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Fuel Ethanol: Background and Public Policy Issues

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Fuel Ethanol: Background and Public Policy Issues

Summary

In light of a changing regulatory and legislative environment, concern has arisen regarding the future prospects for ethanol as a motor fuel. Ethanol is produced from biomass (mainly corn) and is mixed with gasoline to produce cleaner-burning fuel called "gasohol" or "E10."

The market for fuel ethanol, which consumes 6% of the nation's corn crop, is heavily dependent on federal subsidies and regulations. A major impetus to the use of fuel ethanol has been the exemption that it receives from the motor fuels excise tax. Ethanol is expensive relative to gasoline, but it is subject to a federal tax exemption of 5.3 cents per gallon of gasohol (or 53 cents per gallon of pure ethanol). This exemption brings the cost of pure ethanol, which is about double that of conventional gasoline and other oxygenates, within reach of the cost of competitive substances. In addition, there are other incentives such as a small ethanol producers tax credit. It has been argued that the fuel ethanol industry could scarcely survive without these incentives.

The Clean Air Act requires that ethanol or another oxygenate be mixed with gasoline in areas with excessive carbon monoxide or ozone pollution. The resulting fuels are called oxygenated gasoline (oxyfuel) and reformulated gasoline (RFG), respectively. Using oxygenates, vehicle emissions of volatile organic compounds (VOCs) have been reduced by 17%, and toxic emissions have been reduced by approximately 30%. However, there has been a push to change the oxygenate requirements for two reasons. First, methyl tertiary butyl ether (MTBE), the most common oxygenate, has been found to contaminate groundwater. Second, the characteristics of ethanol-blended RFG–along with high crude oil prices and supply disruptions–led to high Midwest gasoline prices in Summer 2000, especially in Chicago and Milwaukee.

Uncertainties about future oxygenate requirements, as both federal and state governments consider changes, have raised concerns among farm and fuel ethanol industry groups and have prompted renewed congressional interest in the substance. Without the current regulatory requirements and incentives, or something comparable, much of ethanol's market would likely disappear. Expected changes to the reformulated gasoline requirements could either help or hurt the prospects for fuel ethanol (subsequently affecting the corn market), depending on the regulatory and legislative specifics. As a result, significant efforts have been launched by farm interests, the makers of fuel ethanol, agricultural states, and the manufacturers of petroleum products to shape regulatory policy and legislation.

Ethanol provisions in the House and Senate versions of H.R. 4, the comprehensive energy package, have increased interest in the benefits and drawbacks of the fuel.

This report provides background concerning various aspects of fuel ethanol, and a discussion of the current related policy issues.

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Introduction

Ethanol (ethyl alcohol) is an alcohol made by fermenting and distilling simple sugars. Ethyl alcohol is in alcoholic beverages and it is denatured (made unfit for human consumption) when used for fuel or industrial purposes.[1] The biggest use of fuel ethanol in the United States is as an additive in gasoline. It serves as an as an oxygenate (to prevent air pollution from carbon monoxide and ozone), as an octane booster (to prevent early ignition, or "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. It is produced and consumed mostly in the Midwest, where corn—the main feedstock for ethanol production—is produced.

The initial stimulus to ethanol production in the mid-1970s was the drive to develop alternative and renewable supplies of energy in response to the oil embargoes of 1973 and 1979. Production of fuel ethanol has been encouraged by a partial exemption from the motor fuels excise tax. Another impetus to fuel ethanol production has come from corn producers anxious to expand the market for their crop. More recently the use of fuel ethanol has been stimulated by the Clean Air Act Amendments of 1990, which require oxygenated or reformulated gasoline to reduce emissions of carbon monoxide (CO) and volatile organic compounds (VOCs).

While oxygenates reduce CO and VOC emissions, they also can lead to higher emissions of nitrogen oxides, 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 trade-offs between air quality, water quality, and consumer price have sparked congressional debate on these requirements. In addition, there has been a long-running debate over the tax incentives that ethanol-blended fuels receive.

Fuel ethanol is used mainly as a low concentrate blend in gasoline, but can also be used in purer forms as an alternative to gasoline. In 2000, 99.7% of fuel ethanol

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[1] Industrial uses include perfumes, aftershaves, and cleansers.

consumed in the United States was in the form of "gasohol" or "E10" (blends of gasoline with up to 10% ethanol).[2]

Fuel ethanol is usually produced from the distillation of fermented simple sugars (e.g. glucose) derived primarily from corn, but also from wheat, potatoes and other vegetables, but can also be produced from cellulosic material such as switch grass, rice straw, and sugar cane (bagasse). The alcohol in fuel ethanol is identical to ethanol used for other purposes, but is treated (denatured) with gasoline to make it unfit for human consumption.

Ethanol and the Agricultural Economy

Corn constitutes about 90% of the feedstock for ethanol production in the United States. The other 10% is largely grain sorghum, along with some barley, wheat, cheese whey and potatoes. Corn is used because it is a relatively low cost source of starch that can be converted to simple sugars, fermented and distilled. It is estimated by the U. S. Department of Agriculture (USDA) that about 615 million bushels of corn was used to produce about 1.5 billion gallons of fuel ethanol during the 2000/2001 corn marketing year.[3] This was 6.17% of the projected 9.755 billion bushels of corn utilization.[4]

Producers of corn, along with other major crops, receive farm income support and price support. Farms with a history of corn production received "production flexibility contract payments" of about $1.186 billion during the 2000/2001 corn marketing year. Emergency economic assistance (P.L. 106-224) more than double the corn contract payments. Corn producers also are guaranteed a minimum national average price of $1.89/bushel under the nonrecourse marketing assistance loan program.[5]

The added demand for corn created by fuel ethanol raises the market price for corn above what it would be otherwise. Economists estimate that when supplies are large, the use of an additional 100 million bushels of corn raises the price by about 4¢ per bushel. When supplies are low, the price impact is greater. The ethanol market is particularly welcome now, when the average price received by farmers is forecast by USDA to average about $1.80 per bushel for the 2000/01 marketing year. This price would be the lowest season average since 1986. The ethanol market of 615 million bushels of corn, assuming a price impact of about 25¢ per bushel on all corn sales, means a possible $2.4 billion in additional sales revenue to corn farmers.

