Section 5.1: Ethanol[1]

Topic / Issue Description

Ethanol, or ethyl alcohol, is a clear, flammable liquid, which is familiar to many as an ingredient in alcoholic beverages. Most U.S. ethanol is made from corn, but it can also be produced from other feedstocks such as grain sorghum, wheat, barley, or potatoes. In Kansas, more than half of the ethanol produced comes from grain sorghum, with most facilities using corn and sorghum interchangeably.

As of August 2007, U.S. ethanol production capacity was at 6.8 billion gallons, with another 6.7 billion gallons of capacity under construction.[2] Since 2003, U.S. annual consumption has outpaced production (by 300 million gallons in 2005, the date of the most recent data).[3] Most of the imported ethanol comes from Brazil, with a smaller portion coming from Central American countries.

Ethanol an be produced using a wet or dry mill process; however, 82 percent of U.S. production uses the dry mill process. In both processes, the starch in the feedstock is fermented into sugar and then distilled into alcohol. Dry milling involves grinding the corn or sorghum feedstock into flour before fermentation, while wet milling uses soaking to separate the corn or sorghum kernel components. Co-products of dry milling corn or sorghum are distillers grains with solubles, a highly nutritious livestock feed, and carbon dioxide, which can be collected and compressed for sale to other industries. Sorghum distillers grains have a higher protein content and less fat and ash than the corn equivalent.[4] Co-products of wet milling are corn or sorghum oil (a potential biodiesel feedstock) and corn or sorghum gluten meal (protein).

Cellulosic ethanol uses lignocellulose, the main structural material in any plant, as a feedstock. Cellulosic feedstocks require an extra step to break down the lignocellulose into fermentable starch, thus increasing production costs. The bulkier cellulosic feedstocks are also more costly to harvest, transport, and store. Research on cellulosic feedstocks (such as switchgrass, wood chips, and corn stover) is ongoing. The U.S. Department of Energy (DOE) has set 2012 as a target to achieve technological advances to make cellulosic ethanol cost competitive with corn ethanol.[5] In conjunction with cellulosic ethanol research, some researchers are investigating the use of perennial polyculture crop systems for cellulosic feedstocks.

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[1] For charts and graphs related to biomass and biofuels, please refer to the *Kansas Energy Chart Book*, Chapter 5 (http://kec.kansas.gov/chart_book/).

[2] U.S. Dept. of Energy, Energy Efficiency and Renewable Energy, 2007, Biomass Program, Technologies, Biomass FAQs: http://www1.eere.energy.gov/biomass/biomass_basics_faqs.html (accessed December 12, 2007).

[3] U.S. Dept. of Energy, Energy Information Administration, 2007, Biofuels in the Transportation Sector, Figure 22: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html (accessed December 2007).

[4] Shurson, Jerry, 2006, Quality Characteristics and Nutritional Profiles of DGS, University of Minnesota, Dept. of Animal Science, powerpoint presentation: http://www.ddgs.umn.edu/ppt-swine/2006-Shurson-%20Quality%20characteristics%20(NGFA).pdf (accessed December 2007).

[5] U.S. Government Accountability Office (GAO), 2007, Biofuels: DOE Lacks a Strategic Approach to Coordinate Increasing Production with Infrastructure Development and Vehicle Needs (GAO-07-713), p. 5.

As an agricultural state, Kansas has great potential for biofuel production and has seen rapid growth in the ethanol industry. As of December 2007, Kansas had ten grain-ethanol plants in operation, representing 370 million gallon/year (MGY) in capacity (with six more under construction), and pre-permit application meetings and preparations are underway for one proposed cellulosic ethanol plant in Hugoton.

Economic Impacts—There is no doubt that the growth in the ethanol industry has provided economic benefits to the state, both in terms of the jobs associated with each of the state's ten ethanol facilities (with the newest plants providing approximately 35 jobs each) and the additional market for the state's corn and grain sorghum producers. Given the federal and state incentives in place to support biofuels (see list of existing policies and programs below), it is likely that demand for corn and other food crops for fuel feedstocks will remain high and continue to impact prices.

