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Ethanol Production Impacts Transportation System

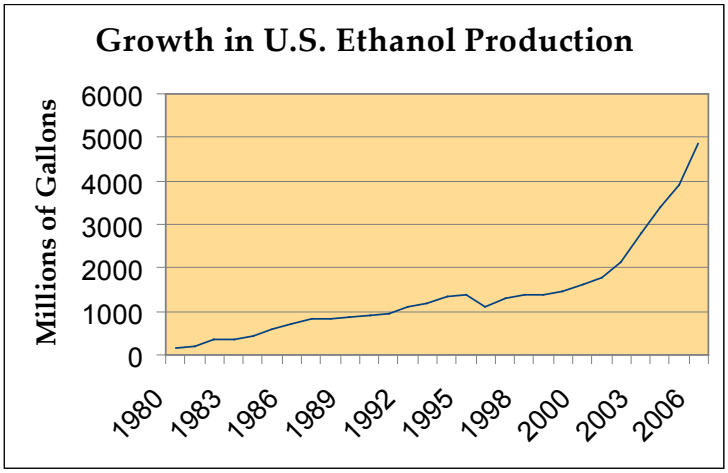
Over the past few years, renewable and alternative fuels have received significant public and media attention regarding energy prices, national energy security, economic impacts, environmental effects and a whole range of other issues. But how do fuels such as ethanol ultimately get to consumers at the filling station? The logistical aspects of transporting energy feedstocks like corn to ethanol plants, and moving fuels to filling stations has received less scrutiny.

In 2005, the U.S. used 20.7 million barrels of petroleum each day, using 67 percent for transportation, the largest single use of petroleum. Imports of oil have outstripped domestic production since 1996, with 12.4 million barrels imported per day.[1] This makes fuels such as ethanol a focal point in discussions of how to displace demand for petroleum, which requires an investigation of fuel transport trends.

"The biofuels industry has a major impact on the transportation system," says Northern Iowa Council of Governments Executive Director Joe Myhre, who has witnessed significant growth of ethanol in the COG's eight-county region. "Locally, the counties have to invest monies to build and maintain the infrastructure that supports the ethanol or biodiesel plants, and the state has been a tremendous partner in providing assistance."

Ethanol Production in the United States

Use of ethanol in the United States began in the mid-1800s, but production was limited until after lead was phased out of gasoline and government incentives to produce ethanol were established in the 1970s. Several events in the past few years, such as rising petroleum prices, a mandate in the 2005 Energy Policy Act to include 7.5 billion gallons in gasoline by 2012, new tax incentives, and decreasing use of the fuel additive methyl tertiary butyl ether (MTBE, which is often replaced by ethanol) because of environmental concerns, have caused another major increase in ethanol production in recent years.



Source: Renewable Fuels Association

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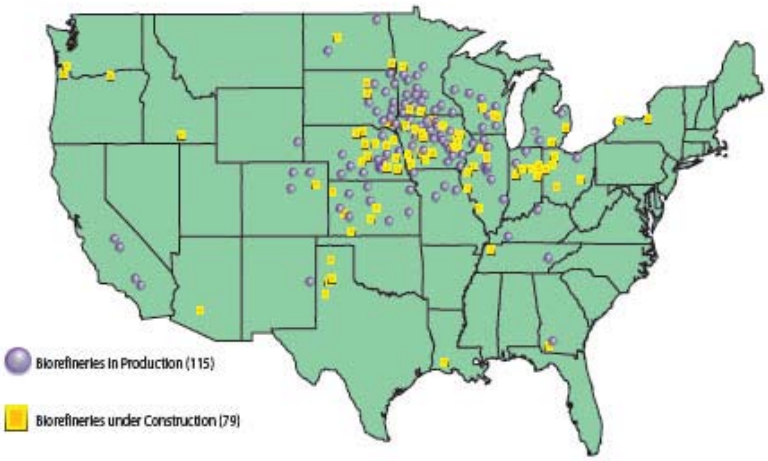

U.S. Ethanol Biorefinery Locations
Source: Renewable Fuels Association, April 2007. Used by permission.

"From the mostly Midwestern production points, railroads on average, move a carload of ethanol about 800 miles to destinations typically on the East Coast, California and Texas."