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[2] U.S. Department of Energy (DOE), Energy Information Administration (EIA). *Alternatives to Traditional Transportation Fuels 1999.* Updated February 2001.

[3] One bushel of corn generates approximately 2.5 gallons of ethanol.

[4] Utilization data are used, rather than production, due to the existence of carryover stocks. Corn utilization data address the total amount of corn used within a given period.

[5] Detailed explanations are available in CRS Report RS20271, *Grain, Cotton, and Oilseeds: Federal Commodity Support*, and CRS 98-744, *Agricultural Marketing Assistance Loans and Loan Deficiency Payments*.

In the absence of the ethanol market, lower corn prices probably would stimulate increased corn utilization in other markets, but sales revenue would not be as high. The lower prices and sales revenue would be likely to result in higher federal spending on corn payments to farmers, as long as corn prices were below the price triggering federal loan deficiency subsidies.

Table 1. Corn Utilization, 2000/2001 Forecast

	Quantity (million bushels)	Share of Total Use
Livestock feed & residual	5,775	59.2%
Food, seed & industrial:	1,980	19.9%
– Fuel alcohol	**615**	6.2%
– High fructose corn syrup	550	5.5%
– Glucose & dextrose	220	2.2%
– Starch	225	2.6%
– Cereals & other products	190	1.9%
– Beverage alcohol	130	1.3%
– Seed	20	0.2%
Exports	2000	20.1%
TOTAL USE	9,775	100.00%
TOTAL PRODUCTION	9,968	

Source: Basic data are from USDA, Economic Research Service, Feed Outlook, March 10, 2000.

Ethanol Refining and Production

According to the Renewable Fuels Association, about 55% of the corn used for ethanol is processed by "dry" milling plants (a grinding process) and the other 45% is processed by "wet" milling plants (a chemical extraction process). The basic steps of both processes are as follows. First, the corn is processed, with various enzymes added to separate fermentable sugars. Next, yeast is added to the mixture for fermentation to make alcohol. The alcohol is then distilled to fuel-grade ethanol that is 85-95% pure.[6] Finally, for fuel and industrial purposes the ethanol is denatured

[6] The byproduct of the dry milling process is distillers dried grains. The byproducts of wet milling are corn gluten feed, corn gluten meal, and corn oil. Distillers dried grains, corn (continued...)

with a small amount of a displeasing or noxious chemical to make it unfit for human consumption.[7] In the U.S. the denaturant for fuel ethanol is gasoline.

Ethanol is produced largely in the Midwest corn belt, with almost 90% of production occurring in five states: Illinois, Iowa, Nebraska, Minnesota and Indiana. Because it is generally less expensive to produce ethanol close to the feedstock supply, it is not surprising that the top five corn-producing states in the U.S. are also the top five ethanol-producers. Most ethanol use is in the metropolitan centers of the Midwest, where it is produced. When ethanol is used in other regions, shipping costs tend to be high, since ethanol-blended gasoline cannot travel through petroleum pipelines, and must be transported by truck, rail, or barge.

This geographic concentration is an obstacle to the use of ethanol on the East and West Coasts. The potential for expanding production geographically is a motivation behind research on cellulosic ethanol, since if regions could locate production facilities closer to the point of consumption, the costs of using ethanol could be lessened. Furthermore, if regions could produce fuel ethanol from local crops, there would be an increase in regional agricultural income.

Table 2. Top 10 Ethanol Producers by Capacity, 2002

Million Gallons Per Year

Archer Daniels Midland (ADM)	950
Minnesota Corn Processors	140
Williams Bio-Energy	135
Cargill	110
High Plains Corporation	85
New Energy Corp	85
Midwest Grain	78
Chief Ethanol	62
A.E. Staley	60
AGP	52
All Others	981
U.S. Total	2738

Source: Renewable Fuels Association, Ethanol Industry Outlook 2002.

Ethanol production is also concentrated among a few large producers. The top five companies account for approximately 52% of production capacity, and the top ten companies account for approximately 64% of production capacity. (See **Table 2**.) Critics of the ethanol industry in general — and specifically of the ethanol tax incentives — argue that the tax incentives for ethanol production equate to "corporate

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[6] (...continued)
gluten feed, and corn gluten meal are used as livestock feed.

[7] Renewable Fuels Association, Ethanol Industry Outlook 2002, Growing Homeland Energy Security. [http://www.ethanolrfa.org/outlook2002.html]

welfare" for a few large producers.[8] However, the share of production capacity controlled by the largest producers has been dropping as more producers have entered the market.

Overall, domestic ethanol production capacity is approximately 2.7 billion gallons per year. With current laws and incentives, consumption is expected to increase from 1.8 billion gallons per year in 2001 to approximately 2.6 billion gallons per year in 2005. Production will need to increase proportionally to meet the increased demand.[9] However, if the Clean Air Act is amended to limit or ban MTBE, or if other incentives for ethanol use are enacted, ethanol production capacity may expand at a faster rate. This is especially true if MTBE is banned while maintaining the oxygenate requirements, since ethanol is the most likely substitute for MTBE.[10] The comprehensive energy package, H.R. 4, may play a key role in determining the future of ethanol consumption (See the section on "Comprehensive Energy Legislation").

Fuel is not the only output of an ethanol facility, however. Co-products play an important role in the profitability of a plant. In addition to the primary ethanol output, the corn wet milling generates corn gluten feed, corn gluten meal, and corn oil, and dry milling creates distillers grains. Corn oil is used as a vegetable oil and is higher priced than soybean oil. Approximately 12 million metric tons of gluten feed, gluten meal, and dried distillers grains are produced in the United States and sold as livestock feed annually. A major market for corn gluten feed and meal is the European Union, which imported nearly 5 million metric tons of gluten feed and meal during FY1998.

