SJR

16

SENATE COMMITTEE REPORT
First Committee of Referral

DATE: 4/7/03

FURTHER:

Date of 5-Day Notice: 4/17/03
(in accordance with Uniform Rule 23)

DATE TURNED IN TO OFFICE: 4/22/03

State Affairs Committee considered SENATE JOINT RESOLUTION NO. 16

SJR 16 END FEDERAL ETHANOL SUBSIDY

Encouraging the federal government to end the federal subsidy of ethanol, and requesting the Congress of the United States to mandate that land currently used to grow corn for the production of ethanol be returned to its natural state.

and recommends:

Senate Bill:
[ ] same title
[ ] new title
House Bill:
[ ] same title
[ ] technical title
[ ] new: SCR #_____

[ ] be **replaced** with _____ **CS** _____ (_____)

[ ] adopt **previous** _____ **CS** _____ (_____)

[ ] attached amendment(s)

[ ] adopt Letter of Intent by _____ Committee

[ ] further referral to _____ Committee

NEW FISCAL NOTE(S):

Department	Date	Fiscal	Zero	FN#
LTA	4/7/03		✓	1

PREVIOUS FISCAL NOTE(S):

Department	Date	Fiscal	Zero	FN#

[ ] **APPROPRIATION - no fiscal note**

SIGNATURES AND RECOMMENDATIONS:	DO PASS	DO NOT PASS	NO REC	AMEND
	✓			
	✓			
CHAIR:	✓			

THE
FOLLOWING
DOCUMENT(S)
ARE
POOR
ORIGINAL
COPIES

FISCAL NOTE

STATE OF ALASKA
2003 LEGISLATIVE SESSION

Fiscal Note Number:
Bill Version: SJR 16
(S) Publish Date:

Revision Date/Time (Note if correction):
Dept. Affected:
Title: End Federal Ethanol Subsidy
BRU
Component
Sponsor: Senator Bunde
Requester: Senate State Affairs Committee
Component No.

Expenditures/Revenues (Thousands of Dollars)

Note: Amounts do not include inflation unless otherwise noted below.

OPERATING EXPENDITURES	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Personal Services						
Travel						
Contractual						
Supplies						
Equipment						
Land & Structures						
Grants & Claims						
Miscellaneous						
TOTAL OPERATING	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL EXPENDITURES						
CHANGE IN REVENUES ( )						

FUND SOURCE (Thousands of Dollars)

1002 Federal Receipts						
1003 GF Match						
1004 GF						
1005 GF/Program Receipts						
1037 GF/Mental Health						
Other (Specify Type--Do not abbreviate)						
TOTAL	0.0	0.0	0.0	0.0	0.0	0.0

Estimate of any current year (FY2003) cost: 0.0
Mark this box (X) if funding for this bill is included in the Governor's FY 2004 budget proposal:

POSITIONS

Full-time						
Part-time						
Temporary						

ANALYSIS: *(Attach a separate page if necessary)*

Prepared by: SENATE STATE AFFAIRS COMMITTEE
Division
Phone 465-4522
Approved by: Senator Gary Stevens, Chair
Agency
Date/Time 4/17/03 12:33 PM
Date 4/17/2003

(Revised 9/2002 OMB)

Oxygenated Fuel in Alaska

My staff spoke with Tom Chapple, Director of DEC's Division of Air and Water Quality. He said oxygenated fuel (using ethanol) is sold in Alaska. Oxygenated fuel is required only in Anchorage between November and March.

However, he said, "we don't need it anymore." When asked why we don't need it, he said because cars made in 1994 and later have better combustion controls that do the same air quality job as oxygenated fuels. For that reason, the Governor's proposed budget would end the 6-cent state tax credit for using ethanol that refiners and distributors are given.

Alaska State Legislature

DURING SESSION
STATE CAPITOL
JUNEAU, AK 99801-1182
(907) 465-4843 (800) 992-4843
FAX: (907) 465-3871

WEB SITE
www.akrepublicans.org/Bunde

SENATOR CON BUNDE
District P

DURING INTERIM
716 W. FOURTH AVE.
ANCHORAGE, AK 39501-2133
(907) 269-0181
FAX: (907)269-0184

E-MAIL
Senator.Con.Bunde@legis.state.ak.us

VICE-CHAIR: SENATE FINANCE COMMITTEE
CHAIR: SENATE LABOR & COMMERCE COMMITTEE
MEMBER: LEGISLATIVE BUDGET & AUDIT COMMITTEE

SPONSOR STATEMENT

SJR 16

A resolution "Encouraging the federal government to end the federal subsidy of ethanol, and requesting the Congress of the United States to mandate that land currently used to grow corn for the production of ethanol be returned to its natural state."

Fifty-two United States Senators recently voted against the opening of ANWR to oil drilling, proclaiming that by doing so, they were saving wilderness and preserving wildlife.