– Craig Rockey, American Association of Railroads

In 2006, ethanol accounted for about 3.5 percent of U.S. gasoline supplies, and it was included in about half of the gasoline consumed. According to the Renewable Fuels Association, there are currently about 120 ethanol plants in operation in the United States, with the capacity to produce 6.3 billion gallons per year. Another 6.2 billion gallons of capacity is under construction, up from 175 million gallons produced in 1980.[2]

Although research is being conducted into a variety of feedstocks, nearly all of the ethanol produced in the United States is currently derived from corn. Since most of the nation's corn is produced in rural regions of the Midwest, ethanol plants have been concentrated within this region. With production capacity of 1.9 billion gallons per year,[3] Iowa alone produces about 30 percent of the nation's ethanol and has two to three times as much production capacity as neighboring states.

In contrast, the greatest demand for ethanol occurs in the nation's large population centers. In 2004, California used more ethanol than any other state; nearly 900 million gallons of ethanol were blended with gasoline. Other states with high ethanol use include Illinois, with 421 million gallons, and New York, which used over 300 million gallons.[4]

At a 2006 renewable energy conference, American Association of Railroads Senior Vice President for Policy and Economics Craig Rockey estimated, "From the mostly Midwestern production points, railroads on average, move a carload of ethanol about 800 miles to destinations typically on the East Coast, California and Texas"—leading to a major transportation challenge that also has economic impacts.[5]

Transporting Ethanol Requires a Multi-modal System

A recent Iowa State University Extension survey of ethanol plants found that, on average, plants had storage for about five percent of the amount of corn used annually, and they tended to store corn for about 14 days.[6] Storage for ethanol and its co-products is also limited by the available space at each plant. Just as the manufacturing sector has increasingly turned to just-in-time production to streamline warehousing needs, ethanol plants must have an efficient transportation network to ensure a steady supply of corn and timely movements of ethanol shipments and keep it competitive with prices of petroleum-based fuels.

Corn is frequently delivered by truck from farms or grain storage locations to ethanol plants. A 100-mgy facility would require an average of 160 trucks to deliver corn each day, or over 41,000 loads per year.

Ethanol plants have created new, more localized demand for Midwestern corn, changing the transportation needs of the agriculture industry. Prior to the recent ethanol boom, some corn was used on the farm and locally, but the remainder was often trucked to a grain elevator, moved by barge or rail to export facilities, or shipped by truck or rail to other states to be used in livestock feed, food and industrial functions.[7]

USDA projects that the volume of corn used for ethanol will grow far more quickly than for any other use. In 1996, just five percent of corn grown in the United States was used to produce ethanol. By 2006, that share grew to 17 percent, and it may be up to 31 percent by 2016.[8] This will continue to change transportation patterns, as more grain is used for ethanol and less for export.

For many plants, corn is frequently delivered by truck from farms or grain storage locations to ethanol plants. A 100-million gallon per year (mgy) facility would require an average of 160 trucks to deliver corn each day, or over 41,000 loads per year.[9] Outbound movement of ethanol and distillers grains, a by-product used in livestock feed, occurs via multiple modes. But every mode has its concerns.

"Ethanol production is putting a lot more trucks on the road. That increases the wear and tear on the roads and creates new infrastructure needs, such as for hard-surface access roads and turning, acceleration and deceleration lanes," Myhre notes.

In another recent report by Iowa State University Extension, author Roger Ginder discusses truck traffic moving corn to new ethanol plants: "While the existing infrastructure in most parts of [Iowa] can handle the added volume in the near term, the added traffic is likely to accelerate the need for road and bridge maintenance in the future."[10]

In 2005, trucks moved about 30 percent of ethanol produced, while barges moved just 10 percent. In trucking, shortages of qualified drivers and equipment could cause transportation problems, while the barge industry is increasing its numbers of tank barges in spite of its currently limited role to try to avoid such considerations as ethanol production grows.[11]

Many ethanol plants locate near existing rail or build rail spurs, allowing them to ship by both truck and rail. Rail shipments of ethanol grew from about 40,000 to 82,000 carloads between 2000 and 2005, but rail's share decreased during that period from 69 to 60 percent of ethanol produced.[12] Rail can move fuel efficiently, but the logistics can be tricky.