Revenue from the ethanol byproducts help offset the cost of corn. The net cost of corn relative to the price of ethanol (the ethanol production margin) and the difference between ethanol and wholesale gasoline prices (the fuel blending margin) are the major determinants of the level of ethanol production. Currently, the ethanol production margin is high because of the low price of corn. At the same time, the wholesale price of gasoline is increasing against the price of ethanol, which encourages the use of ethanol.

Fuel Consumption

Approximately 1.8 billion gallons of ethanol fuel were consumed in the United States in 2001, mainly blended into E10 gasohol. While large, this figure represents only 1.4% of the approximately 125 billion gallons of gasoline consumption in the same year.[11] According to DOE, ethanol consumption is expected to grow to 2.6 billion gallons per year in 2005 and 3.3 billion gallons per year in 2020. This would

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[8] James Bovard, *Archer Daniels Midland: A Case Study in Corporate Welfare*. Cato Institute. September 26, 1995.

[9] DOE, EIA, *Annual Energy Outlook 20001*. December 22, 2000. Table 18.

[10] For more information, see section on MTBE.

[11] DOE, EIA, *Alternatives to Traditional Transportation Fuels 1999*. Table 10.

increase ethanol's market share to approximately 1.5% by 2005. Under current conditions, which may change considerably in the near future, this 1.5% share is projected to remain constant through 2020.[12]

The most significant barrier to wider use of fuel ethanol is its cost. Even with tax incentives for ethanol producers (see the section on Economic Effects), the fuel tends to be more expensive than gasoline per gallon. Furthermore, since fuel ethanol has a somewhat lower energy content, more fuel is required to travel the same distance. This energy loss leads to an approximate 3% decrease in miles-per-gallon vehicle fuel economy with gasohol.[13]

However, ethanol's chemical properties make it very useful for some applications, especially as an additive in gasoline. 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.[14] Oxygenates are used to promote more complete combustion of gasoline, which reduces carbon monoxide and volatile organic compound (VOC) emissions.[15] In addition, oxygenates can replace other chemicals in gasoline, such as benzene, a toxic air pollutant (see the section on Air Quality).

The two most common oxygenates are ethanol and methyl tertiary butyl ether (MTBE). MTBE, primarily made from natural gas or petroleum products, is preferred to ethanol in most regions because it is generally much less expensive, is easier to transport and distribute, and is available in greater supply. Because of different distribution systems and blending processes (with gasoline), substituting one oxygenate for another can lead to significant cost increases.

Despite the cost differential, there are several possible advantages of using ethanol over MTBE. Ethanol contains 35% oxygen by weight—twice the oxygen content of MTBE. Furthermore, since ethanol is produced from agricultural products, it has the potential to be a sustainable fuel, while MTBE is produced from natural gas and petroleum, fossil fuels. In addition, ethanol is readily biodegradable, eliminating some of the potential concerns about groundwater contamination that have surrounded MTBE (see the section on MTBE). However, there is concern that ethanol use can lead to contamination by benzene and other toxic compounds.[16]

Both ethanol and MTBE also can be blended into otherwise non-oxygenated gasoline to raise the octane rating of the fuel. High-performance engines and older engines often require higher octane fuel to prevent early ignition, or "engine knock."

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[12] DOE, EIA, *Annual Energy Outlook 2001*. December 22, 2000. Tables 2 and 18.

[13] It should be noted that the use of ethanol does not effect the efficiency of an engine. There is simply less energy in one gallon of ethanol than in one gallon of gasoline.

[14] Section 211, subsections k and m (respectively). 42 U.S.C. 7545.

[15] CO, VOCs and nitrogen oxides are the main precursors to ground-level ozone.

[16] Susan E. Powers, David Rice, Brendan Dooher, and Pedro J. J. Alvarez, "Will Ethanol-Blended Gasoline Affect Groundwater Quality?," *Environmental Science and Technology*. January 1, 2001. p. 24A.

Other chemicals may be used for the same purpose, but some of these alternatives are highly toxic, and some are regulated as pollutants under the Clean Air Act.[17] Furthermore, since these additives do not contain oxygen, their use may not lead to the same emissions reductions as oxygenated gasoline.

In purer forms, ethanol can also be used as an alternative to gasoline in vehicles specifically designed for its use, although this only represents approximately 0.3% of ethanol consumption in the U.S. The federal government and state governments, along with businesses in the alternative fuel industry, are required to purchase alternative-fueled vehicles by the Energy Policy Act of 1992.[18] In addition, under the Clean Air Act Amendments of 1990, municipal fleets can use alternative fuel vehicles to mitigate air quality problems. Blends of 85% ethanol with 15% gasoline (E85), and 95% ethanol with 5% gasoline (E95) are currently considered alternative fuels by the Department of Energy.[19] The small amount of gasoline added to the alcohol helps prevent corrosion of engine parts, and aids ignition in cold weather.

Table 3. Estimated U. S. Consumption of Fuel Ethanol, MTBE and Gasoline

(Thousand Gasoline-Equivalent Gallons)

	1994	1996	1998	2000
E85	80	694	1,727	3,344
E95	140	2,699	59[a]	54
Ethanol in Gasohol (E10)	845,900	660,200	916,000	1,011,800
MTBE in Gasoline	2,108,800	2,749,700	2,915,600	3,104,200
Gasoline[b]	113,144,000	117,783,000	122,849,000	124,651,000

Source: Department of Energy, Alternatives to Traditional Transportation Fuels1999 .

[a] A major drop in E95 consumption occurred between 1997 and 1998 because of a significant decrease in the number of E95-fueled vehicles in operation (347 to 14), due to the elimination of an ethanol-fueled bus fleet in California.

[b] Gasoline consumption includes ethanol in gasohol and MTBE in gasoline.

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[17] Lead was commonly used as an octane enhancer until it was phased-out through the mid-1980s (lead in gasoline was completely banned in 1995), due to the fact that it disables emissions control devices, and because it is toxic to humans.