During debate on Amendment 272, "To prevent consideration of drilling the Arctic National Wildlife Refuge in Senate Concurrent Resolution 23, the fast track budget reconciliation," many senators spoke on behalf of keeping the 1002 region in a state of "pristine wilderness."

For example, Mr. Durbin of Illinois said, "The Arctic Refuge includes boreal forests, dramatic peaks, and tundra. It features a complete range of arctic and sub-arctic ecosystems, with an extraordinary assemblage of wildlife." He declared, "We have a responsibility in this generation to leave to the next generation the natural heritage that we were given."

Illinois produces 766 million gallons of ethanol produced from corn, the most of all fifty states. I hope that he understands that this resolution would protect the next generation from ethanol subsidies.

The amendment's sponsor, Senator Barbara Boxer of California, explained her position this way. "I say to my friends from Alaska, I hope they will understand the people in this country who support keeping this 5 percent of the North Slope in its pristine environment are doing so because we think it is good for the soul of this country, and we believe there are more jobs to be created through other means.

However, I agree with Senator Lisa Murkowski, who said during the debate, "But this thought process implies that ... Alaskan residents, my constituents, the jobs they will get are carrying bags for these people when they come to visit as a tourist."

Many of the senators who voted for Amendment 272 represent the top 20 ethanol-producing states in the nation. Some of the nation's most influential businesses profit greatly from the federal ethanol subsidy and do big business in those states. Those senators support industrial development in their states, to the detriment of their own wildlife and wild lands. Yet many in those and other states who supported keeping ANWR closed to development are ardent environmentalists – when it comes to someone else's state.

I also agree with Senator Murkowski when she said, "It is demeaning and it is unfair to say that Massachusetts can keep its 20,000 petroleum-based jobs; that New Jersey can keep its 27,000 petroleum-industry jobs; and New York can keep its 36,000 petroleum-industry jobs, while Alaska supposedly looks to other alternatives. Why is it OK for everybody else to do it, and yet in Alaska for some reason we are not responsible, we can't handle it, we don't do it right, we need to lock it up and preserve it because it is the last Serengeti?"

This resolution is meant to send a message to those United States Senators who support the environmentalists' viewpoint. They believe that saving 2,000 acres in Alaska is worth more than Alaskan jobs and Alaskans' right to develop our state in the manner we see fit.

I ask you to join me in sending the message that what is good for the goose must be good for the gander.

U.S. Senate Roll Call Vote
Boxer Amendment No. 272 to S.Con.Res. 23, "To prevent consideration of drilling in ANWR in a fast-track budget reconciliation bill.

Ethanol Producing States	Million Gallons Per Year (2003) *	Senator's Name	Vote	Senator's Name	Vote
Illinois	766	Durbin (D)	Yea	Fitzgerald (R)	Yea
Iowa	695	Grassley (R)	Nay	Harkin (D)	Yea
Nebraska	422	Hagel (R)	Nay	Nelson (D)	Yea
Minnesota	393.6	Coleman (R)	Yea	Dayton (D)	Yea
South Dakota	371	Daschle (D)	Yea	Johnson (D)	Yea
Indiana	95	Bayh (D)	Yea	Lugar (R)	Nay
Missouri	80	Bond (R)	Nay	Talent (R)	Nay
Kansas	79.5	Brownback (R)	Nay	Roberts (R)	Nay
Wisconsin	79	Feingold (D)	Yea	Kohl (D)	Yea
Tennessee	65	Alexander (R)	Nay	Frist (R)	Nay
Michigan	45	Levin (D)	Yea	Stabenow (D)	Yea
North Dakota	33.5	Conrad (D)	Yea	Dorgan (D)	Yea
Kentucky	24	Bunning (R)	Nay	McConnell (R)	Nay
New Mexico	15	Bingaman (D)	Yea	Domenici (R)	Nay
California	9	Boxer (D)	Yea	Feinstein (D)	Yea
Idaho	6	Craig (R)	Nay	Crapo (R)	Nay
Wyoming	5	Enzi (R)	Nay	Thomas (R)	Nay
Florida	4	Graham (D)	Yea	Nelson (D)	Yea
Colorado	1.5	Allard (R)	Nay	Campbell (R)	Nay
Washington	0.7	Cantwell (D)	Yea	Murray (D)	Yea
Non-Ethanol Producing States					
Alabama		Sessions (R)	Nay	Shelby (R)	Nay
Alaska		Murkowski (R)	Nay	Stevens (R)	Nay
Arizona		Kyl (R)	Nay	McCain (R)	Yea
Arkansas		Lincoln (D)	Yea	Pryor (D)	Yea
Connecticut		Dodd (D)	Yea	Lieberman (D)	Yea
Delaware		Biden (D)	Yea	Carper (D)	Yea
Georgia		Chambliss (R)	Nay	Miller (D)	Nay
Hawaii		Akaka (D)	Nay	Inouye (D	Nay
Louisiana		Breaux (D)	Nay	Landrieu (D)	Nay
Maine		Collins (R)	Yea	Snowe (R)	Yea
Maryland		Mikulski (D)	Yea	Sarbanes (D)	Yea
Massachusetts		Kennday (D)	Yea	Kerry (D)	Yea
Nevada		Ensign (R)	Nay	Reid (D)	Yea
New Hampshire		Gregg (R)	Nay	Sununu (R)	Nay
New Jersey		Conrzine (D)	Yea	Lautenberg (D)	Yea
New York		Clinton (D)	Yea	Schumer (D)	Yea
North Carolina		Dole (R)	Nay	Edwards (D)	Yea
Ohio		DeWine (R)	Yea	Voinovich (R)	Nay
Oklahoma		Inhofe (R)	Nay	Nickles (R)	Nay
Oregon		Smith (R)	Yea	Wyden (D)	Yea
Pennsylvania		Santorum (R)	Nay	Specter (R)	Nay
Rhode Island		Chafee (R)	Yea	Reed (D)	Yea
South Carolina		Graham (R)	Nay	Hollings (D)	Yea
Texas		Cornyun (R)	Nay	Hutchison (R)	Nay
Utah		Bennett (R)	Nay	Hatch (R)	Nay
Vermont		Jeffords (I)	Yea	Leahy (D)	Yea
Virginia		Allen (R)	Nay	Warner (R)	Nay
West Virginia		Byrd (D)	Yea	Rockefeller (D)	Yea