The impact of higher corn prices on the cost of food has been widely discussed in recent months. According to a recent report from the U.S. Bureau of Labor Statistics, prices for chicken, milk, and eggs (foods strongly affected by the price of corn) were 8.4 percent, 21.1 percent, and 33.7 percent higher in July 2007 than in July 2006,[6] though other inputs such as fuel costs are also driving the higher food prices.[7]

Environmental Impacts—Ethanol production, like many industrial and agricultural practices, involves a consumptive use of water. A 50-MGY ethanol plant uses about 200 MGY of water (or about 550,000 gallons per day), primarily from evaporation during cooling and wastewater discharge. Ethanol production technology has improved to use water more efficiently: plants today use about 50 percent less water than 10 to 15 years ago.[8] It currently takes roughly three to four gallons of water to produce one gallon of ethanol. Under Kansas' established system for appropriating water resources, all ethanol plants must purchase water from a rural water district or municipality or acquire a water right. In parts of the state closed to new water appropriations, any new venture must purchase existing water rights, and any new use of that appropriation must be approved by the Chief Engineer to ensure that the net consumptive impact does not increase. Nonetheless, some have raised concerns that increased corn production statewide may cause additional declines over time, as a result of diminished recharge (less irrigation water replenishing aquifers).[9]

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[6] U.S. Dept. of Labor, 2007, Bureau of Labor Statistics, Consumer Price Indexes (CPI), CPI Detailed Report Data for July 2007: http://www.bls.gov/cpi/cpid0707.pdf (accessed December 2007).

[7] U.S. Dept. of Agriculture, Economic Research Service, 2007, Changing Consumer Food Prices, by A. J. Reed, Kenneth Hanson, Howard Elitzak, and Gerald Schluter, Technical Bulletin Number 1862Reed, A.J., et al., 1997, Changing Consumer Food Prices: A User's Guide to ERS Analysis: http://www.ers.usda.gov/publications/TB1862/tb1862.pdf (accessed December 2007).

[8] Greg Krissek, ICM, personal communication, September 2007.

[9] Irrigating the corn used for one gallon of ethanol can require up to 200 times the water used in processing the feedstock, according to the National Research Council, 2007, Committee on Water Implications of Biofuels Production in the United States, p. 38: http://books.nap.edu/openbook.php?record_id=12039&page=R1 (accessed September 2007).

Wastewater from ethanol plants is regulated by the Kansas Department of Health and Environment (KDHE), which administers both the federal National Pollution Discharge Elimination System (NPDES) permits and Kansas Water Pollution Control permits. In most instances, KDHE issues the state-level permit, which requires ethanol plants to use the wastewater for beneficial land applications rather than simply discharging into streams and rivers.[10]

Ethanol's impact on air quality varies depending on the fuel blend and use. Up through 2005, most ethanol was used in blends up to 10 percent as an oxygenate in reformulated gasoline to reduce vehicle emissions in targeted metropolitan areas with high ground-level ozone readings.[11] Combusting pure ethanol or ethanol blends releases less of certain ozone-causing pollutants than gasoline combustion—particularly hydrocarbons, carbon monoxide, and nitrous oxide, although ethanol blends around E24 are shown to release more nitrous oxide.[12]

With respect to carbon dioxide, biofuels are often considered carbon neutral because the amount of carbon sequestered by replanting the biofuel feedstock is roughly equivalent to the amount emitted by combusting the biofuel. However, inputs such as fertilizer and the energy used to produce the ethanol change the equation. On average, using ethanol (in any blend) instead of gasoline reduces carbon emissions by 19%, and with improvements in ethanol production, this reduction is expected to be 21% by 2010.[13]

Distribution and Blending Issues—Because of its chemical characteristics (e.g., it is water soluble and a corrosive solvent), ethanol can't share the existing gasoline pipeline distribution system; gasoline pipelines would have to be switched over to transporting ethanol exclusively, which is unlikely to happen. In 2005, 60 percent of U.S. ethanol production was shipped by rail, then offloaded and transported by truck, pipeline, or barge to the point of sale. Transportation is typically the third highest expense for ethanol producers.[14] In Kansas, as in most of the Midwest where ethanol plants are numerous, most ethanol sold in state is shipped short distances to the terminal by rail and then distributed by tanker trucks. Most ethanol produced in Kansas is shipped to western and southwestern U.S.