[18] P.L. 102-486.

[19] More diluted blends of ethanol, such as E10, are considered to be “extenders” of gasoline, as opposed to alternatives.

Approximately 3.3 million gasoline-equivalent gallons (GEG)[20] of E85, and 54 thousand GEG of E95 were consumed in 2000, mostly in Midwestern states.[21] (See **Table 3**.) One reason for the relatively low consumption of E85 and E95 is that there are relatively few vehicles on the road that operate on these fuels. In 2000, approximately 35,000 vehicles were fueled by E85 or E95,[22] as compared to approximately 210 million gasoline- and diesel-fueled vehicles that were on the road in the same year.[23] One obstacle to the use of alternative fuel vehicles is that they are generally more expensive than conventional vehicles, although this margin has decreased in recent years with newer technology. Another obstacle is that, as was stated above, fuel ethanol is generally more expensive than gasoline or diesel fuel. In addition, there are very few fueling sites for E85 and E95, especially outside of the Midwest.

Research and Development in Cellulosic Feedstocks

For ethanol to play a more significant role in U.S. fuel consumption, the fuel must become price-competitive with gasoline. Since a major part of the total production cost is the cost of feedstock, reducing feedstock costs could lead to lower wholesale ethanol costs. For this reason, there is a great deal of interest in the use of cellulosic feedstocks, which include low-value waste products, such as recycled paper and rice hulls, or dedicated fuel crops, such as switch grass and fast growing trees. A dedicated fuel crop is one that would be grown and harvested solely for the purpose of fuel production.

However, as the name indicates, cellulosic feedstocks are high in cellulose, and cellulose cannot be fermented. Cellulose must first be broken down into simpler carbohydrates, and this can add an expensive step to the process. Therefore, research has focused on both reducing the process costs for cellulosic ethanol, and improving the availability of cellulosic feedstocks.

On August 12, 1999, the Clinton Administration announced the Biobased Products and Bioenergy Initiative, which aims to triple the use of fuels and products derived from biomass by 2010.[24] Research and development covers all forms of biobased products, including lubricants, adhesives, building materials, and biofuels. Because federal research into cellulosic ethanol is ongoing, it is possible that funding could increase under the initiative.

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[20] Since different fuels produce different amounts of energy per gallon when consumed, the unit of a gasoline-equivalent gallon (GEG) is used to compare total energy consumption.

[21] DOE, EIA, *Alternatives to Traditional Transportation Fuels 1999.*

[22] Ibid. In 1997, some manufacturers made flexible E85/gasoline fueling capability standard on some models. It is expected, however, that most of these vehicles will be fueled by gasoline.

[23] Stacy C. Davis, DOE, *Transportation Energy Data Book: Edition 20.* November 2000.

[24] Executive Order 13134. August 12, 1999.

Costs and Benefits of Fuel Ethanol

Economic Effects

Given that a major constraint on the use of ethanol as an alternative fuel, and as an oxygenate, is its high price, ethanol has not been competitive with gasoline as a fuel. Wholesale ethanol prices, before incentives from the federal government and state governments, are generally twice that of wholesale gasoline prices. With federal and state incentives, however, the effective price of ethanol is much lower. Furthermore, gasoline prices have risen recently, making ethanol more attractive.

The primary federal incentive to support the ethanol industry is the 5.3¢ per gallon exemption that blenders of gasohol (E10) receive from the 18.4¢ federal excise tax on motor fuels.[25] Because the exemption applies to blended fuel, of which ethanol comprises only 10%, the exemption provides for an effective subsidy of 53¢ per gallon of pure ethanol. (See **Table 4**.)

Table 4. Price of Pure Ethanol Relative to Gasoline

July 1998 to June 1999

Ethanol Wholesale Price[a]	103 ¢/gallon
Alcohol Fuel Tax Incentive	53 ¢/gallon
Effective Price of Ethanol	50 ¢/gallon
Gasoline Wholesale Price[b]	46 ¢/gallon

Source: Hart's Oxy-Fuel News; Energy Information Agency, Petroleum Marketing Monthly.

[a] This is the average price for pure ("neat") ethanol.
[b] This is the average rack price for regular conventional gasoline (i.e. non-oxygenated, standard octane).

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, in conjunction with the congressional debate over extension of the tax exemption, concluded that ethanol production from corn would decline from 1.5 billion gallons per year, and stabilize at about 290 million gallons per year, if the exemption were eliminated.[26]

The tax exemption for ethanol is criticized by some as a corporate subsidy,[27] because, in this view, it encourages the inefficient use of agricultural and other

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[25] 26 U.S.C. 40.

[26] Food and Agriculture Policy Research Institute. *Effects on Agriculture of Elimination of the Excise Tax Exemption for Fuel Ethanol*, Working Paper 01-97, April 8, 1997.

[27] James Bovard. p. 8.

resources, and deprives the Highway Trust Fund of needed revenues.[28] In 1997, the General Accounting Office estimated that the tax exemption lead to approximately $7.5 to $11 billion in foregone Highway Trust Fund revenue over the 22 years from FY1979 to FY2000.[29] The petroleum industry opposes the incentive because it also results in reduced use of petroleum.

Proponents of the tax incentive argue that ethanol leads to better air quality, and that substantial benefits flow to the agriculture sector due to the increased demand for corn created by ethanol. Furthermore, they argue that the increased market for ethanol leads to a stronger U.S. trade balance, since a smaller U.S. ethanol industry would lead to increased imports of MTBE to meet the demand for oxygenates.[30]

Air Quality

One of the main motivations for ethanol use is improved air quality. Ethanol is primarily used in gasoline to meet minimum oxygenate requirements of two Clean Air Act programs. Reformulated gasoline (RFG)[31] is used to reduce vehicle emissions in areas that are in severe or extreme nonattainment of National Ambient Air Quality Standards (NAAQS) for ground-level ozone.[32] Ten metropolitan areas, including New York, Los Angeles, Chicago, Philadelphia, and Houston, are covered by this requirement, and many other areas with less severe ozone problems have opted into the program, as well. In these areas, RFG is used year-round. By contrast, the Oxygenated Fuels program operates only in the winter months in 16 areas[33] that are listed as carbon monoxide (CO) nonattainment areas.[34]

EPA states that RFG has led to significant improvements in air quality, including a 17% reduction in volatile organic compounds (VOCs) emissions from vehicles, and a 30% reduction in toxic emissions. Furthermore, according to EPA "ambient monitoring data from the first year of the RFG program (1995) also showed strong signs that RFG is working. For example, detection of benzene (one of the air

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[28] U.S. General Accounting Office (GAO), *Effects of the Alcohol Fuels Tax Incentives.* March, 1997.