Factors in Ethanol Plant Site Location

- Availability and transportation of corn or other feedstock
- Distance to natural gas pipeline or other energy source
- Highway and interstate access for inbound and outbound shipments
- Cost to state and local governments and ethanol plants for constructing and maintaining roads used for inbound and outbound shipments
- Cost of rail spur construction
- Access to national rail service
- Number of transportation providers for each mode, and options for competitive transportation service
- Transportation to petroleum distribution terminals
- Available water supply and infrastructure (over 3 gallons of water is needed per gallon of ethanol produced)
- Water treatment requirements
- Incentives such as infrastructure grants and loans, tax abatements, or agreements between state and local governments and plants for sharing costs of constructing and maintaining infrastructure
- Storage, transportation, and market for ethanol co-products, such as distiller's grains and carbon dioxide

Source: A Guide for Evaluating the Requirements of Ethanol Plants

According to Rockey, with the railroads running at or near capacity in many parts of the country, "ethanol-related traffic must vie with other traffic for time slots, for train crews, for power and for cars on the line." Another difficulty is a shortage of rail tank cars, which despite an increase in production may take 2 years for orders to be filled. With an interest in developing new business, however, railroads are dialoguing with the ethanol industry, and Class I and short-line railroads are making capital investments in the Midwest.[13]

Class I railroads such as CSX Transportation and BNSF have introduced unit train service for ethanol, in which a complete train of about 95 cars carries the fuel from a single origin to one destination where it is blended with gasoline and sold. Filling an entire unit train may be difficult for smaller plants, however, since a 95-car train could carry nearly 2.8 million gallons of ethanol.

Transporting petroleum from refinery to gas station costs about 3 – 5 cents per gallon, while the cost for ethanol ranges from 13 – 18 cents per gallon.

A new facility in northern Iowa near I-35 and I-90 may assist producers with marketing and transporting their ethanol more efficiently, however. This loading depot, called the Manly Terminal, will open in 2007. The 100-acre facility is sited along the short-line Iowa Northern Railway and can receive truck deliveries of ethanol. With fuel storage available on-site, the Manly Terminal will be able to fill 25 rail cars at once, loading a 100-car unit train in about eight hours. The Iowa Northern Railway runs 163 miles from Manly to Cedar Rapids, Iowa and offers connections with Class I railroads like BNSF and Union Pacific.[14]

It would typically take 20 days for an individual 50-mgy ethanol plant, or 10 days for a 100-mgy plant, to produce enough ethanol to fill a unit train. Marketing and transporting smaller quantities more frequently will get the fuel to market more quickly and may reduce the need for ethanol producers to pay switching fees.

Ethanol's Economic Impacts

Along with the infrastructure impacts, the growing industry is having an economic impact on both the producing regions and elsewhere in the nation. Infrastructure investments help to keep the system running smoothly—necessary for the cost of moving ethanol to remain competitive with petroleum. Transporting petroleum from refinery to

gas station costs about 3 – 5 cents per gallon, while the cost for ethanol ranges from 13 – 18 cents per gallon. Since many regions now depend on ethanol as a fuel additive, reliable and efficient movement of ethanol is key to maintaining the economy and avoiding price spikes. In addition, according to the Renewable Fuels Association, the ethanol industry added 163,034 jobs and $41.9 billion of gross output (in spending on annual operations, transportation and capital spending) to the nation's economy in 2006.[15] Having a reliable system with sufficient capacity to transport ethanol efficiently also has an impact on the nation's economy.

In the Midwest, Iowa has seen considerable investment by the state and counties in putting in hard surfaced access roads and providing assistance with rail siding to ethanol plants. Much of this support has come through the Revitalize Iowa's Sound Economy (RISE) program, funded through the state gas tax to support economic development. Accordingly, significant economic impacts have occurred, in employment and returns on investment.

More new plants are beginning operation outside the Midwest, meaning corn would have to be shipped to them, and other feedstocks are being investigated, which could radically change the industry's needs if it moved away from primarily using corn.

Myhre says about the plants in his region: "Ethanol clearly has a huge economic impact on the area. People wonder whether it would survive without subsidies, but it does create well-paying jobs. Since the plants are for-profit, there's a huge tax base. The new and expanded facilities represent a sizable investment. With a local market for their corn, farmers see financial gain, and the profitability for investors has been tremendous."

The ethanol industry has many transportation concerns, and as it continues to grow and develop, new issues will certainly arise. More new plants are beginning operation outside the Midwest, meaning corn would have to be shipped to them, and other feedstocks are being investigated, which could radically change the industry's needs if it moved away from corn. These complex transportation issues affect the investments that states and local jurisdictions make to support biofuels and have impacts both locally and nationally, not only ethanol and agriculture producers, but also other regional stakeholders and the national economy.