Production Level information provided by Ethanol Industry Outlook 2003 by the Renewable Fuels Association

** includes gallons under production*

Provided by Senator Con Bunde

Text from the Congressional Record, March 18, 2003

Amendment No. 272

Mrs. BOXER. I send an amendment to the desk and ask for its immediate consideration. I ask the following cosponsors be included on this amendment: Mr. Chafee, Mr. Lieberman, Ms. Snowe, Mr. Kerry, Mr. Feingold, Mr. Daschle, Mr. Lautenberg, Mrs. Murray, Mr. Durbin, Mr. Wyden, Mr. Reid of Nevada, Ms. Stabenow, Mr. Harkin, Mr. Kennedy, Mr. Edwards, and Mr. Bingaman.

The PRESIDING OFFICER. The clerk will report. The legislative clerk read as follows:

The Senator from California [Mrs. Boxer], for herself, and Mr. Chafee, Mr. Lieberman, Ms. Snowe, Mr. Kerry, Mr. Feingold, Mr. Daschle, Mr. Lautenberg, Mrs. Murray, Mr. Durbin, Mr. Wyden, Mr. Reid, Ms. Stabenow, Mr. Harkin, Mr. Kennedy, Mr. Edwards, and Mr. Bingaman, proposes an amendment numbered 272.

Mrs. BOXER. I ask unanimous consent reading of the amendment be dispensed with.

The PRESIDING OFFICER. Without objection, it is so ordered.

The amendment is as follows: (Purpose: To prevent consideration of drilling in the Arctic National Wildlife Refuge in a fast-track budget reconciliation bill.)

Mrs. BOXER. Madam President, it is a great honor for me to offer this amendment. I hope very much that Members on both sides will support it. The amendment is very simple. It strikes the reconciliation instructions given to the Energy Committee that will lead to oil drilling in a pristine place in America, a God-given gift, the Arctic National Wildlife Refuge. We are striking, in essence, the instructions, and that will in essence say, no, we will not have drilling in this pristine area.

House GOP revives ANWR drilling

THE ASSOCIATED PRESS

Drilling effort revived: Area 1002, a section inside the Arctic National Wildlife Refuge in Alaska, proposed to be used for oil exploration by the Bush administration, is shown in this undated photo. A House committee is reviving President Bush's top energy proposal – opening a section of ANWR to oil drilling – despite its recent rejection by the Senate.

By H. JOSEF HEBERT
THE ASSOCIATED PRESS

WASHINGTON – The House is moving swiftly to enact energy legislation, hoping to revive a proposal for oil drilling in an Alaska wildlife refuge and, in a boon to farmers, expand the use of ethanol as a gasoline additive.

Both provisions were included Wednesday as separate committees crafted key parts of the energy legislation. Lawmakers said they expected an energy bill to be voted on by the full House, possibly as early as next week.

The Senate will not begin writing a detailed energy bill until next week, although a proposal for $15.5 billion in energy tax incentives also was approved by the Senate Finance Committee on Wednesday.

The House was to take up energy tax issues today.

As separate House committees crafted various parts of the energy package, it became clear that the push to open the Arctic National Wildlife Refuge was far from over, although the Senate two weeks ago rejected a drilling proposal 52-48.

"We're talking about a very small amount of land," Rep. Don Young, R-Alaska, said shortly before the House Resources Committee passed a package of energy measures that included opening the Alaska refuge to oil companies.

"This nation needs the oil," he said.