[29] Jim Wells, GAO, *Petroleum and EthanolFuels: Tax Incentives and Related GAO Work*. September 25, 2000.

[30] Katrin Olson, "USDA Shows Losses Associated with Eliminating Ethanol Incentive," *Oxy- Fuel News*. May 19, 1997. p. 3.

[31] Clean Air Act, Section 211, subsection k. 42 U.S.C. 7545.

[32] Ground-level ozone is an air pollutant that causes smog, adversely affects health, and injures plants. It should not be confused with stratospheric ozone, which is a natural layer some 6 to 20 miles above the earth and provides a degree of protection from harmful radiation.

[33] Only the Los Angeles and New York areas are subject to both programs.

[34] Clean Air Act, Section 211, subsection m. 42 U.S.C. 7545.

toxics controlled by RFG, and a known human carcinogen) declined dramatically, with a median reduction of 38% from the previous year."[35]

However, the need for oxygenates in RFG has been questioned. Although oxygenates lead to lower emissions of VOCs, and CO, they may lead to higher emissions of nitrogen oxides (NO_X). Since all three contribute to the formation of ozone, the National Research Council recently concluded that while RFG certainly leads to improved air quality, the oxygenate requirement in RFG may have little overall impact on ozone formation.[36] Some argue that the main benefit of oxygenates use is that they displace other, more dangerous compounds such as benzene. Furthermore, the high price of Midwest gasoline in Summer 2000 has raised further questions about the RFG program (see the section on Phase 2 Reformulated Gasoline).

Evidence that the most widely-used oxygenate, methyl tertiary butyl ether (MTBE), contaminates groundwater has led to a push by some to eliminate the oxygen requirement in RFG. MTBE has been identified as an animal carcinogen, and there is concern that it is a possible human carcinogen. In California, MTBE was to be banned as of December 31, 2002. However, because of a projected spike in consumer gasoline prices California Governor Gray Davis postponed the ban until December 31, 2003.[37] California petitioned EPA to exempt the state from the oxygenate requirement, but on June 12, 2001, Administrator Whitman announced that the Agency could not grant California's request.[38]

If the oxygenate requirements were eliminated, some refiners claim that the environmental goals of the RFG program could be achieved through cleaner, although potentially more costly, gasoline that does not contain any oxygenates.[39] These claims have added to the push to remove the oxygen requirement and allow refiners to produce RFG in the most cost-effective manner, whether or not that includes the use oxygenates. However, some environmental groups are concerned that an elimination of the oxygenate requirements would compromise air quality gains resulting from the current standards, since oxygenates also displace other harmful chemicals in gasoline. This potential for "backsliding" is a result of the fact that the current performance of RFG is substantially better that the Clean Air Act requires. If the oxygenate standard were eliminated, environmental groups fear that

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[35] Margo T. Oge, Director, Office of Mobile Sources, U.S. EPA, *Testimony Before the Subcommittee on Energy and Environment of the Committee on Science, U.S. House of Representatives.* September 14, 1999.

[36] National Research Council, *Ozone-Forming Potential of Reformulated Gasoline.* May, 1999.

[37] Caroyln Whetzel, "California Governor Delays MTBE Ban by 12 Months, Citing Possible Price Hikes," *Daily Environment Report.* March 18, 2002. p. A-15.

[38] EPA, *Headquarters Press Release: EPA Issues Decision on California Waiver Request.* June 12, 2001.

[39] Al Jessel, Senior Fuels Regulatory Specialist of Chevron Products Company, *Testimony Before the House Science Committee Subcommittee on Energy and Environment.* September 30, 1999.

refiners would only meet the requirements of the law, as opposed to maintaining the current overcompliance.

While the potential ozone benefit from oxygenates in RFG has been questioned, there is little dispute that the winter Oxy-Fuels program has led to lower emissions of CO. The Oxy-Fuels program requires oxygenated gasoline in the winter months to control CO pollution in NAAQS nonattainment areas for the CO standard. However, this program is small relative to the RFG program.[40]

The air quality benefits from purer forms of ethanol can also be substantial. Compared to gasoline, use of E85 and E95 can result in a 30-50% reduction in ozone-forming emissions. And while the use of ethanol also leads to increased emissions of acetaldehyde, a toxic air pollutant, as defined by the Clean Air Act, these emissions can be controlled through the use of advanced catalytic converters.[41] However, as was stated above, these purer forms of ethanol have not seen wide use.

Climate Change

Another potential environmental benefit from ethanol is the fact that it is a renewable fuel. Proponents of ethanol argue that over the entire fuel-cycle[42] it has the potential to reduce greenhouse gas emissions from automobiles relative to gasoline, therefore reducing the risk of possible global warming.

Because ethanol (C_2H_5OH) contains carbon, combustion of the fuel necessarily results in emissions of carbon dioxide (CO_2), the primary greenhouse gas. However, since photosynthesis (the process by which plants convert light into chemical energy) requires absorption of CO_2, the growth cycle of the feedstock crop can serve—to some extent—as a "sink" that absorbs some of these emissions. In addition to CO_2 emissions, the emissions of other greenhouse gases may increase or decrease depending on the fuel cycle.[43]

According to Argonne National Laboratory, using E10, vehicle greenhouse gas emissions (measured in grams per mile) are approximately 1% lower than with the same vehicle using gasoline. With improvements in production processes, by 2010, the reduction in greenhouse gas emissions from ethanol relative to gasoline could be as high as 8-10% for E10, while the use of E95 could lead to significantly higher reductions.[44]

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[40] In 1998, an average of 90.9 million gallons per day of RFG were sold in the U.S., as opposed to 8.0 million gallons per day of Oxy-Fuel gasoline.

