The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Corn-Based Ethanol: Is This a Solution?

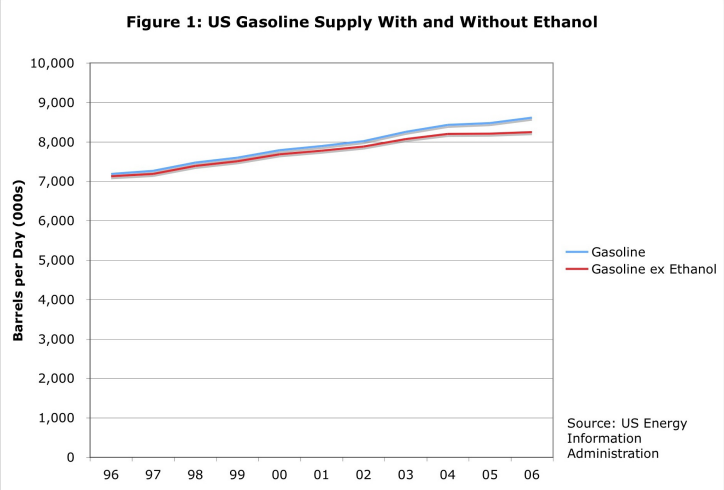
Posted by Gail the Actuary on June 7, 2007 - 10:51am
Topic: Alternative energy
Tags: ethanol [list all tags]

Many people have high hopes for ethanol made from corn--that it will prevent future gasoline shortages, prevent global warming, be a wonderful investment, and improve the income of farmers, among other things. Other observers raise a whole host of concerns including scalability, impact on the environment, and impact on food prices. Why is there such a huge disparity in views? What is the real promise for corn ethanol? Many questions and answers under the fold.

---

1. Why don't we see more stations selling E85 (85% ethanol/15% gasoline mixture)?

In 2006, about 20% of the US corn crop was used to produce ethanol. Even with this huge share of the corn crop, US corn-based ethanol amounted to only about 3.5% of the US gasoline supply by volume, and 2.4% of the supply by energy contribution.



Even if all the corn-based ethanol that was produced were used as E85, there would not be many gasoline stations selling E85. In fact, only a very small portion of the corn ethanol that is produced is used to make E85 -- the remainder is used as a fuel additive, in concentrations up to 10% of the gasoline.

2. Why is so much ethanol used as a gasoline additive?

There are two reasons:

a. E85 isn't very popular. The fuel is quite corrosive, and only a small percentage of cars that have been specially manufactured (or adapted) can use it. E85 is also quite expensive for the energy it provides. It is often priced similarly to gasoline, but gets about 25% worse mileage.

b. MTBE is being phased out, and ethanol can be used as a substitute. Until recently, methyl tertiary-butyl ether (MTBE) was used as a gasoline additive, to raise octane of gasoline and to make fuel burn more cleanly. MTBE does not biodegrade and often gets into the ground water, where it gives a bad taste and smell. Furthermore, laboratory tests suggest it may cause cancer. MTBE was banned in some states, and is being phased out in other states because of liability concerns.

Ethanol can be used as a substitute for MTBE. The amount of ethanol needed as an MTBE substitute is huge -- roughly equal to the 5 billion gallons of corn based ethanol produced in 2006. With so much ethanol used as a substitute for MTBE, there is very little left over for E85. One advantage of using ethanol as an additive is that in concentrations up to 10%, it can be used in any car without modification.

3. How does ethanol compare to MTBE as a gasoline additive?

Ethanol is clearly better than MTBE in one regard -- Ethanol biodegrades well, so there is no issue with it contaminating the ground water.

In other regards, ethanol's score is mixed. Ethanol makes gasoline somewhat cleaner burning, so it helps oil companies meet emission standards.

