Prepared by the North Dakota Legislative Council staff for the Agriculture Committee
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PRODUCTION AND CONSUMPTION OF ETHANOL - BACKGROUND MEMORANDUM

Section 1 of 2001 Senate Bill No. 2282 (attached as an appendix) directs the Legislative Council to study methods for encouraging the production and consumption of ethanol.

INTRODUCTION

Ethanol is an alcohol made by fermenting and distilling simple sugars. Ethyl alcohol is found in alcoholic beverages. When denatured, it can be used for fuel or for industrial purposes. The most significant use of fuel ethanol in the United States is as an additive in gasoline. In this venue, it serves as an oxygenate (to prevent air pollution from carbon monoxide and ozone), as an octane booster (to prevent "engine knock"), and as an extender of gasoline. In purer forms, it can also be used as an alternative to gasoline in automobiles designed for its use. Ethanol is produced and consumed mostly in the Midwest, where corn--the main feedstock used for ethanol production--is produced.

The oil embargoes of the early 1970s prompted the search for alternative fuels and renewable sources of energy. Ethanol fell into both categories. First used as a product extender, ethanol production was further enhanced by a partial exemption from the motor fuels excise tax and the desire of corn producers to expand the market for their crop. More recently, the production of ethanol has been stimulated by the Clean Air Amendments of 1990, which require oxygenated or reformulated gasoline to reduce emissions of carbon monoxide and volatile organic compounds.

Oxygenates are known to reduce carbon monoxide and volatile organic compound emissions. In addition, they can lead to higher emissions of nitrogen oxides, the precursors to ozone formation.

> While reformulated gasoline has succeeded in reducing ground-level ozone, the overall effect of oxygenates on ozone formation has been questioned. Furthermore, ethanol's main competitor in oxygenated fuels, methyl tertiary butyl ether (MTBE), has been found to contaminate groundwater. This has led to a push to ban MTBE, or eliminate the oxygenate requirements altogether. High summer gasoline prices in the Midwest, especially in Chicago and Milwaukee, where oxygenates are required, have added to the push to remove the oxygenate requirements. The tradeoffs between air quality, water quality, and consumer price have sparked congressional debate on these requirements.
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> In addition, there has been a long-running debate over the tax incentives that ethanol-blended fuels receive. (See, *Fuel Ethanol: Background and Public Policy*, CRS Issue Brief for Congress.)

Fuel ethanol is used mainly as a low-concentrate blend in gasoline. In 1999, 99.8 percent of the ethanol consumed in the United States was used in a blended form--10 percent ethanol to 90 percent gasoline. It can also be used in purer forms as an alternative to gasoline.

ETHANOL AND AGRICULTURE

Approximately 90 percent of the feedstock used in ethanol production comes from corn. The remaining 10 percent consists of grain sorghum, barley, wheat, cheese whey, and potatoes. Because one bushel of corn can produce 2.5 gallons of ethanol, the United States Department of Agriculture estimated that for the 2000-01 marketing year, 615 million bushels of corn were used to produce 1.5 billion gallons of ethanol. This amounts to 6.17 percent of corn utilization.

ETHANOL PRODUCTION

Ethanol can be processed by dry milling plants, which use a grinding process, or by wet milling plants, which use a chemical extraction process. In both instances, the corn is processed and various enzymes are added to separate fermentable sugars. Yeast is then added to make alcohol. If the alcohol is to be used for fuel and industrial purposes, it is denatured to make it unfit for human consumption.

Ninety percent of all ethanol production occurs in the corn belt states of Illinois, Iowa, Nebraska, Minnesota, and Indiana. The proximity of the ethanol production facilities to the raw material helps keep shipping costs low. Consequently, the major purchasers of ethanol are the metropolitan regions in the Midwest. When ethanol is shipped to other regions, costs tend to escalate because ethanol blended gasoline cannot be shipped through petroleum pipelines. During the year 2000, the largest producer of ethanol was Archer Daniels Midland, at 797 million gallons. Minnesota Corn Processors produced 110 million gallons, while Williams Energy Services and Cargill produced 100 million gallons. All other production constituted significantly smaller amounts.

