

# The Economics of Biofuels

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Recently a large amount of interest has been shown in renewable energy options in Kentucky. Many seem to have recognized both the positive and negative impacts of the corn-based ethanol trend we have seen in the last few years. Corn growers have experienced nice returns while the livestock industry has been hit hard with higher feed costs. Recently, critics of corn-based ethanol have suggested that it takes more energy to produce ethanol than what we are saving by producing a cleaner fuel. Regardless of the pros or cons of corn-based ethanol, the Renewable Fuels Standard (RFS) mandates that we produce 15 billion gallons of corn-based ethanol by 2022. In 2008, we will have produced just less than 10 billion gallons. Right now, things have calmed down with lower fuel prices, and corn prices have returned to a more moderate level. However, to meet this RFS requirement, we can expect the corn market to exhibit more volatility in the future.

In addition, the RFS states that 21 billion gallons of ethanol should be produced using cellulosic residues. In the future, we are likely to see switchgrass, sugarcane, sweet sorghum, algae, and wood used as materials for ethanol production. Tennessee has recently broken ground on a switchgrass ethanol blending facility. Meanwhile, Dupont says it has created the technology to convert biomass into ethanol; it just needs enhancement for large-scale production. If this is a profitable venture for producers, Kentucky could contribute pasture and hay ground towards growing switchgrass for ethanol. There are some plots in Kentucky that have already started experimenting with switchgrass production.

## U.S. Energy Consumption in 2007

Kentucky has a per capita carbon score of 8, with the 25th highest resident population. Each Kentucky resident produces approximately 35 tons of carbon dioxide each year. Kentucky is the 14th highest carbon dioxide polluting state in the United States, according to the U.S. Department of Energy. Thus Kentucky has a relatively large carbon footprint. Table 1 provides a brief overview of what Kentucky consumes relative to the rest of the country.

Given Kentucky's apparent reliance on non-renewable energy sources and the carbon footprint we leave behind, the state, along with the rest of the nation, is exploring other energy options that include alternative fuels (biodiesel and biofuels) and energy efficiency options that could include wind and solar energy.

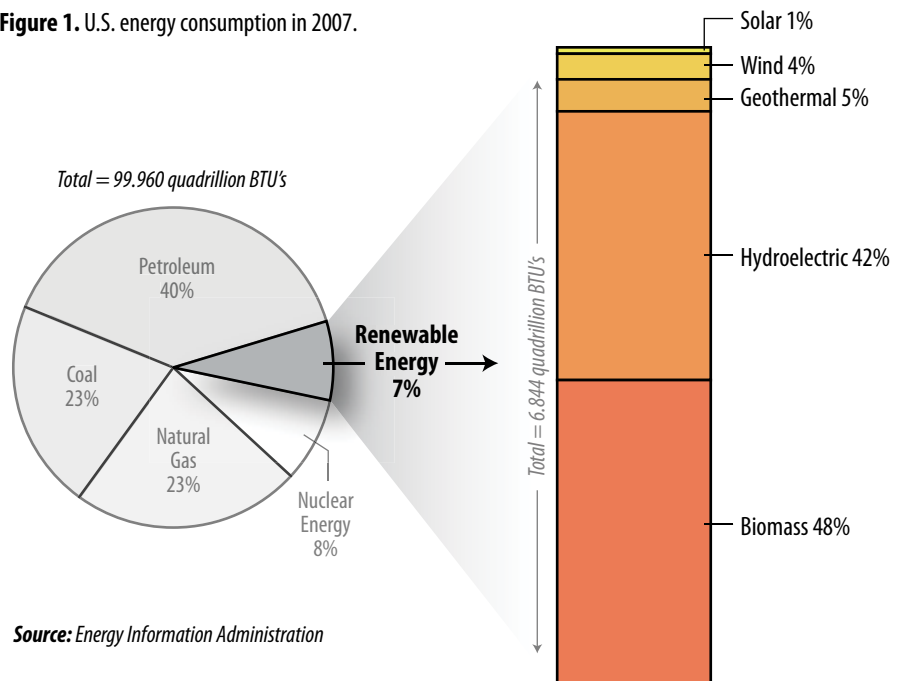
Table 1. Kentucky energy consumption in 2007.