[41] California Energy Commission, *Ethanol-Powered Vehicles.*

[42] The fuel-cycle consists of all inputs and processes involved in the development, delivery and final use of the fuel.

[43] For example, nitrous oxide emissions tend to increase with ethanol use because nitrogen-based fertilizers are used extensively in agricultural production.

[44] M. Wang, C. Saricks, and D. Santini, "Effects of Fuel Ethanol on Fuel-Cycle Energy and Greenhouse Gas Emissions." Argonne National Laboratory.

While some studies have called into question the efficiency of the ethanol production process, most recent studies find a net energy gain.[45] If efficiency were diminished, overall reductions in greenhouse gas emissions would also be diminished, due to higher fuel consumption during the production process.

Energy Security

Another frequent argument for the use of ethanol as a motor fuel is that it reduces U.S. reliance on oil imports, making the U.S. less vulnerable to a fuel embargo of the sort that occurred in the 1970s, which was the event that initially stimulated development of the ethanol industry. According to Argonne National Laboratory, with current technology the use of E10 leads to a 3% reduction in fossil energy use per vehicle mile, while use of E95 could lead to a 44% reduction in fossil energy use.[46]

However, other studies contradict the Argonne study, suggesting that the amount of energy needed to produce ethanol is roughly equal to the amount of energy obtained from its combustion, which could lead to little or no reductions in fossil energy use.[47] However, because most of the energy used to produce ethanol comes from natural gas or electricity, overall petroleum dependence could be diminished through the use of ethanol.

As was stated above, fuel ethanol only accounts for approximately 1.2% of gasoline consumption in the United States by volume. In terms of energy, ethanol accounts for approximately 0.7%. This small market share led GAO to conclude that the ethanol tax incentive has done little to promote energy security.[48] Furthermore, since ethanol is currently dependent on the U.S. corn supply, any threats to this supply (e.g. drought), or increases in corn prices, would negatively affect the cost and/or supply of ethanol. This happened when high corn prices caused by strong export demand in 1995 contributed to an 18% decline in ethanol production between 1995 and 1996.

Policy Concerns and Congressional Activity

Recent congressional interest in ethanol fuels has mainly focused on six issues: 1) RFG oxygenate requirements and a possible phase-out of MTBE; 2) a renewable fuels standard; 3) implementation of Phase 2 of the RFG program; 4) "boutique" fuels; 5) the alcohol fuel tax incentives; and 6) fuel economy credits for dual fuel vehicles. Several of these issues are addressed in either the House or Senate version of H.R. 4, the comprehensive energy package. The House passed H.R. 4 on August

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[45] Hosein Shapouri, James A. Duffield, and Michael S. Graboski, USDA, Economic Research Service, *Estimating the Net Energy Balance of Corn Ethanol.* July 1995.

[46] Wang, et. al. p. 1

[47] Shapouri, et. al. Table 1.

[48] U.S. General Accounting Office, *Effects of the Alcohol Fuels Tax Incentives.* March, 1997.

2, 2001; the Senate passed the bill on April 25, 2002. On June 27, 2002, the conference committee convened to reconcile the House and Senate versions of the bill.

Reformulated Gasoline and MTBE

A key issue involving ethanol is the current debate over MTBE. Since MTBE, a possible human carcinogen, has been found in groundwater in some states (especially in California), there has been a push both in California and nationally to ban MTBE.[49] In March 1999, California's Governor Davis issued an Executive Order requiring that MTBE be phased out of gasoline in the state by December 31, 2002, although the date of the ban was recently pushed back to December 31, 2003. At least twelve other states have also instituted limits or bans on MTBE. In July 1999, an advisory panel to EPA recommended that MTBE use should be "reduced substantially."[50]

A possible ban on MTBE could have serious consequences for fuel markets, especially if the oxygenate requirements remain in place. Since ethanol is the second most used oxygenate, it is likely that it would be used to replace MTBE. However, there is not currently enough U.S. production capacity to meet the potential demand. Therefore, it would likely be necessary to phase out MTBE over time, as opposed to an immediate ban. Furthermore, the consumer price for oxygenated fuels would likely increase because ethanol, unlike MTBE, cannot be shipped through pipelines and must be mixed close to the point of sale, adding to delivery costs. Increased demand for oxygenates could also be met through imports from countries such as Brazil, which is a leader worldwide in fuel ethanol production, and currently has a surplus.[51]

While a ban on MTBE would seem to have positive implications for ethanol producers, it could actually work against them. Because MTBE is more commonly used in RFG and high-octane gasoline, and because current ethanol production can not currently meet total U.S. demand for oxygenates and octane, there is also a push to suspend the oxygenate requirement in RFG, which would remove a major stimulus to the use of fuel ethanol. Furthermore, environmental groups and state air quality officials, although supportive of a ban on MTBE, are concerned over the possibility of "backsliding" if the oxygenate standard is eliminated. Because current RFG formulations have a lower level of toxic substances than is required under the Clean Air Act, there are concerns that new RFG formulations without oxygenates will meet the existing standard, but not the current level of overcompliance.

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[49] For more information, see CRS Report 98-290 ENR, *MTBE in Gasoline: Clean Air and Drinking Water Issues.*

[50] Blue Ribbon Panel on Oxygenates in Gasoline, *Achieving Clean Air and Clean Water: The Report of the Blue Ribbon Panel on Oxygenates in Gasoline.*

[51] Adrian Schofield, "Brazilian Ambassador Sees Opportunity in United States Ethanol Market," *New Fuels & Vehicles Report.* September 16, 1999. p. 1.