Blending of ethanol and gasoline usually occurs at or near local fueling terminals. After being blended at the terminal, the resulting ethanol-gasoline mixture (e.g., E10, which

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[10] Donald Carlson, Kansas Dept. of Health &Environment, Bureau of Water, personal correspondence, December 2007.

[11] In some instances, oxygenates can lead to higher emissions of nitrogen oxides and volatile organic compounds, which can combine with atmospheric conditions to increase ground-level ozone formation. Source: U.S. Government Accountability Office (GAO), 2007, Biofuels: DOE Lacks a Strategic Approach to Coordinate Increasing Production with Infrastructure Development and Vehicle Needs (GAO-07-713), p. 12.

[12] C. Hammel-Smith, J. Fang, M. Powders, and J. Aabakken, 2002, Issues Associated with the Use of Higher Ethanol Blends, DOE National Renewable Energy Laboratory: http://www.nrel.gov/docs/fy03osti/32206.pdf (accessed November 2007).

[13] M. Wang, M. Wu, and H. Huo, 2007, Life-cycle energy and greenhouse gas emission impacts of different corn ethanol plant types, Environmental Research Letters (April-June 2007): http://www.iop.org/EJ/article1748-9326/2/2/024001/erl7_2_024001.html#erl245942s5.6 (accessed October 2007).

[14] U.S. Dept. of Agriculture, Agricultural Marketing Service, 2007, Ethanol Transportation Backgrounder, September 2007: http://www.ams.usda.gov/tmd/TSB/EthanolTransportationBackgrounder09-17-07.pdf (accessed December 18, 2007).

contains 10% ethanol by volume) is trucked to fueling stations. Of the 18 terminals (totaling 50 loading bays) operating in Kansas as of September 1, 2007, 11 have E10 available (at a total of 27 bays), and only three terminals in eastern Kansas have E85 available. Due to this somewhat limited availability of blended product, many marketers, especially in western Kansas, have to send a tanker truck to both a gasoline fueling terminal and an ethanol plant and splash-blend the product in the tanker.[15]

Because of ethanol's solubility and solvency, marketers have to pay special attention to pumping and storage equipment. Although E10 can be combusted in nearly any gasoline engine, higher blends such as E85 are officially approved only for flex-fuel vehicles. According to DOE data, 6.6% of all light duty vehicles sold in 2007 were E85 capable flex-fuel vehicles, up from 3.4% in 2004.[16] In Kansas, as of November 2007, 26 stations offered E85.[17]

Pure ethanol provides only 66% of the energy in the same volume of regular gasoline—in other words, a vehicle will travel further on a gallon of gasoline than it will on a gallon of some ethanol blend.[18] It is useful to account for this fact when comparing the price of ethanol and gasoline.

Existing Policies and Programs

1. The Volumetric Ethanol Excise Tax Credit (VEETC), established under the 2004 American Jobs Creation Act, provides an excise tax exemption of $0.51 per gallon of ethanol blended into gasoline by petroleum blenders. The credit is currently set to expire in 2010.

2. The Renewable Fuel Standard (RFS), part of the 2005 Energy Policy Act, mandates that 4.0 billion gallons of renewable fuel be blended in 2006, increasing incrementally to 7.5 billion gallons in 2012.

3. The 2005 Energy Policy Act extended and slightly modified the existing federal production tax credit; ethanol producers with capacity below 60 MGY receive $0.10 per gallon for the first 15 million gallons produced.

4. The 2006 Tax Relief and Healthcare Act imposes a 2.5% *ad valorem* tariff and a most-favored-nation duty of $0.54 per gallon of ethanol imported to the U.S. from most countries, with some exceptions such as the Caribbean Basin Initiative nations.