	Consumption	Share of U.S.
Per capita	472 million BTU	Ranked 6th
<b>By Source</b>		
Total Energy	1,970 trillion BTU	2%
Total petroleum	138,745 thousand barrels	1.8%
Natural Gas	211,067 million cubic feet	.9%
Coal	Not disclosed	

## The Renewable Fuels Standard

The U.S. Environmental Protection Agency (EPA) has established a national renewable fuel program. The Renewable Fuel Standard, or RFS, program is designed to encourage the blending of renewable fuels into our nation's motor vehicle fuel. The law sets a modified standard of 9 billion gallons in 2008 up to 36 billion gallons in 2022. By then, 21 billion gallons is to come from cellulosic ethanol, and 16 billion gallons is to come from corn-based ethanol.

Figure 1. U.S. energy consumption in 2007.



Source: Energy Information Administration

The United States leads the world in ethanol production; Brazil plays a close second. In 2007, the United States produced 6,500 million gallons of ethanol, which still falls short of the RFS for 2008 (Figure 2). Forecasts originally indicated that the U.S. was going to produce nearly 9.9 billion gallons of ethanol in 2008; however, with gas prices falling at the end of the year, ethanol production was only around 9 billion gallons (U.S. Department of Energy).

### Biofuels in Kentucky

The production of ethanol has rapidly increased, although the number of states with an ethanol plant has only increased from 18 states to 21 states since 1999. Kentucky currently only has one real ethanol plant, located in Hopkinsville. Two more plants are planned for the near future. The production capacity at the Hopkinsville plant is 33 million gallons per year, which is now significantly lower than the average ethanol plant.

### Potential Benefits from Investing in Renewable Fuels

Obvious benefits are associated with producing renewable fuels and investing in alternative energies. They include but are not limited to the following:

- Reduced reliance on imported fuel sources
- Decreased amount of carbon released by transportation vehicles using traditional fuel sources
- Enhanced rural development and profitability
- Larger share of energy payments retained in Kentucky
- Attraction of new industries that offer good-paying jobs

Let's explore some of our renewable fuel options, keeping in mind that not all are necessarily suitable for Kentucky. Ethanol is most commonly used in the transportation sector as a fuel additive that enhances fuel combustion and reduces emissions. The number of flex-fuel vehicles increases each year; however

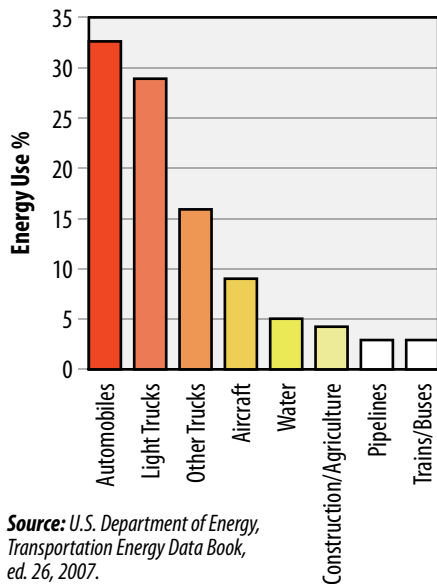
we are still constrained in Kentucky by the number of filling stations. Currently, Kentucky has three E-85 (85% ethanol) fuel stations in Kentucky. There are also numerous E10 stations, most found in western and central Kentucky along I-64.

### Corn-Based Ethanol

Corn is currently the material most widely used for producing ethanol. As a result, corn prices increased drastically from the fall of 2006 through the summer of 2008, largely due to rising crude oil prices. Current estimates are for about one third of the 2008 corn crop to go into ethanol production. This new use has put pressure on corn prices, which have increased feed cost for livestock producers. Grain producers have enjoyed higher prices, and the livestock industry has been forced to absorb higher costs.