Rep. Ed Markey, D-Mass., argued that drilling in ANWR's 1.5 million acre coastal plain would "ruin the jewel of the national wildlife refuge system" and said more oil could be save if the government imposed tougher fuel economy requirements on automobiles.

But hours later, in another committee, a Markey proposal was rejected that would have forced automakers to make more fuel efficient cars by requiring a 10 percent reduction in gasoline use.

The Resource panel passed a series of financial incentives aimed at spurring production of oil, natural gas and coal.

The bill would allow producers to forego paying federal royalties when developing deep offshore wells in search of natural gas in the Gulf of Mexico and off Alaska, remove limits on how many acres coal companies may lease and require the government to reimburse energy companies for the cost of meeting environmental reviews.

Rep. Nick Rahall, D-W.Va., called it "a buffet table" for the oil and gas industry.

"Robin Hood is turning in his grave," said Rahall, but a Democratic attempt to gut some of the royalty benefits was defeated 27-15.

Republicans called the industry incentives necessary to spur domestic energy production and get producers to drill high-risk wells. With a war in Iraq, "doesn't it make sense for us to adopt some sensible policies that will boost our energy security?" argued Rep. Richard Pombo, R-Calif., the Resource panel's chairman.

Meanwhile, the House Energy and Commerce Committee, working until nearly midnight Wednesday, wrapped up other parts of the energy package.

The legislation would require refiners to use at least 5 billion gallons a year of corn-based ethanol in gasoline by 2015, a mandate that is expected to be a boon to corn farmers. The industry now produces about 2.5 billion gallons annually.

When Rep. Lois Capps, D-Calif., sought to also ban MTBE, another gasoline additive, that has been widely blamed for contaminating drinking water, her amendment was turned back, 32-18. Instead, lawmakers approved liability protection for MTBE manufactures who might face environmental lawsuits.

Rep. Joe Barton, R-Texas, whose district includes MTBE manufacturers, said the refiners turned to MTBE because of federal clean air rules, and should not be penalized. Numerous states already are moving to phase out MTBE use because of environmental concerns, he said.

The House legislation also would:

- Give the Federal Energy Regulatory Commission authority to order the taking of private land for power line construction if a state does not act.
- Streamline federal approval of hydroelectric dams.
- Rescind a Depression-era law that restricted certain mergers among large power holding companies. Consumer groups argued the law shouldn't be scrapped unless FERC is given more authority to deal with merger abuses.

Order Code RL30369

Fuel Ethanol: Background and Public Policy Issues

Updated July 2, 2002

Brent D. Yacobucci
Environmental Policy Analyst
Resources, Science, and Industry Division

Jasper Womach
Specialist in Agricultural Policy
Resources, Science, and Industry Division

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.

Contents

List of Tables

Fuel Ethanol: Background and Public Policy Issues

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

---

[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.

---

[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

---

[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

---

[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."

---

[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 Fuels 1999 .

[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.

---

[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.

---

[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

---

[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

---

[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

---

[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]

---

[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

---

[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.

---

[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.

---

[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

---

[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.

---

[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

---

[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.

Building a Secure Energy Future

RFA

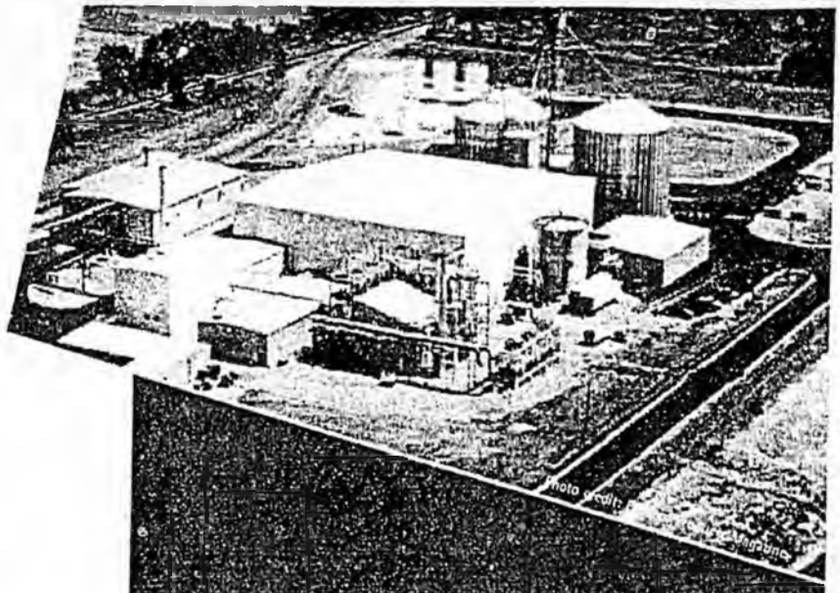
Renewable Fuels Association

Provided by Senator Con Bunde

Record Ethanol Production Capacity

In response to growing market opportunities, the ethanol industry built annual production capacity to a record 3.7 billions gallons at the end of 2002. This represents an increase of more than one billion gallons compared to only three years ago.