UNITED STATES ETHANOL PRODUCTION CAPACITY

Company	Location	Feedstock	Million Gallons Per Year
Adkins Energy*	Lena, IL	Corn	30
AE Stanley	Louden, TN	Corn	45
AGP	Hastings, NE	Corn	52
Agri-Energy	Luverne, MN	Corn	17
Alchem	Grafton, ND	Corn	10.5
Al-Corn Clean Fuel	Claremont, MN	Corn	17
ADM	Decatur, IL Peoria, IL Cedar Rapids, IA Clinton, IA Walhalla, ND	Corn/barley Corn/barley Corn/barley Corn/barley Corn/barley	797**
BC International*	Jennings, LA	Bagasse/rice hulls	20
Broin Companies	Scotland, SD	Corn	7
Cargill	Blair, NE Eddyville, IA	Corn Corn	100**
Central Minnesota	Little Falls, MN	Corn	18
Chief Ethanol	Hastings, NE	Corn	62
Chippewa Valley	Benson, MN	Corn	20
Corn Plus	Winnebago, MN	Corn	20
Denco	Morris, MN	Corn	15
ESE Alcohol	Leoti, KS	Seed corn	1.1
Ethanol 2000	Bingham Lake, MN	Corn	28
Exol	Albert Lea, MN	Corn	17
Georgia Pacific	Bellingham, WA	Paper waste	7
Golden Cheese	Corona, CA	Cheese whey	5
Golden Triangle Energy Coop.	Craig, MO	Corn	15
Gopher State Ethanol	St. Paul, MN	Corn	15
Grain Processing Corporation	Muscatine, IA	Corn	10
Heartland Corn Products	Winthrop, MN	Corn	35
Heartland Grain Fuels	Aberdeen, SD Huron, SD	Corn Corn	8 14
High Plains Corporation	York, NE Colwich, KS Portales, NM	Corn/milo Corn/milo Corn/milo	70**
JR Simplot	Caldwell, ID Burley, ID	Potato waste Potato waste	6**
Kraft, Inc.	Melrose, MN	Cheese whey	2.6
Lake Area Corn Processors*	Wentworth, SD	Corn	15
Manildra Ethanol	Hamburg, IA	Corn/milo/wheat starch	7
Merrick/Coors	Golden, CO	Waste beer	1.5
Midwest Grain	Pekin, IL Atchison, KS	Corn/wheat/starch Corn/wheat/starch	78**
Minnesota Corn Processors	Columbus, NE Marshall, MN	Corn Corn	110**
Minnesota Energy	Buffalo Lake, MN	Corn	12
Nebraska Energy	Aurora, NE	Corn	30
New Energy Corporation	South Bend, IN	Corn	85
Northeast MO Grain Processors	Macon, MO	Corn	15
Pabst Brewing*	Olympia, WA	Brewery waste	7
Parallel Products	Louisville, KY Bartow, FL Rancho Cucamonga, CA	Beverage waste Beverage waste Beverage waste	12**
Permeate Refining	Hopkinton, IA	Sugars and starches	1.5
Plover Ethanol*	Plover, WI	Seed corn	4
Pro Corn	Preston, MN	Corn	18
Reeve Agri Energy	Garden City, KS	Corn/milo	10
Spring Green Ethanol*	Spring Green, WI	Cheese whey	7
Sunrise Energy	Blairstown, IA	Corn	7
Sutherland Associates	Sutherland, NE	Corn	15
TriCounty Corn Processors*	Rosholt, SD	Corn	15
Williams BioEnergy	Pekin, IL	Corn	100
Wyoming Ethanol	Torrington, WY	Corn	5

* Under construction

** Reflects combined total for listed plants

Presently, domestic ethanol production capacity is approximately two billion gallons per year. Domestic ethanol use is approximately 1.7 billion gallons and is expected to increase to 2.6 billion gallons by the year 2005. (See, Department of Energy, *Annual Energy Outlook 2001*.) If, however, amendments are made to the Clean Air Act which limit the use of or ban MTBE,

the annual use of ethanol is expected to rise significantly, especially so if the amendments would ban the use of MTBE but maintain the current oxygenate requirements.

ETHANOL USAGE - NATIONWIDE

During 1999, 1.4 billion gallons of ethanol were consumed in the United States. Most of this was in a blend of 10 percent ethanol and 90 percent gasoline. During that same year, 125 billion gallons of gasoline were used. Ethanol's market share in 1999 was 1.2 percent. Even with growth predictions of 2.6 billion gallons by 2005 and 3.3 billion gallons by 2020, ethanol's market share would still be only 1.5 percent. Additional growth is not expected because even with tax incentives, ethanol tends to cost more per gallon than gasoline. In addition, ethanol has a lower energy count than gasoline and consequently, more fuel is required to travel the same distance.

Ethanol on the other hand has chemical properties that do make it beneficial as an additive.

> Major stimuli to the use of ethanol have been the oxygenate requirements of the Reformulated Gasoline (RFG) and Oxygenated Fuels programs of the Clean Air Act. Oxygenates are used to promote more complete combustion of gasoline, which reduces carbon monoxide and volatile organic compound (VOC) emissions. In addition, oxygenates can replace other chemicals in gasoline, such as benzene, a toxic air pollutant. (See, *Fuel Ethanol: Background and Public Policy*, CRS Issue Brief for Congress.)