Additional Ethanol and Transportation Resources:

A Guide for Evaluating the Requirements of Ethanol Plants, 2006, cleanfuelsdc.org/pubs/documents/ethanol_plant_guide.pdf

American Coalition for Ethanol, www.ethanol.org

Center for Transportation Advancement and Regional Development, www.ruraltransportation.org/Resources/Resource-Library/Energy

DTN Ethanol Center, www.dtnethanolcenter.com/

Potential Infrastructure Constraints on Ethanol Production in Iowa, Roger Ginder, Iowa State University Extension, www.extension.iastate.edu/ag/GinderPresent.indd.pdf

Renewable Fuels Association, www.ethanolrfa.org

U.S. Department of Agriculture (USDA) Corn Briefing Room, www.ers.usda.gov/Briefing/Corn/

USDA Renewable Energy and Energy Efficiency Program, www.rurdev.usda.gov/rbs/farmbill/index.html

Ethanol Reshapes the Corn Market, USDA, www.ers.usda.gov/AmberWaves/May07SpecialIssue/Features/Ethanol.htm

U.S. Department of Energy (DOE), Alternative Fuels Data Center, www.eere.energy.gov/afdc/altfuel/ethanol.html

U.S. DOE, Energy Information Administration, www.eia.doe.gov

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[1] *Energy Perspectives*, U.S. Department of Energy, Energy Information Administration, July 27, 2006
[2] Paul C. Westcott, "Ethanol Expansion in the United States: How Will the Agricultural Sector Adjust?" USDA, ERS, May 2007, p. 2, 4; Renewable Fuels Association, U.S. Fuel Ethanol Industry biorefineries and Production Capacity, http://www.ethanolrfa.org/industry/locations/, accessed 06/18/2007
[3] Iowa Renewable Fuels Association, Ethanol Refineries, http://www.iowarfa.org/ethanol_refineries.php, accessed 06/22/2007
[4] Federal Highway Administration, "Estimated use of gasohol," Highway Statistics 2004
[5] Craig Rockey, Rail and Logistics, transcript of the "Liquid Fuels and Bioproducts" breakout session, Advancing Renewable Energy Conference, October 11, 2006
[6] Connie Hardy, Mary Holz-Clause, Howard Shepherd and Charles Hurburgh, "Sourcing Corn for Ethanol: Impacts of Local Processing," Iowa State University Extension, 2006
[7] Iowa Department of Transportation (DOT), Office of Rail Transportation, "How ethanol has changed transportation in Iowa," *Iowa Railroad Ties*, May 2007; Nick Marathon, Tamara Van-Wechel and Kimberly Vachal, Transportation of U.S. Grains A Modal Share Analysis, 1978-2004, United States Department of Agriculture Agricultural Marketing Service, October 2006
[8] Westcott, 2007, p. 5
[9] Craig O'Riley, Iowa DOT Office of Systems Planning, "Impact of Ethanol on Iowa's Transportation System," presented 8/24/2006
[10] Roger Ginder, "Potential Infrastructure Constraints on Ethanol Production in Iowa," Iowa State University Extension, November 2006
[11] Marina Denicoff, "Rising Ethanol Production Creates Demand for More Rail Tank Cars," *Grain Transportation Report*, USDA, Agricultural Marketing Service, Transportation Marketing Program Transportation Services Branch, December 7, 2006
[12] Allen Baker and Steven Zahniser, USDA ERS, "Ethanol Reshapes the Corn Market," May 2007, p. 71; Denicoff, 2006
[13] Rockey, 2006; Marina Denicoff, "Ethanol Production Growth Affects Transportation Infrastructure," *Grain Transportation Report*, USDA, Agricultural Marketing Service, Transportation Marketing Program Transportation Services Branch, June 14, 2007; "How ethanol has changed transportation in Iowa," *Iowa Railroad Ties*, Iowa DOT, May 2007
[14] Personal communication with Joe Myhre, June 2007; www.iowanorthern.com, accessed June 21, 2007
[15] "Biofuels: DOE lacks a strategic approach to coordinate increasing production with infrastructure development and vehicle needs," Government Accountability Office, June 2007; John Urbanchuk, 2007, "Contribution of the Ethanol Industry Economy of the United States," Renewable Fuels Association, p. 5

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