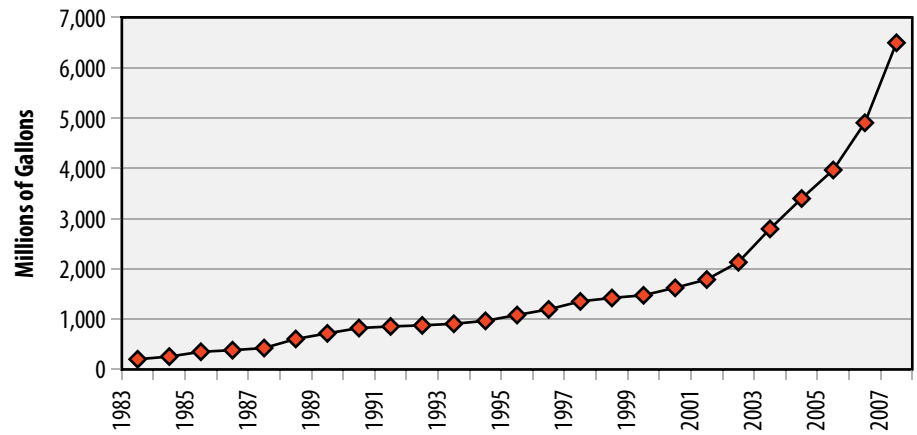
In 2008, Kentucky planted 1.21 million acres of corn and 1.39 million acres of soybeans. Prices for corn, which

**Figure 2.** Transportation fuels.



Source: U.S. Department of Energy, Transportation Energy Data Book, ed. 26, 2007.

**Figure 3.** U.S. ethanol production since 1983.

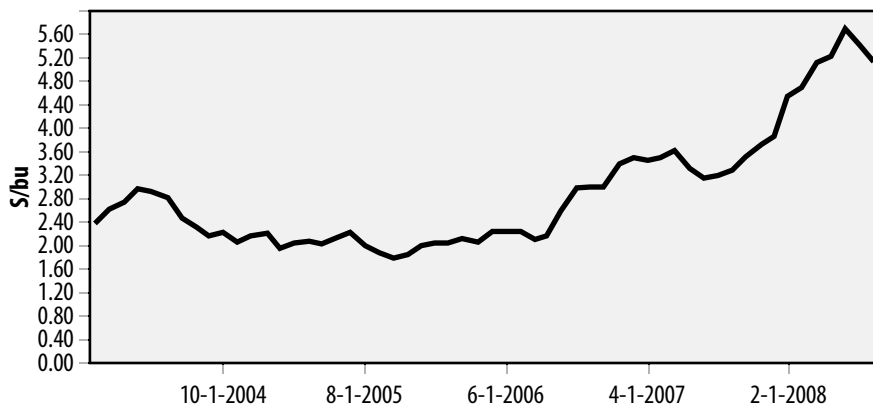


Source: U.S. Department of Energy.

**Table 2.** Kentucky's renewable energy efforts.

Alternative fuels		Share of U.S.
Alternative-fuel vehicles in use (2006)	6,136	1%
Ethanol plants (2008)	1	.7%
Ethanol plant capacity (2008)	33 MGPY	.4%

**Figure 4.** Average monthly corn prices received by Illinois farmers.



Source: <http://www.agstats.state.il.us>

historically have been around \$3, were trading above \$7 on the Chicago Board of Trade for a period. As the overall U.S. economy lost steam and the dollar strengthened, crude oil prices began to fall. As this happened, corn prices were bid down as ethanol became less valuable. Ethanol plants purchase corn and sell ethanol and distiller's grains. Therefore, their willingness to pay for corn will be affected by the ultimate value of the corn for these uses. Further, there is a \$0.51 per gallon subsidy on ethanol that has been largely bid back into corn prices. This subsidy was reduced to \$0.45 in the 2008 Farm Bill but remains incredibly significant. For each bushel of corn, which yields about 2.8 gallons of ethanol, the subsidy represents approximately \$1.26 per bushel of corn.

