Ethanol & Energy

An Ethanol Across America White Paper — Fall 2005

The Case for Using a Sensible Alternative Fuel

Much has been said and written in the recent national debate surrounding the Energy Bill as to whether ethanol or E85 is a wise choice as an alternative fuel. Now that the Bill has been signed into law, including a 7.5 billion gallon Renewable Fuel Standard, it may be useful to set the record straight on several issues outside of Washington politics. The debate seemed to be focused on several issues:

- Miles per gallon: Will using E85 reduce my fuel economy? Why does it matter?
- The cost: Will it cost me more to use ethanol or E85 than it costs to use gasoline? Since I can't go as far on a gallon of E85, is it a bad choice?
- The energy balance question: Does it take more energy to produce a gallon of ethanol than you get out of it? If I use ethanol, will I be using more energy instead of saving it?
- What is the national energy debate really trying to solve? How can we help reduce our dependence on oil? How can we address concerns about greenhouse gas emissions?

Ethanol is a renewable alternative fuel, currently made from corn grown in the U.S. It is a good motor fuel that can be made not only from corn, but from just about any organic or "biomass" sources, such as corn and wheat stalks, forestry waste and even municipal solid waste products.

Research conducted jointly by the University of Toronto and General Motors determined that it is well within the realm of possibility to replace 30% of U.S. gasoline use with ethanol from all potential sources including biomass. No other near term alternative fuel has that kind of potential. And ethanol is renewable, meaning the supply is virtually limitless, and it does not come from fossil energy sources such as petroleum or natural

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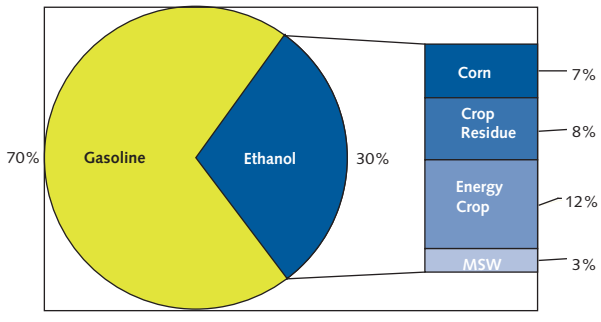
Mr. Herwick holds a Bachelor of Science degree in mechanical engineering from Ohio University.

Practical Estimate of Potential U.S. Ethanol Portion of U.S. Light-Duty Fuels (Year 2020)



All percentages are on an energy equivalent basis

Source: General Motors-University of Toronto Joint Research on Ethanol Supply

gas. Also, it can substantially reduce greenhouse gas emissions, because the process of making it recaptures carbon. No other currently available propulsion technology or alternative fuel, including hybrids or natural gas, even comes close. Fuel cells and hydrogen fuel have the potential to do better, but they are likely many years away from being commercially available alternatives.

A gallon of ethanol contains less energy than a gallon of gasoline. (Gasoline contains about 115,000 BTUs per gallon; ethanol contains about 76,000 BTUs per gallon, or about 2/3 of the energy content of gasoline.) E85 is an alternative fuel composed of 85 percent renewable ethanol and 15 percent gasoline. It's a mix that uses as much ethanol as possible that consumers can use today in over 6 million E85 Flex Fuel vehicles in the U.S. vehicle fleet. Fuel systems are upgraded in these vehicles with readily available materials to accommodate the high concentration of ethanol. The 15 percent gasoline is needed to make sure the fuel vaporizes and all cars start readily in cold temperature conditions.

Due to energy content differences and the way fuel ethanol is made, a gallon of E85 ends up having about 75% of the energy content of a gallon of gasoline. (The actual E85 mix is closer to 80/20 since fuel ethanol must be "denatured" by adding gasoline.) That means if you get 30 miles per gallon of gasoline, your fuel economy might be reduced to as low as 22.5 miles per gallon, and you have to fill up more often. Fuel economy usually doesn't drop that much in actual use because most cars automatically adjust to take advantage of the higher octane value of ethanol. So, to make E85 equivalent in value, it should be sold at about 75% of the price of unleaded regular gasoline. E85 at $1.76 per gallon is equivalent in energy value to gasoline at $2.35 per gallon.* E85 is currently selling at this price difference in many Midwest states. With the exception of the energy content difference, consumers should experience no other differences in engine performance. Years of field experience have confirmed that this is true.