Growth will continue to dominate the ethanol industry. With several plants under construction and a number of expansions to existing facilities under way, ethanol production capacity will surpass 3 billion gallons during 2003. Dozens of projects under development will ensure continued growth in the future.

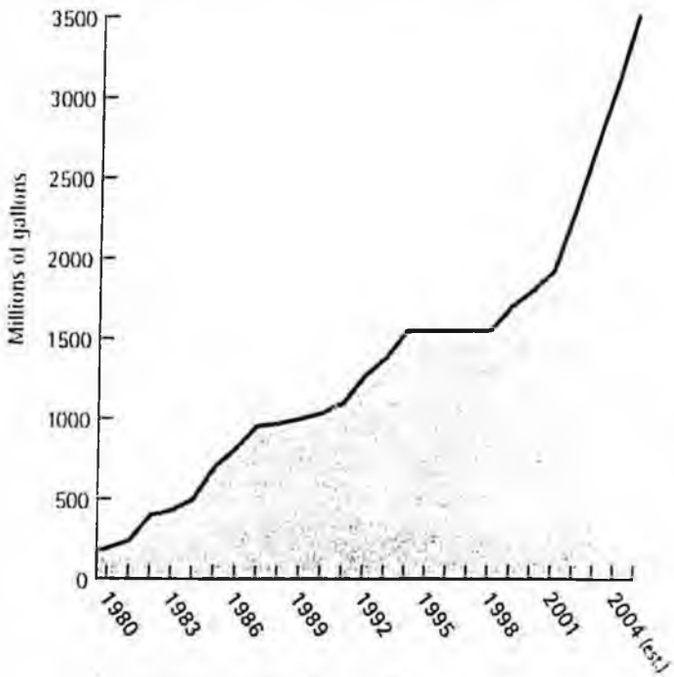


STATE ETHANOL PRODUCTION CAPACITY

State	Million gallons/year
Illinois	766
Iowa	695
Nebraska	422
Minnesota	393.6
South Dakota	371
Indiana	95
Missouri	80
Kansas	79.5
Wisconsin	79
Tennessee	65
Michigan	45
North Dakota	33.5
Kentucky	24
New Mexico	15
California	9
Idaho	6
Wyoming	5
Florida	4
Colorado	1.5
Washington	0.7
Total	3189.8 mgy

Includes gallons currently under construction.

Annual U.S. Ethanol Production Capacity



Source: Renewable Fuels Association

Securing the Future of the American Farm

Ethanol production is the third largest and fastest growing market for U.S. corn. In 2002, over 800 million bushels of corn were processed into ethanol and valuable feed co-products, boosting corn prices by 30 to 40 cents per bushel nationally. Additionally, 45 million bushels of grain sorghum were used in the production of ethanol.

Farmers Invest in Their Future

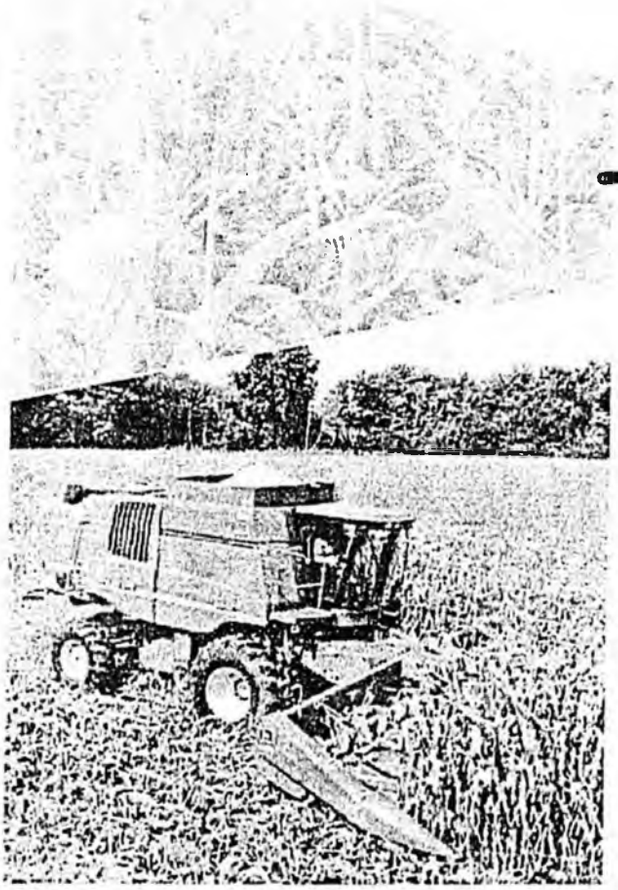
The recent boom in ethanol plant construction has been spearheaded by farmers seeking to capture new value-added markets for the commodities they grow. Since 1999, farmer-owned ethanol plants have increased their percentage of total production capacity from 20% to over 35%. Today, 70% of the ethanol plants under construction are farmer-owned.