Some blame corn-based ethanol production for the surge in food prices. Some foods have become more expensive because of higher corn prices, but higher food prices are mostly explained by weather, energy prices, transportation costs, and the value of the dollar. It is difficult to estimate what the impact of ethanol on food prices will be in the future because of the uncertainties associated with other commodity-based ethanol technologies.

## Cellulosic Based Ethanol

### Switchgrass

Partly in response to the highly volatile corn market, cellulosic materials have received a lot of attention recently as a potential in the production of ethanol. The technology has not been ironed out yet for large scale production, but many believe that the capability is right around the corner. We are relying on switchgrass as a major feeder of the cellulosic-based ethanol market. Depending on the prevailing price for switchgrass, Kentucky does have potential to produce for this market. In 2008, Kentucky harvested over 2.64 million acres of hay. In addition, Kentucky has approximately 6 million pasture acres. Some of this ground could be shifted to switchgrass production if there was a potential for profit. For example, if Kentucky shifted 5 percent of its pasture and 10 percent of its hay ground to switchgrass production, approximately 550,000 acres would be available. At a yield of 7 tons per acre, Kentucky could produce as much as 1,925 tons of switchgrass.

If the technology is successfully developed and the appropriate price incentives in place, we could see considerable hay price volatility as producers explore this option. This unfortunately has the potential to negatively impact the livestock industry once again.

### Sugar

To date, no firm in the United States has begun producing ethanol from sugarcane juice. A Texas A&M study found that a sugar to ethanol plant has a 100 percent chance of the net present value being positive or the plant being an economic success. Sugar has proven to be one of the most promising crops for ethanol production. Unfortunately, Kentucky does not provide the necessary climate to grow sugarcane and won't be able to share in the production of ethanol produced from sugar.

### Sweet sorghum

The adaptation of sorghum to sub-humid and semi-arid climates has extended sorghum production into larger regions than other warm-cereal grains.

Sorghum is relatively inexpensive to grow with high yields and can be used to produce a range of high value added products such as ethanol, energy, and distillers' dried grains. Sweet sorghum is a feedstock that has some potential in Kentucky. In 2007, approximately 12,000 acres were harvested in the state, which accounted for 90 bushels per acre, or just over one million bushels for the year.

## Wood Based Ethanol

Although slightly less energy efficient than switchgrass, wood may be used for ethanol production and will likely one day be considered a viable option. Right now it is not cost-effective; however, experts believe that with additional funding aimed at non-food inputs, wood will be an important resource for ethanol by 2012. If this prediction is true, Kentucky will obviously be a likely player in the market, given the vast forests in the eastern part of the state.

## Algae and Duckweed-based Ethanol

With the pressure on food crop prices, researchers are looking anywhere they can for other sources to aid in the production of ethanol. The newest sources are algae and duckweed. According to research, "Duckweed is an aquatic plant that creates a scum on the surface of ponds, doubles its mass every few days and can be manipulated as it grows so that up to three-quarters of that mass is starchy content that can be broken down and fermented into ethanol. Because the duckweed can be harvested almost daily, it can produce four times the amount of ethanol per acre as corn."

## References

- Herrera, Stephan. Wood-based ethanol advances on the international front. *Industrial Biotechnology* 2(2), summer 2006.
- North Carolina State Research Magazine. Researchers find fuel in odd places, winter 2008.
- Outlaw, Joe, et al. Economics of sugar-based ethanol production and related policy issues. *Journal of Agricultural and Applied Economics*, August 2007.
- U.S. Department of Energy. 2003. Energy Information Administration data.
- U.S. Department of Energy. 2007. Transportation Energy Data Book, ed. 26.