There are several areas in which ethanol is not as good as MTBE:

a. Ethanol, when blended with gasoline, tends to evaporate in summer, causing smog. This tendency can be partly overcome by modifying the gasoline base to which it is added.

b. Ethanol needs to be shipped separately from gasoline. Because of its corrosive nature and tendency to combine with water, ethanol needs a separate truck/barge/train shipping system (or a dedicated pipeline, but this would be very expensive). MTBE can simply be added to gasoline at the refinery, and shipped by pipeline.

c. MTBE acted as a US-produced non-petroleum gasoline extender. While it may seem strange, ethanol is not as good as MTBE in this role. MTBE (made from natural gas) was relatively plentiful, and could be added in quantities up to 15% to gasoline as required. Ethanol is less available, and can only be mixed to a concentration of 10% of gasoline. Adjustments must also be made to the gasoline base, in order to minimize ethanol smog problems.

4. What kind of impacts did the US Energy Information Administration (EIA) expect when oil companies phased out MTBE and increased the use of ethanol as an additive?

The EIA expected that phasing out MTBE and substituting ethanol would tend to **decrease** the amount of gasoline available and **raise prices**, as discussed in this report. It would also somewhat negatively impact air quality.

Currently, most ethanol is used between the months of May and September. It seems likely that the use of ethanol during this time-period contributes to the higher gasoline prices experienced in recent summers.

5. To what extent can the production of corn-based ethanol be increased?

We are currently using 20% of the corn produced in the United States to produce ethanol. Under the most optimistic scenarios, this amount could be tripled, to the equivalent of 60% of our 2006 corn production. At this production level, corn-based ethanol would replace about 10% of the

volume (or about 7.2% of the energy content) of the US gasoline supply. This is still not very much, and there are serious questions whether this optimistic production level can in fact be reached.

If this level of production can be reached, the full amount of corn-based ethanol produced could be used as a fuel additive (as the 10% level), with no ethanol left over for E85.

6. What impact does corn-based ethanol have on global warming gasses?

Many people believe that using ethanol from corn would greatly reduce the emission of gasses implicated in global warming. This belief is based on the observation that if a corn plant grew, and then was burned, without any fossil fuel inputs or fertilizer, there would be no net gain in global warming gasses. This is because the carbon dioxide released in the burning of the plant would be offset by the carbon dioxide absorbed by the plant while the plant was growing.

This simplistic model is not correct for the production of corn-based ethanol because fossil fuels are used in the growing of corn and the production of ethanol, and these contribute to global warming gasses. Nitrogen used in fertilizer also tends to produce nitrous oxide, which is 300 times as potent a global warming gas as carbon dioxide.

There are also secondary impacts -- for example, increasing US corn production is likely to result in less US soybean production. If this occurs, Brazil, the largest producer of soybeans, is likely to increase its soybean production. Space for this increased Brazilian production is likely to be obtained by cutting down rain forests, which will tend to increase global warming gasses.

One review of the impact of ethanol on global warming gasses found "ambiguous" indications, with some studies indicating small increases, and others indicating small decreases. The authors' best estimate was a 13% decrease relative to the emissions made by gasoline. This implies that burning ethanol **still contributes** to global warming gasses -- but to a slightly smaller extent than gasoline.

7. What other biological/ environmental impacts does the production of corn-based ethanol have?

• Huge use of water. Approximately 4 gallons of water are used for every gallon of ethanol produced. Water use is much greater if irrigation is required. If ethanol production is in an arid region, non-renewable aquifers may be drawn down.

• Increased soil erosion. Even when corn is grown using the latest “no till” methods on flat land, there is some soil erosion. The amount of erosion increases if land in hilly or low-lying areas is tilled. Since soil regenerates very slowly, soil loss is a serious concern.

• More fertilizer use. Nitrogen fertilizer use is associated with increased global warming gasses and its run-off causes "dead" areas in the sea. Nitrogen fertilizer is made from natural gas, which is is in declining supply in North America. In the future, we will depend more and more on foreign imports of nitrogen fertilizer.