Renewable Fuels Standard Grows Farm Economy

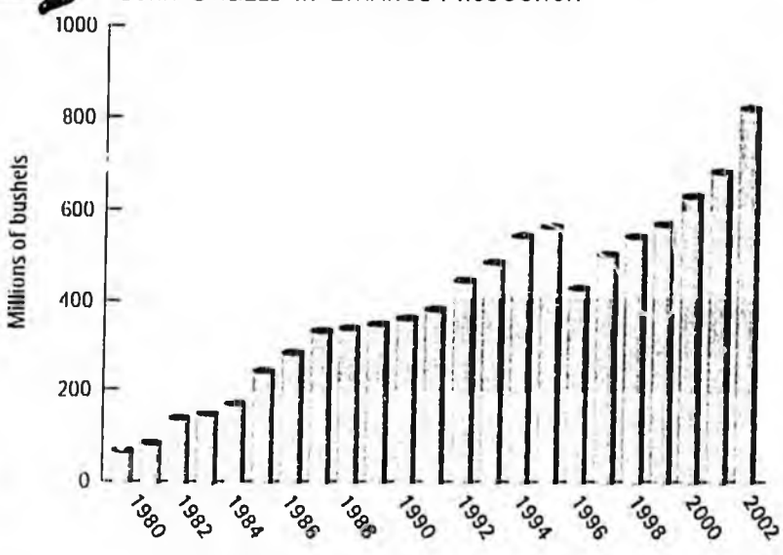
According to a study conducted on behalf of the National Corn Growers Association, enacting a renewable fuels standard that increases ethanol use to 5 billion gallons by 2012 would:

- Boost corn use to more than 2 billion bushels per year
- Increase corn prices by 6.8% above baseline projections
- Add $51 billion to farm income through 2012
- Reduce direct government payments to farmers by $5.9 billion through 2012

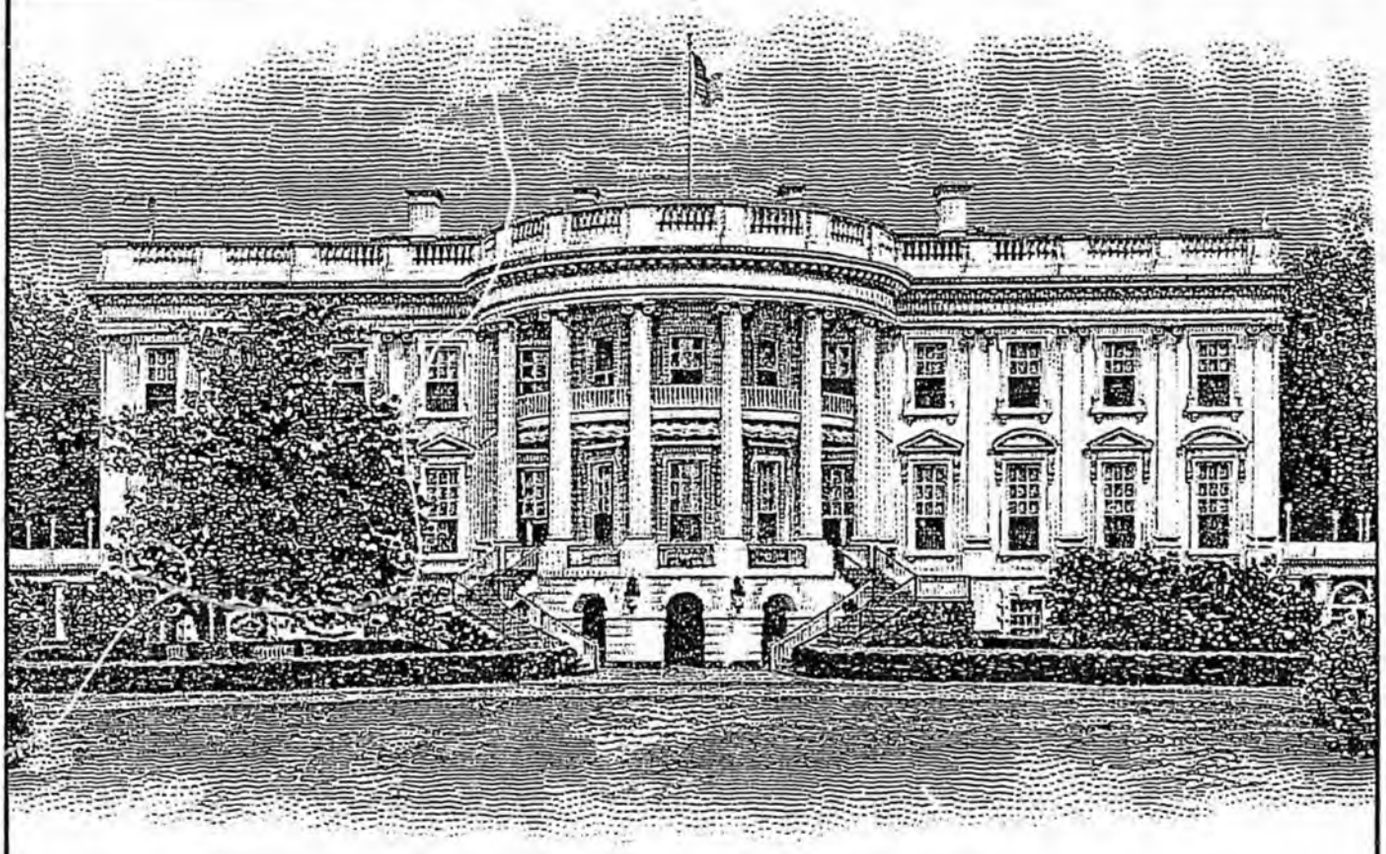
Source: "Impact of the Renewable Fuels Standard on the U.S. Agriculture Sector," John Urbanchuk, AUS Consultants, September 2002