ETHANOL USAGE - NORTH DAKOTA

North Dakota consumes 373 million gallons of gasoline each year. Approximately 20 percent of that amount contains 10 percent ethanol. The size of North Dakota's ethanol market is therefore in the range of eight million gallons per year, while our current annual production capacity is in the 30 million gallon per year range. Markets for our excess capacity can be found in Montana, which has an annual usage of six million gallons and no production capacity, Wyoming, which has an annual usage of nine million gallons and a production capacity of only five million gallons, and Minnesota, which has an annual usage of 240 million gallons and a production capacity of 224 million gallons.

ETHANOL COSTS

Federal Tax Incentives

In attempting to assess the viability of ethanol as either a fuel additive or as an alternative fuel, the cost of ethanol must be considered. Ethanol blends have been either wholly or partially exempt from the federal excise tax on gasoline since the late 1970s. During that period, the exemption has ranged from four to six cents per gallon. At the present time, there is in place a 5.3 cents per gallon exemption from the 18.3 cents per gallon federal excise tax on gasoline if the taxable product is blended in a mixture containing at least 8 percent alcohol (gasohol) or an approved derivative. Revenues from the excise tax are dedicated to the highway trust fund.

The excise tax exemption has been revised and extended five times since its inception in 1978. The current schedule is found in the highway funding reauthorization legislation known as TEA 21--the Transportation Efficiency Act of the 21st Century. Enacted in June 1998, TEA 21 is scheduled to expire on December 31, 2007. It contains the following level of exemptions:

FEDERAL EXCISE TAX EXEMPTION SCHEDULE

Now - 2002	5.3 cents per gallon
2003-04	5.2 cents per gallon
2005-07	5.1 cents per gallon

Small Ethanol Producer Credit

The small ethanol producer credit is a federal income tax credit of 10 cents per gallon of qualified ethanol fuel production by an eligible small ethanol producer. Qualified ethanol is that which is at least 150 proof and which is not derived from petroleum, natural gas, or coal. The credit is available if the alcohol is sold or used by the producer for use in the production of a qualified fuel mixture in a trade or business, used as a fuel in a trade or business, or sold at retail and placed in the purchaser's fuel tank. A small ethanol producer is defined as one whose production of ethanol does not exceed 30 million gallons per year. The credit is applied on a per gallon basis for up to 15 million gallons produced each year.

State Tax Incentive

The state of North Dakota makes available a 40 cent per gallon production credit for ethanol produced and sold in the state, provided it is manufactured from agriculturally derived products. The incentive is subject to a number of qualifications, including the previous year's production volume and whether the plant received an incentive payment in fiscal year 1995. The program is subject to a biennial appropriation by the state and is currently due to expire in 2009.

Effect of Incentives

Wholesale ethanol prices, before governmental incentives, are generally twice that of wholesale gasoline prices. With governmental incentives, the price paid by consumers at the pump is lowered. The

5.3 cents per gallon exemption refers to the amount per gallon of blended fuel. Because ethanol generally comprises only 10 percent of a gallon of blended fuel, the federal exemption in effect provides for a subsidy of 53 cents per gallon of ethanol. A Congressional Research Service Issue Brief entitled *Fuel Ethanol: Background and Public Policy*, contained the following chart:

PRICE OF PURE ETHANOL RELATIVE TO GASOLINE JULY 1998 TO JUNE 1999

Ethanol Wholesale Price	$1.03 per gallon
Alcohol Fuel Tax Incentive	$ 0.54 per gallon
Effective Price of Ethanol	$ 0.49 per gallon
Gasoline Wholesale Price	$ 0.46 per gallon

It is argued that the ethanol industry could not survive without the tax exemption. An economic analysis conducted in 1998 by the Food and Agriculture Policy Research Institute concluded that ethanol production from corn would decline from 1.4 billion gallons per year, and stabilize at about 290 million gallons per year, if the exemption were eliminated.

The tax exemption is criticized by some as a corporate subsidy because it encourages the inefficient use of agricultural and other resources and deprives the highway trust fund of needed revenues. In 1997 the General Accounting Office estimated that the tax exemption would lead to approximately $10.4 billion in foregone highway trust fund revenue over the 22 years from fiscal year 1979 to fiscal year 2000. The petroleum industry opposes the incentive because it also results in reduced use of petroleum. (See, *Fuel Ethanol: Background and Public Policy*, CRS Issue Brief for Congress.)