Along with California's ban on MTBE, the state requested that the oxygen requirement be waived. On June 12, 2001, EPA informed California that the agency could not grant the request. CAA only grants EPA the authority to suspend fuel requirements if there are threats to air quality, despite potential hazards to water quality.[52] Some have proposed that the CAA be amended to allow EPA the authority to suspend fuel requirements in the case of water contamination.

Supporters of ethanol have proposed that along with a ban of MTBE, a renewable standard should be introduced. This would require that a certain percentage of fuel in the U.S. be made from renewable sources. This type or requirement, if large enough, would protect the ethanol market if the RFG oxygenate standard were eliminated. (See below)

There are some key RFG-related provisions in the Senate version of H.R. 4. MTBE would be eliminated, although individual states could petition EPA to continue its use. Further, the RFG oxygen standard would be eliminated, and a new renewable fuels standard for all gasoline would be created. In addition, the Senate version would provide some assistance to MTBE producers who convert plants to produce other fuel additives. The House version of H.R. 4 would not change the RFG program, but would require that EPA study various changes to the program.

Several other RFG and MTBE-related bills have been introduced in the 107th Congress. These bills address different facets of the MTBE issue, including limiting or banning the use of MTBE, granting waivers to the oxygenate requirement, authorizing funding for MTBE cleanup, eliminating or waiving the oxygen requirement, and creating a renewable fuel standard.

Renewable Fuels Standard

There is congressional interest in establishing a renewable fuels standard. This would require motor fuel to contain a certain percentage or set amount of renewable fuel. It is likely that most of the fuel required would be ethanol, while some would be biodiesel.[53] Supporters argue that without an oxygen requirement in RFG (see above), a key market for ethanol would be lost. They argue that demand for ethanol creates jobs, and that there are major environmental and energy security benefits to using renewable fuels. However, opponents argue that any renewable fuels standard would only exacerbate a situation of artificial demand for ethanol. Any requirement above the existing level for ethanol would require the construction and/or expansion of ethanol plants, and would likely lead to increased fuel prices and further instability in an already tight fuel supply chain. Further, they argue that a renewable fuels standard would lead to increased corn prices caused by higher demand.

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[52] EPA, *Headquarters Press Release: EPA Issues Decision on California Waiver Request.* June 12, 2001.

[53] Biodiesel is an synthetic diesel fuel made from oils such as soybean oil. Fore more information, see CRS Report RL30758, *Alternative Transportation Fuels and Vehicles: Energy, Environment, and Development Issues.*

The Senate version of H.R. 4 would require that gasoline contain 2.3 billion gallons of renewable fuel in 2004, increasing to 5.0 billion gallons in 2012. Because the majority of this requirement would likely be met with ethanol, this would mean nearly a tripling of ethanol consumption over that time. After 2012, the percentage of renewable fuel in gasoline would be required to remain constant. The House version of H.R. 4 does not contain a similar standard, but does require EPA and DOE to study the feasibility of such a standard. Several other bills in the 107th Congress would establish a renewable fuels standard, but the provisions in those bills are generally similar to the provisions in the Senate version of H.R. 4.

Phase 2 Reformulated Gasoline

Under the new Phase 2 requirements of the RFG program, which took effect in 2000, gasoline sold in the summer months (beginning June 1) must meet a tighter volatility standard.[54] Reid Vapor Pressure (RVP) is a measure of volatility, with higher numbers indicating higher volatility. Because of its physical properties, ethanol has a higher RVP than MTBE. Therefore, to make Phase 2 RFG with ethanol, the gasoline, called RBOB,[55] must have a lower RVP. This low-RVP fuel is more expensive to produce, leading to higher production costs for ethanol-blended RFG.

Before the start of Phase 2, estimates of the increased cost to produce RBOB for ethanol-blended RFG ranged from 2 to 4 cents per gallon, to as much as 5 to 8 cents per gallon.[56] In Summer 2000, RFG prices in Chicago and Milwaukee were considerably higher than RFG prices in other areas, and it has been argued that the higher production cost for RBOB was one cause. However, not all of the price difference is attributable to the new Phase 2 requirements or the use of ethanol. Conventional gasoline prices in the Midwest were also high compared with gasoline prices in other areas. High crude oil prices, low gasoline inventories, pipeline problems, and uncertainties over a patent dispute pushed up prices for all gasoline in the Midwest.

To decrease the potential for price spikes, on March 15, 2001, EPA announced that Chicago and Milwaukee will be allowed to blend slightly higher RVP reformulated gasoline during the summer months.[57] This action is not a change in regulations but a revision of EPA's enforcement guidelines. In addition to EPA's action, one possible regulatory option that has been suggested to control summer RFG prices is a more significant increase in the allowable RVP under Phase 2. Although the volatility standard is set by the Clean Air Act, the Environmental Protection Agency (EPA) is currently reviewing whether credits from ethanol's improved performance on carbon monoxide emissions are possible as an offset to its higher volatility. Legislative options have included eliminating the oxygenate

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[54] Volatility of gasoline is its tendency to evaporate.

[55] RBOB: Reformulated Gasoline Blendstock for Oxygenate Blending.

[56] Estimates from the Renewable Fuels Association and EPA, respectively.

[57] Pamela Najer, "Refiners Get Flexibility to Blend Ethanol for Summer Fuel Supply in Two Cities," *Daily Environment Report.* March 19, 2001. p. A9.

standard for RFG, or suspending the program entirely. However, some in the petroleum industry suggest that additional changes to fuel requirements could further disrupt gasoline supplies.

The House version of H.R. 4 would require EPA to determine whether certain accounting procedures related to Phase 2 should be modified to improve the cost and availability of RFG. The Senate version contains no similar provision. Four other bills in the 107th Congress would allow a higher RVP for ethanol blended fuels. These are H.R. 454 (Johnson, T.), H.R. 1999 (Nussle), S. 670 (Daschle), and S. 892 (Harkin). All four have been referred to committee. No hearings or markups have been held.