Corn Utilized in Ethanol Production



Source: National Corn Growers Association



FISCAL YEAR 2004

ANALYTICAL PERSPECTIVES

BUDGET OF THE U.S. GOVERNMENT

Table 6–2. ESTIMATES OF TAX EXPENDITURES FOR THE CORPORATE AND INDIVIDUAL INCOME TAXES

(In millions of dollars)

		Corporations								Individuals							
		2002	2003	2004	2005	2006	2007	2008	2004–2008	2002	2003	2004	2005	2006	2007	2008	2004–2008
	National Defense																
1	Exclusion of benefits and allowances to armed forces personnel	.....	.....	.....	.....	.....	.....	.....	.....	2,190	2,210	2,240	2,260	2,290	2,310	2,330	11,430
	International Affairs																
2	Exclusion of income earned abroad by U.S. citizens	.....	.....	.....	.....	.....	.....	.....	.....	2,740	2,620	2,680	2,750	2,810	2,940	3,100	14,280
3	Exclusion of certain allowances for Federal employees abroad	.....	.....	.....	.....	.....	.....	.....	.....	760	800	840	880	930	980	1,030	4,660
4	Extraterritorial income exclusion	4,820	5,150	5,510	5,890	6,290	6,730	7,200	31,620	.....	.....	.....	.....	.....	.....	.....	.....
5	Inventory property sales source rules exception	1,470	1,540	1,620	1,700	1,790	1,880	1,980	8,970	.....	.....	.....	.....	.....	.....	.....	.....
6	Deferral of income from controlled foreign corporations (normal tax method)	7,000	7,450	7,900	3,400	8,930	9,550	10,210	44,990	.....	.....	.....	.....	.....	.....	.....	.....
7	Deferred taxes for financial firms on certain income earned overseas	1,950	2,050	2,130	2,190	2,260	960	0	7,540	.....	.....	.....	.....	.....	.....	.....	.....
	General Science, Space, and Technology																
8	Expensing of research and experimentation expenditures (normal tax method)	1,630	2,160	2,710	3,320	3,910	4,190	4,300	18,430	30	40	50	70	80	80	80	360
9	Credit for increasing research activities	6,810	5,590	4,950	2,890	1,240	520	170	9,770	60	50	40	20	0	0	0	60
	Energy																
10	Expensing of exploration and development costs, fuels	130	150	130	70	50	40	30	320	20	20	20	10	10	0	0	40
11	Excess of percentage over cost depletion, fuels	510	550	530	500	510	530	540	2,610	100	120	120	110	110	110	110	560
12	Alternative fuel production credit	1,500	900	500	500	500	500	200	2,200	60	40	20	20	20	20	10	90
13	Exception from passive loss limitation for working interests in oil and gas properties	.....	.....	.....	.....	.....	.....	.....	.....	10	10	10	10	10	10	10	50
14	Capital gains treatment of royalties on coal	.....	.....	.....	.....	.....	.....	.....	.....	100	110	110	120	120	130	140	620
15	Exclusion of interest on energy facility bonds	30	30	30	30	30	30	30	150	80	90	100	110	110	120	130	570
16	Enhanced oil recovery credit	300	310	320	330	330	340	350	1,670	30	30	30	30	30	30	40	160
17	New technology credit	100	180	250	270	270	270	270	1,330	0	0	0	0	0	0	0	0
18	Alcohol fuel credits [1]	20	20	20	20	20	20	20	100	10	10	10	10	10	10	10	50
19	Tax credit and deduction for clean-fuel burning vehicles	50	60	40	20	–10	–60	–60	–70	20	30	30	20	0	–10	–10	30
20	Exclusion from income of conservation subsidies provided by public utilities	.....	.....	.....	.....	.....	.....	.....	.....	80	80	80	80	80	80	80	400
	Natural Resources and Environment																
21	Expensing of exploration and development costs, nonfuel minerals	30	30	30	30	30	40	40	170	0	0	0	0	0	0	0	0
22	Excess of percentage over cost depletion, nonfuel minerals	240	240	250	260	270	270	280	1,330	20	20	20	20	20	20	20	100
23	Exclusion of interest on bonds for water, sewage, and hazardous waste facilities	110	110	120	120	120	130	130	620	340	370	420	460	490	520	550	2,440
24	Capital gains treatment of certain timber income	.....	.....	.....	.....	.....	.....	.....	.....	100	110	110	120	120	130	140	620
25	Expensing of multiperiod timber growing costs	240	250	260	260	270	280	280	1,350	120	120	120	120	130	130	130	630
26	Tax incentives for preservation of historic structures	160	170	180	190	200	210	220	1,000	40	40	50	50	50	50	60	260
	Agriculture																
27	Expensing of certain capital outlays	20	20	20	20	20	20	30	110	150	160	150	150	150	150	160	760
28	Expensing of certain multiperiod production costs	20	20	20	20	20	20	20	100	110	110	100	100	100	100	100	500
29	Treatment of loans forgiven for solvent farmers	.....	.....	.....	.....	.....	.....	.....	.....	10	10	10	10	10	10	10	50
30	Capital gains treatment of certain income	.....	.....	.....	.....	.....	.....	.....	.....	1,010	1,060	1,120	1,180	1,250	1,310	1,380	6,240
31	Income averaging for farmers	.....	.....	.....	.....	.....	.....	.....	.....	70	70	80	80	80	90	90	420
32	Deferral of gain on sale of farm refiners	10	10	10	10	10	10	20	60	.....	.....	.....	.....	.....	.....	.....	.....
	Commerce and Housing																
	Financial institutions and insurance:																
33	Exemption of credit union income	1,020	1,090	1,160	1,240	1,320	1,410	1,510	6,640	.....	.....	.....	.....	.....	.....	.....	.....
34	Excess bad debt reserves of financial institutions	0	0	0	0	0	0	0	0	.....	.....	.....	.....	.....	.....	.....	.....
35	Exclusion of interest on life insurance savings	1,770	1,800	1,830	1,860	1,890	1,920	1,950	9,450	15,920	17,330	18,910	20,610	22,500	24,430	26,360	112,810
36	Special alternative tax on small property and casualty insurance companies	10	10	10	10	10	10	10	50	.....	.....	.....	.....	.....	.....	.....	.....
37	Tax exemption of certain insurance companies owned by tax-exempt organizations	210	220	240	250	270	280	290	1,330	.....	.....	.....	.....	.....	.....	.....	.....
38	Small life insurance company deduction	100	100	100	100	100	100	100	500	.....	.....	.....	.....	.....	.....	.....	.....
	Housing:																
39	Exclusion of interest on owner-occupied mortgage subsidy bonds	210	220	230	230	240	250	260	1,210	660	740	820	910	970	1,020	1,100	4,820
40	Exclusion of interest on rental housing bonds	40	50	50	50	50	50	50	250	140	150	170	190	200	210	230	1,000
41	Deductibility of mortgage interest on owner-occupied homes	.....	.....	.....	.....	.....	.....	.....	.....	63,590	65,540	68,440	71,870	74,790	78,160	82,650	375,910
42	Deductibility of State and local property tax on owner-occupied homes	.....	.....	.....	.....	.....	.....	.....	.....	21,760	22,320	22,160	19,750	16,240	14,580	13,580	86,310