• More herbicide and pesticide use. Causes pollution problems. Also, since these are made from oil and natural gas, future supply is likely to depend on imports.

8. To what extent does the use of corn-based ethanol reduce fossil fuel use?

Studies vary in the extent to which the extent to which corn-based ethanol can be expected to reduce fossil fuel use, depending on how the corn is grown, and the "boundaries" considered in the

analyses. Some studies show that more fossil fuel energy is used in the production of ethanol than is provided in the ethanol produced. Other studies show a small net gain - typically about 20% of the fossil fuel inputs. Thus, the ratio of energy output to fossil fuel input is about 1.2 to 1.0.

One concern is that this net gain is much lower than for many other liquid fuel sources. For oil produced from wells, typically 15 gallons of oil are produced for each gallon of fossil fuel used in production. For ethanol from sugar cane produced in Brazil, the net energy gain is about 8 or 9 to 1. For most types of biodiesel, the net gain is about 2.0 and 3.0 to 1.0. Thus, even when the best planting areas are available, ethanol from corn appears to be inefficient compared to other liquid fuels.

9. Does it matter whether there is a net energy loss in the production of corn-based ethanol -– that is, it takes more fossil fuel energy to produce ethanol than the ethanol itself produces?

Some argue that we need liquid fuels, and we have large amounts of coal and natural gas, so it does not matter if we use an inefficient way of converting these fuels to a liquid form. Thus, having a net energy loss is the production of corn-based ethanol is OK.

This argument is wrong for two reasons. First, our fossil fuels are much more limited than most people believe. Natural gas is in especially short supply. If we use large amount of natural gas for ethanol production, we risk shortages for other purposes, including electrical production and home heating. We also drive up the price of natural gas.

Second, using large amounts of fossil fuels to produce ethanol is likely to exacerbate global warming. One argument for using ethanol is that it (hopefully) reduces fossil fuel use, and thus produces less carbon dioxide, which contributes to global warming. If instead of decreasing fossil fuel use, it really increases fossil fuel use, the effect is reversed – more carbon dioxide is produced, rather than less.

10. To what extent does corn-based ethanol replace imported foreign oil?

As discussed above, ethanol in the quantity produced today is almost exclusively a replacement for MTBE. MTBE is made from natural gas, and was primarily US produced. Thus, what we are doing is replacing one US produced item with a more expensive US produced item. Since some diesel fuel is used in the production of ethanol, one might argue that we may even be slightly increasing our use of foreign oil.

11. What economic impact does corn-based ethanol have?

Since at this point we are replacing one US-made product (MTBE) with a more expensive US-made product performing a similar function, the basic impact is inflationary. We are reducing the amount of corn available for export abroad, so we are most likely making our balance of payments worse. It is not clear that there is any savings on the amount of petroleum needed to be imported from overseas.

The price of corn, and in fact many food products, is expected to increase with the greater use of corn ethanol. This tends to raise the income of farmers. Costs to farmers are also expected to rise, as the price of land rises and the cost of other inputs, such as fertilizer and fuel oil, rise. Consumers are likely to have to pay more for food products, so this transfers more of their wealth to those producing food.

The overall effect is expected to be a slightly lower standard of living for Americans, because a

less efficient approach is being used to produce a fuel additive. Resources which might have been used for goods with higher value to consumers are now being devoted to ethanol production. There will be some transfer of wealth among groups, with farmers and ethanol producers perhaps being winners.

12. Is there a possibility of a better economic outcome, if the production of corn-based ethanol is greatly expanded?

It is not clear that corn production can be greatly expanded, without harmful impacts. At this point, nearly all of the land that can reasonably be used for corn without undesirable impacts is already being used for that purpose. To increase corn production, one or more of the following approaches are likely:

• Grow corn on land that needs to be irrigated. Result: more fossil fuel energy used than obtained from ethanol; may deplete aquifers.

• Grow corn on hill sides, or on other areas subject to erosion. Result: soil loss; not sustainable.