FEDERAL ACTIVITY AFFECTING ETHANOL

Reformulated gasoline (RFG) is used to reduce vehicle emissions in areas that are in severe or extreme nonattainment of National Ambient Air Quality Standards. These areas include New York, Los Angeles, Chicago, Philadelphia, and Houston. Under the new Phase 2 requirements of the RFG program, which took effect in 2000, gasoline sold in the summer months must meet a tighter volatility standard. Reid vapor pressure is a measure of volatility. The higher numbers indicate higher volatility. Ethanol has a higher Reid vapor pressure than MTBE. Consequently, if Phase 2 RFG is to be made with ethanol, the gasoline itself must have a lower Reid vapor pressure. This lower Reid vapor pressure gasoline is more expensive to produce. As a result, RFG blended with ethanol will be more expensive for the consumer to purchase. Estimates of increased cost range from two to eight cents per gallon.

An accompanying issue involves the continued use of MTBE. It is a known carcinogen, and it has been found in ground water. In 1999 California required that it be phased out of gasoline in the state by December 2003. Other states, including Arizona, Connecticut, Iowa, Minnesota, Nebraska, New York, and South Dakota, have instituted similar limits or bans of MTBE.

The unknown aspect of the MTBE debate is the ultimate effect on ethanol producers. If current oxygenate requirements are left in place, ethanol, the second most used oxygenate, should theoretically be used to replace MTBE. There is not, however, sufficient United States production capacity to meet the potential demand. In addition, the consumer price for oxygenated fuel would likely increase because ethanol, unlike MTBE, cannot be shipped through pipelines and must therefore be mixed with gasoline close to the point of sale. Increased demands for oxygenates would be met through imports from countries such as Brazil. Brazil is a worldwide leader in ethanol production and currently has a surplus. (See, *New Fuels & Vehicles Report*, September 16, 1999.)

Since current ethanol production cannot meet the demands for oxygenates, federal officials are being encouraged to suspend the oxygenate requirement. If this is ultimately the path selected, it would remove a major impetus for ethanol production. Presently six MTBE related bills await congressional action. These bills include limiting or banning the use of MTBE, granting waivers to the oxygenate requirement, and authorizing funding for MTBE cleanup.

OTHER USES FOR ETHANOL

Industrial Use Ethanol

Historically, ethanol for industrial purposes has been a synthetic product manufactured by the addition of water to ethylene for use in nonbeverage and nonfuel applications. However, advances in technology now allow industrial alcohol to be manufactured from grains as well. Ethanol for fuel use is denatured with gasoline, while industrial ethanol can be denatured with a variety of substances depending on its end use. These substances include sodium hydroxide, ammonia, methanol, and benzene. Although the quality and purity requirements for industrial use ethanol are both higher and more difficult to achieve than those for beverage or fuel use, the market for industrial ethanol is remarkably stable and not subject to the same pricing variations and legislative interventions as is the fuel ethanol market. In 1999 approximately 267 million gallons of industrial use ethanol were consumed in North America--60 percent of this amount was used in solvents and the remaining 40 percent was used as chemical intermediates.

E-85

E-85 is a fuel containing 75 to 85 percent of denatured ethanol. It is appropriate for use in flexible fuel vehicles. Current annual sales projections for such vehicles are set at upwards of 700,000 gallons. Although this would appear to be a ready market for E-85, in reality, the fuel is available in only a very few limited markets and is not at all available outside of the Midwest. Although the fuel has a higher octane than gasoline, it contains less energy per gallon, thereby necessitating more frequent refueling or larger gas tanks. It takes approximately 1.3 gallons of E-85 to travel the same distance as allowed by a gallon of gas, and the cost of E-85 is about 20 cents per gallon higher than gasoline.

ETBE

By reacting ethanol with isobutylene, one achieves a product that can overcome some of ethanol's negative handling characteristics, e.g., water sensitivity and vapor pressure increase. During the 1990s, it was not marketed aggressively, in large part because it could not be produced at a price that was competitive with MTBE, which is the product achieved by reacting methanol with isobutylene. Because of concerns regarding water contamination, MTBE has since fallen into disfavor. Ethyl tertiary butyl ether (ETBE), with its very similar properties, has experienced the same fate.

Oxydiesel

Oxydiesel is achieved by blending diesel fuel with up to 15 percent fuel-grade ethanol and various special additives. It can be used in traditional diesel engines without modifications. Early demonstration tests found favorable emissions ratings. The Chicago Transit Authority is engaged in further testing at this time.

Aviation Ethanol

An aviation fuel called 100LL is the last commercial fuel allowed to contain lead. Users of aviation fuel are concerned that if lead is banned from use in aviation fuel, they may not have access to a fuel with high enough octane. One promising alternative is AGE85, which contains 88 percent ethanol, 11 percent pentane isomerate, and 1 percent biodiesel. After a variety of demonstration projects, AGE85 was certified by the Federal Aviation Administration for use in Cessna 180 and 182 engine-airframe combinations. Research for an expansion of certification is ongoing.

ATTACH:1