"Boutique" Fuels[58]

As a result of the federal reformulated and oxygenated gasoline requirements, as well as related state and local environmental requirements, gasoline suppliers may face several different standards for gasoline quality. These different standards sometimes require a supplier to provide several different fuels in that area. These different formulations are sometimes referred to as "boutique" fuels.[59] Because of varying local requirements, if there is a disruption to the supply of fuel in one area, refiners in other areas may not be able to supply fuel quickly to meet the increased demand.

EPA conducted a study on the effects of harmonizing standards, and released a staff white paper in October, 2001. In its preliminary analysis, EPA concluded that some minor changes could be made that might mitigate supply disruptions without significantly increasing costs or adversely affecting vehicle emissions. However, all of the scenarios in EPA's study would require amendments to the RFG provisions in the Clean Air Act.

Congressional interest has centered on the question of whether the various standards could be harmonized to reduce the number of gasoline formulations. In the 107th Congress, the House and Senate versions of H.R. 4 would require studies on harmonization of these standards. The House version would require EPA and DOE to publish a report by the end of this year, while the Senate version would require a report by June, 2006. H.R. 1834 would require a similar study. H.R. 1834 has been referred to committee.

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[58] EPA, Office of Transportation and Air Quality, *Staff White Paper: Study of Unique Gasoline Fuel Blends ("Boutique Fuels"), Effects on Fuel Supply and Distribution and Potential Improvements.* October, 2001.

[59] For more information on boutique fuels, see CRS Report RL31361, *"Boutique Fuels" and Reformulated Gasoline: Harmonization of Fuel Standards.*

Alcohol Fuel Tax Incentives[60]

As stated above, the exemption that ethanol-blended fuels receive from the excise tax on motor fuels is controversial. The incentive allows fuel ethanol to compete with other additives, since the wholesale price of ethanol is so high. Proponents of ethanol argue that this exemption lowers dependence on foreign imports, promotes air quality, and benefits farmers.[61] A related, albeit smaller incentive for ethanol production is the small ethanol producers tax credit. This credit provides 10 cents per gallon for up to 15 million gallons of annual production by a small producer.[62]

Opponents of the tax incentives argue that the incentives support an industry that could not exist on its own, and reduce potential fuel tax revenue. Despite objections from opponents, Congress in 1998 extended the motor fuels tax exemption through 2007, but at slightly lower rates (P.L. 105-178). In the 107th Congress, neither version of H.R. 4 addresses the tax exemption, though the Senate version would expand eligibility for the small producer tax credit. Also, the Senate version would transfer some fuel tax proceeds from the general fund to the highway trust fund to help make up for lost trust fund revenue due to ethanol consumption.

Other bills in the 107th Congress also address ethanol tax incentives. S. 907 (Carnahan) would extend to alcohol fuels tax exemption through 2015. In addition, five bills would expand the availability of the small producer credit, increase the size of a covered producer, and make the credit available to cooperatives. These four bills are H.R. 1636 (Thune), H.R. 1999 (Nussle), S. 312 (Grassley), S. 613 (Fitzgerald), and S. 907 (Carnahan). All five have been referred to committee, but no markups have been held. A hearing was held on S. 312. H.R. 2303 (Lewis, Ron) contains the above provisions on small producers and cooperatives. In addition, the bill would provide tax credits for the retail sale of ethanol, and for the installation of retail infrastructure. This bill has been referred to committee, but no hearings or markups have been held.

Fuel Economy Credits for Dual Fuel Vehicles

The Energy Policy and Conservation Act (EPCA) of 1975[63] requires Corporate Average Fuel Economy (CAFE) standards for motor vehicles.[64] Under EPCA, the average fuel economy of all vehicles of a given class that a manufacturer sells in a model year must be equal to or greater than the standard. These standards were first enacted in response to the desire to reduce petroleum consumption and promote

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[60] For more information, see CRS Report 98-435 E, *Alcohol Fuels Tax Incentives.*

[61] U.S. General Accounting Office (GAO), *Effects of the Alcohol Fuels Tax Incentives.* March, 1997.

[62] Defined as having a production capacity of less than 30 million gallons per year.

[63] P.L. 94-163.

[64] For more information on CAFE standards, see CRS Issue Brief IB90122, *Automobile and Light Truck Fuel Economy: Is CAFE Up to Standards?*

energy security after the Arab oil embargo. The current standard for passenger cars is 27.5 miles per gallon (mpg), while the standard for light trucks is 20.7 mpg.

However, EPCA and subsequent amendments provide manufacturing incentives for alternative fuel vehicles, including ethanol vehicles.[65] For each alternative fuel vehicle a manufacturer produces, credits are provided which increase that manufacturer's average. These credits include dual fuel vehicles–those vehicles which can be operated on both a conventional fuel (gasoline or diesel) and an alternative fuel, usually ethanol. Concerns have been raised over that fact that while manufacturers are receiving credits for production of these dual fuel vehicles, they are generally operated solely on gasoline, because of the cost and availability of alternative fuels. Supporters of the credits argue that the incentives are necessary for the production of alternative fuel vehicles, and that as the number of vehicles increases, the infrastructure for alternative fuels will grow.

In the 107th Congress, The House version of H.R. 4 would extend the credits through 2012. The Senate version would extend the credits through 2013 and expand increase the maximum allowable credit.

Conclusion

As a result of the current debate over the future of MTBE in RFG, and the RFG program in general, the future of the U.S. ethanol industry is uncertain. A ban on MTBE would greatly expand the market for ethanol, while an elimination of the oxygenate requirement would remove a major stimulus for its use. Any changes in the demand for ethanol will have major effects on corn producers, who rely on the industry as a partial market for their products.

The current size of the ethanol industry is depends significantly on federal laws and regulations that promote its use for air quality and energy security purposes, as well as tax incentives that lessen its cost to consumers. Without these, it is likely that the industry would shrink substantially in the near future. However, if fuel ethanol process costs can be decreased, or if gasoline prices increase, ethanol could increase its role in U.S. fuel consumption

[65] 49 U.S.C. 32905.