• Grow corn without crop rotation. Result: much more fertilizer used; more fossil fuel energy used than obtained from ethanol. Soybean production shifted overseas, resulting in increased imports of soybeans.

Even if expansion of corn production is accomplished, it is not clear that it can be maintained for long. The amount of natural gas available is expected to decline in the next few years, making fertilizer less available, and reducing the fuel available for producing ethanol.

If ethanol expansion occurs, transportation of the ethanol is also a question. Existing train/rail/barge systems are being strained with the current volume of ethanol. Significant investment in infrastructure may be needed if much larger volumes of ethanol are produced.

13. There are a number of new approaches to producing corn-based ethanol, using more renewable energy in the production of ethanol (such as methane from waste products or wind energy). What role do these efforts play in corn-based ethanol's future?

These efforts are to be applauded. To the extent that they are successful, they can perhaps be substituted for some of the natural gas and coal used in producing ethanol today. The use of the renewable fuels in ethanol production will tend to give corn-based ethanol a more positive energy balance and will reduce the use of fossil fuels. Some of these efforts may prove to be cost-effective as well.

It is not clear that these new methods will have a significant impact on the total amount of ethanol that will produced. Current ethanol production seems to be guided by a government plan to increase production to the maximum amount which can produced. This maximum amount apprars to be governed by factors such as the amount of corn that can be grown and the amount of transportation that is available for the final product. Whether or not it is economic to produce fuel in this way does not seem to enter into the decision.

14. What do recent analyses say about expanding ethanol production?

There recently have been two major studies looking at the question of expanding biofuels, one by the Congressional Research Service for Congress and one by the United Nations. Both urge caution in the expansion of biofuels because of the likelihood of unintended consequences. The Congressional Research Service Report looked specifically at the issue of ethanol from corn; the

UN report report looked at biofuels more generally.

One concern raised in the Congressional Research Service Report is that corn-based ethanol is likely to be quite variable in supply, depending upon the weather. Thus, if we expand corn-based ethanol production, we will be exchanging the variability associated with foreign oil with the variability associated with weather.

15. Is there any reason why corn-based ethanol should continue to receive tax subsidies?

No. Corn-based ethanol does not appear to have any particular advantage over other biofuels, and it is questionable whether it can be significantly expanded without adverse consequences. If other types of biofuels make more economic sense, they should be given a level playing field. Corn-ethanol will continue to be produced if it makes economic sense, without tax subsidies. The subsidies in place currently benefit the corporations that produce ethanol, with little benefit for individual farmers.

One potential disadvantage of removing tax subsidies is that this may tend to raise the price of gasoline at the pump. If higher prices encourage consumers to conserve fuel and companies to explore other types of biofuels, the higher prices may in fact be an advantage.

To Learn More

Congressional Research Service Report for Congress, "Ethanol and Biofuels: Agriculture, Infrastructure and Market Restraints Related to Expanded Production"

Supply Impacts of an MTBE Ban, US Energy Information Agency

Refining 101: Summer Gasoline, Robert Rapier on TheOilDrum.com.

Discussion Questions

1. Read the section in Robert Rapier's Refining 101 article about Senator Diane Feinstein's campaign to limit ethanol blending in California, because of smog problems. Would you side with Senator Feinstein or the Environmental Protection Agency? Why?

2. How would the market be different today, if, instead of providing subsidies only for corn ethanol, subsidies had been provided over the years for any type of biofuel, including potato based ethanol, diesel from soybeans, and any other type of biofuel considered?

3. How would the market be different today, if no subsidies had been provided for any type of biofuel?

4. Does it ever make sense for the government to select one "winner", such as corn ethanol, for subsidies?

5. Suppose the government taxes gasoline, but not biofuels. What is likely to happen to government revenue if gasoline production declines and biofuel use increases? Would this make public officials happy or unhappy? Is there any way of avoiding this problem?

This work is licensed under a Creative Commons Attribution-Share Alike 3.0 United States License.