At current U.S. oil prices in the range of $60* per barrel, wholesale prices for ethanol have made ethanol blending attractive to fuel distributors and marketers. The "rack" price for gasoline had been in the range of $1.50 to $1.70* per gallon for much of 2005, compared to a rack price of $1.20 to $1.60* per gallon for ethanol. Assuming equivalent taxes, freight and retail margin, and applying available federal tax credits, the business case may be attractive to sustain a market for E85 for the foreseeable future.

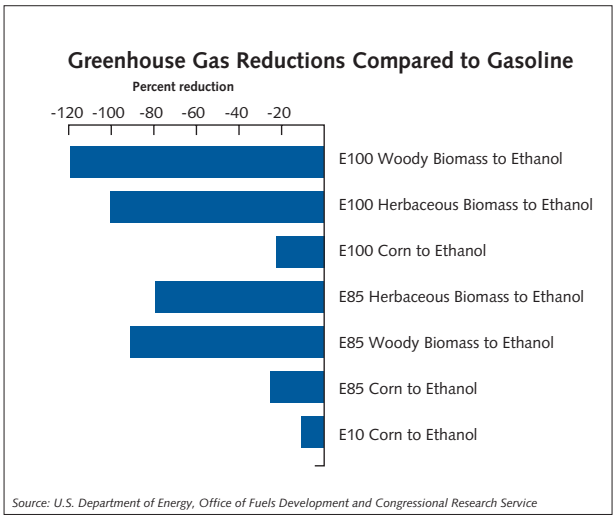
The "energy balance" issue has been debated in the technical literature and the editorial pages of major newspapers for several years. The issue seems to be whether a gallon of ethanol contains more energy than it takes to produce. Stated in this way as it has been in several articles, it's somewhat misleading, since several commonly used energy "carriers", notably electricity and gasoline, have negative energy balances—that is you get less energy out of the final product per unit than it took to produce.

Recently, both the U.S. Department of Agriculture, and the U.S. Department of Energy have spoken out about the ethanol energy balance issue after studying it extensively. They have both concluded that ethanol has at least a slight positive energy balance. The difference in studies conducted by the USDA (Shapouri, et. al.) and Argonne National Laboratory (Wang, et. al.), and the recent paper by Pimentel (Cornell) and Patzek (UC Berkeley) appears to be that substantial energy efficiency improvements in corn-based ethanol production in the last 20 years were ignored in the university research. A more detailed, well documented and understandable "Issue Brief" was recently published by the ***Ethanol Across America*** educational campaign. "Net Energy Balance of Ethanol Production", Fall 2004, is available on the internet at http://www.cleanfuelsdc.org/issues/04CFDC-003_IssueBrief.pdf.

There are opportunities to rethink these issues of energy content, energy balance and value. Instead of thinking as we are conditioned to think in terms of "miles per gallon," perhaps we could consider that E85 offers the opportunity to use 80% less gasoline! Or 22.5 miles per gallon on E85 represents more than 100 miles per gallon

** Prices are offered for illustrative purposes only. Dramatic fluctuations in oil prices as witnessed in recent months will change these figures, but price increases only serve to strengthen the argument for E85.*

of gasoline. Regardless of whether the energy balance is slightly positive or slightly negative, the real value in using ethanol is in reducing fossil energy use. The efficiency of ethanol production can and probably will be improved, but the energy comes from renewable sources that do not deplete finite fossil energy reserves. In terms of value, ethanol appears to be the only alternative fuel with a potentially sustainable business proposition.



General Motors Corporation commissioned a "Well-to-Wheels" life cycle analysis of energy use and greenhouse gas emissions in 2002. That study compared 15 propulsion technologies and 75 different fuel pathways. The results were that "ethanol as E85 reduces greenhouse gas emissions more than any other alternative fuel." This is consistent with the findings of the U.S. Department of Energy, as illustrated in the chart above.

