Sedjo, 2007). Sugar ethanol, on the other hand, is estimated to reduce greenhouse gas emissions by approximately 85 percent.[3] Finally, though the combustion of both sugar and corn ethanol create less carbon than the combustion of fossil fuels, sugar ethanol production creates even less carbon than corn ethanol production (Alonso-Pippo, et al, 2008).

One of the major advantages of cellulosic ethanol over both sugar and corn ethanol is that it is derived from plant waste, including waste from wood mills, grain production, and harvested trees and grasses. This versatility of potential feedstocks means a greater range of suppliers and production sites. For instance, corn is often grown in the mid-western plains while wood chips can be supplied from the various forests that grow across the country. Additionally, agricultural land does not need to be taken out of production to accommodate source material for cellulosic biofuel. As far as greenhouse gas emissions, compared to petroleum, cellulosic ethanol can reduce emissions by as much as 115 percent (Sedjo, 2007).

The conversion process for cellulosic ethanol, however, is more complicated than either that of sugar or corn ethanol. Specifically, the process requires a greater amount of processing to make the sugar available to the microorganisms that are typically used to produce ethanol by fermentation. Cellulosic materials are much more difficult than grain to break down into their various sugars (Sedjo, 2007).

Discussion

Both Brazil and the U.S. encouraged ethanol production through government incentives. The Brazilian government did so through tax incentives and low-interest loans totaling over two billion dollars. Consequently, in less than 20 years, Brazil had a well-established ethanol program. To this day, the nation still imposes a 20-percent value added tax (VAT) on other fuels to support the ethanol industry though many other cost benefits have been phased out as the product became more competitive against gasoline (Froese et al, 2008). The U.S. is equally protectionist when it comes to corn ethanol. Since 1978, ethanol has received a $0.51-per-gallon subsidy. It is also protected from imports, such as sugar ethanol from Brazil, by a $0.54-per-gallon import tariff (Sedjo, 2007). Since cellulosic ethanol is just underway, it does not currently enjoy any subsidies.

[3] Based on information available at http://en.wikipedia.org/wiki/Ethanol_fuel_in_Brazil.

The Brazilian ethanol industry is quite viable. It has become a net exporter of sugar ethanol while the U.S. exports very little of its corn ethanol. Data show that ethanol has had a beneficial impact on the Brazilian economy (Froese, et al, 2008). In the U.S., however, it is questionable whether ethanol production is currently sustainable because of the financial and environmental costs.

Environmentally, both nations are negatively impacted due to the fact that ethanol refineries burn coal for fermentation, the emissions of which are 20 times worse than petroleum refineries (Conniff, 2007). An additional downside for corn ethanol is that corn is a rather high-maintenance crop, requiring a fair amount of fertilization and irrigation. Sugarcane, on the other hand, doesn't require irrigation at all.

Financially, because of the import duties on sugar, Americans pay twice as much for sugar as the world market price (Alonso-Pippo, et al, 2008). Then, too, crop and food prices in the U.S. and the world increased with the expansion of the U.S. ethanol industry. Moreover, the tariff and tax credits for corn ethanol ultimately transfer income away from other sectors such as livestock (Elobeid and Tokgoz, 2008). This is because more farmers devote more land to the corn crop. This increases demand, driving up both the cost of land and the cost of corn. As a feedstock, corn is used to feed cattle. If cattle ranchers have to pay more to feed their cattle, than the public has to pay more to buy beef.

As for cellulosic ethanol, currently, the infrastructure at the commercial level does not yet exist to support large-scale production. Some of the elements still needed include processing technologies, operating facilities, and transportation infrastructure. This is too bad because cellulosic ethanol has the potential to replace up to 30 percent of annual petroleum consumption in the U.S. while significantly reducing greenhouse gas emissions (Froese, et al, 2008). Greater use of cellulosic ethanol would also avoid the pitfall of "robbing Peter to pay Paul," so to speak. In other words, since the cellulosic materials are essentially bio-trash, they do not take edible agricultural crops out of circulation, which is particularly the case when it comes to corn ethanol.

Conclusion

Though it must be noted that all ethanol fuels generally offer lower fuel efficiency than gasoline, ethanol still stands as a viable alternative. Eventually, the supply of crude oil will run dry, and the fuel we have all come to know and rely on these past two to three hundred years will be gone. In the meantime, the governments from whom we purchase our oil are not what one would call ideal, or even commendable. Many of the countries in question have disreputable leaders and the attendant poor human rights records that so often go hand in hand with them; Russia, Iran and Venezuela come immediately to mind. So, again, we must look to ethanol fuels as reasonable alternatives. Of the three we have examined, sugar ethanol is the most viable at this time. Its environmental and economic impact is less than that of corn ethanol, and its history enables it to out-compete cellulosic ethanol, which, though a possible winner in the future, has not yet met its time.

Sugar ethanol is also an ideal product for Brazil, where the labor costs are low, there are millions of acres of arable land, and there is a climate that permits year-round growing, not to mention that sugarcane does not require large quantities of water to grow.

Until something better comes along, then, sugar ethanol is the best biofuel we’ve got.

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