5. The Kansas Ethyl Alcohol Production Incentive (K.S.A. 79-34,163) provides producers with $0.075 per gallon of ethanol sold. Ethanol producers must produce at least 5 million

[15] Curt Wright, KEC member representing petroleum marketers, personal communication, September 2007.
[16] U.S. Dept. of Energy, Energy Information Administration, 2007, Supplemental Tables to the Annual Energy Outlook 2007, Light Duty Vehicle Sales by Technology Type, Table 39, Middle Atlantic: http://www.eia.doe.gov/oiaf/aeo/supplement/pdf/suptab_39.pdf (accessed October 2007).
[17] See Kansas Ethanol web page, E85 Fuel for Flexible Fuel Vehicles, for listing of E85 stations with addresses: http://www.ksgrains.com/ethanol/e85.html.
[18] U.S. Dept. of Energy, Energy Efficiency and Renewable Energy, 2007, Biomass Energy Data Book, Appendix A.1, Heat Content for Various Fuels: http://cta.ornl.gov/bedb/appendix_a.shtml (accessed November 2007).

gallons per year to qualify and are limited to a maximum of 15 million gallons per year (or $1.125 million per year). Funding for the incentive is $875,000 per quarter through 2011.

6. Kansas H.B. 2038 provides 10 year property tax exemptions, accelerated depreciation over 10 years (55% the first year and 5% thereafter, and Kansas Development Finance Authority (KDFA) financing for biomass to energy projects, excluding projects using corn or grain sorghum feedstocks.

7. The Kansas Alternative-Fuel Fueling Station Tax Credit provides tax credits to distributors of renewable fuels. Alternative-fuel fueling stations in service between January 1, 1996, and January 1, 2005, qualify for 50% of total expenditures up to $200,000; stations built between January 1, 2005, and January 1, 2009, receive 40% of expenditures up to $160,000; and stations built after January 1, 2009, receive 40% of expenditures up to $100,000.

8. K.S.A 79-34,141 reduces the ethanol fuel tax from $0.24 per gallon to $0.17 per gallon, starting January 1, 2007. Beginning in 2020, the tax will be reduced to $0.11 per gallon.

9. The Kansas Dealers Incentive Fund provides incentives to retail dealers who sell and dispense renewable fuels at the pump. This fund will begin receiving quarterly payments of $400,000 on January 1, 2009, giving dealers $0.065 per gallon for ethanol sales.

10. The Storage and Blending Equipment Tax Credit provides an income tax credit for equipment used to store and blend biofuels as well as petroleum-based fuels. The income tax credit of 10 percent is provided for the first $10 million of the taxpayer's qualified investment, with a 5 percent credit applied to the amount of investment that exceeds $10 million. The program applies to tax years beginning January 1, 2007, and running through December 31, 2011.

11. The Biomass-to-Energy Plant Tax Credit (K.S.A. 79-32) establishes an income tax credit for new construction or expansion of a biomass-to-energy facility. Investors get a 10% tax credit for the first $250 million invested and a 5% tax credit for any investment exceeding $250 million. The tax credit is applied over 10 years in equal annual installments.

12. A new Kansas law (K.S.A. 79-32,201) establishes an income tax credit covering up to 40% of the incremental or conversion cost of an alternative fuel vehicle (AFV). Owners of E85 flex fuel vehicles must show that they have used at least 500 gallons of E85 in their vehicle to qualify.

13. The 2006 Tax Relief and Healthcare Act allows a 50% tax deduction of the adjusted basis of a new enzymatic cellulosic ethanol plant in its first year of operation.

14. Among Kansas laws targeting biofuels and the state vehicles, K.S.A. 75-3744a requires that a 10% or higher blend of ethanol be purchased for use in state vehicles, provided the

cost is not more than $0.10 per gallon more than gasoline. In addition, SB 262 requires the purchase of E85 vehicles when making new purchases or leases.

15. The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) provides biorefinery grants to address specific technological improvements in the refining process.

16. The 2000 Federal Biomass Research and Development Act establishes grants for research, development, and demonstration of feedstock production, cellulosic ethanol, and product diversification. The grants are administered by the Biomass Research and Development Initiative (BRDI), which is coordinated jointly by USDA and DOE.

17. The DOE offers a number of biofuels loan guarantee and incentive programs authorized by the 2005 Energy Policy Act. Several loan guarantee programs support the production of ethanol from cellulose, municipal waste, or sugar cane. One program authorizes the DOE to provide loan guarantees to projects that reduce air pollution and greenhouse gas emissions, including biofuels projects.