Meanwhile, the debate about greenhouse gas emissions and the potential implications to global climate change continues. The common wisdom seems to be that we may not be convinced of the science connecting so-called greenhouse gas emissions to climate change. But there is enough concern in the scientific community to warrant steps to reduce the growing quantity of carbon dioxide that we are adding to the atmosphere every year. Phase 2 of the General Motors/Argonne National Laboratory "Well-to-Wheels" life cycle analysis of vehicle propulsion systems and fuels released in May 2005 concluded that there is no better currently available way to address petroleum fuel use and carbon dioxide emissions concerns than by using renewable fuels such as ethanol. Hybrid and diesel propulsion systems can reduce CO_2 by 20 to 30 percent. In comparison, E85 can reduce CO_2 by 75 to 85 percent. Fuel cells using renewably produced hydrogen could reduce CO_2 even further, but commercial availability may be decades away.

Now that the politics of the Energy Bill are behind us, we have an opportunity to focus the national energy debate more clearly on what we are really trying to solve. For me, two concerns stand out—petroleum fuel use and greenhouse gas emissions. That seems to cover a lot of ground that the Energy Bill attempted to address.

Should we double vehicle fuel economy standards, wait until technology is developed and implemented that will meet the standards, and hope that consumers can afford it and will buy it if they can? We already tried raising fuel economy standards many years ago, and consumers shifted their car buying habits to trucks and the expected gains were not realized. Are hybrids that cost $4000 to $9000 more than conventional propulsion systems the answer? No matter how innovative and compelling hybrid technology may be, I don't believe that enough of the auto buying public could or would pay the extra cost to make a significant reduction in overall fuel consumption. And even the potential fuel savings of hybrid technology throughout the fleet would not come close to justifying a public subsidy of that magnitude, not to mention the environmental nightmare of disposing of all those batteries.

ExxonMobil, the largest and most successful energy company in the world, projects a 40% growth in global energy demand in the next 15 years including transportation—forcing the production of new supplies of oil and gas amounting to 80% of today's production levels employing so-called non-conventional methods. To supply the projected growth in global transportation energy demand, all viable sources are likely to be needed including renewable alternatives such as ethanol and other biofuels. Clearly, the time to develop these alternatives is now.

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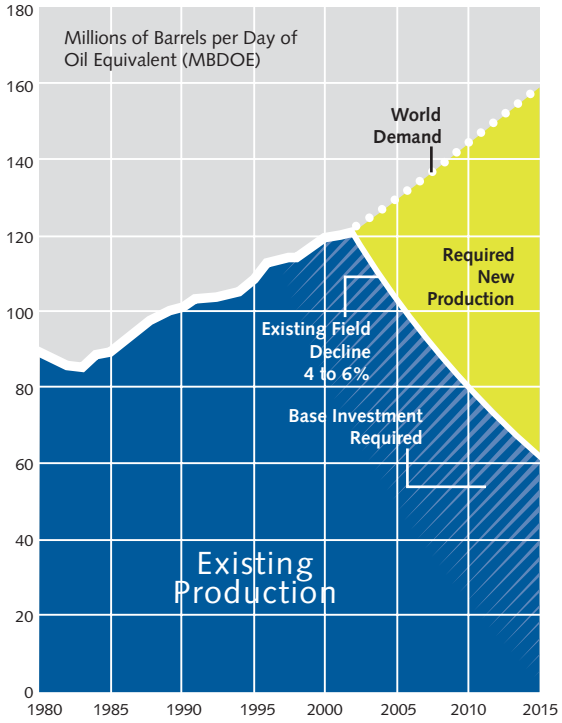
A sensible, economically viable alternative fuel is available that could be made in sufficient quantities to displace at least 30 percent of current annual gasoline use, and substantially reduce greenhouse gas emissions as well.

I suggest that we devote the necessary resources to take advantage of the opportunity that exists today, and to move toward developing the capability to use much more ethanol:

- Develop the infrastructure to sell E85 to take advantage of the 4 million E85 flexible fuel vehicles on the road today.
- Continue and enhance incentives to produce more E85 flexible fuel vehicles. This can be done with much lower cost than subsidizing hybrids.
- Support the implementation of the 7.5 billion gallon Renewable Fuel Standard in all 50 states, and develop ways to expand the use of ethanol much further as a means of diversifying our sources of transportation fuel.
- Support the commercialization of biomass ethanol production through research and investment in start-up ventures.

Supplying Oil and Gas
Demand Will Require Major Investment



A study called Energy Trends, published in 2004 by ExxonMobil, the world's largest oil company, projects major increases in global energy demand through 2020. To meet this demand, it predicts that more expensive "unconventional" production methods will be needed, and alternative energy sources such as biomass will experience substantial growth.

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