Table 6–2. ESTIMATES OF TAX EXPENDITURES FOR THE CORPORATE AND INDIVIDUAL INCOME TAXES—Continued

(In millions of dollars)

		Corporations								Individuals							
		2002	2003	2004	2005	2006	2007	2008	2004–2008	2002	2003	2004	2005	2006	2007	2008	2004–2008
136	Tax credit for corporations receiving income from doing business in U.S. possessions	2,240	2,240	2,240	2,200	1,300	0	0	5,740								
	Interest																
137	Deferral of interest on U.S. savings bonds									510	590	670	750	840	920	1,050	4,230
	Addendum: Aid to State and local governments:																
	Deductibility of:																
	Property taxes on owner-occupied homes									21,760	22,320	22,160	19,750	16,240	14,580	13,580	86,310
	Nonbusiness State and local taxes other than on owner-occupied homes									47,430	50,520	50,910	47,770	40,480	37,190	36,080	212,430
	Exclusion of interest on State and local bonds for:																
	Public purposes	6,170	6,360	6,550	6,750	6,950	7,160	7,370	34,780	19,080	20,420	20,760	20,970	20,860	20,370	20,990	103,950
	Energy facilities	30	30	30	30	30	30	30	150	80	90	100	110	110	120	130	570
	Water, sewage, and hazardous waste disposal facilities	110	110	120	120	120	130	130	620	340	370	420	460	490	520	550	2,440
	Small-issues	80	80	90	90	90	90	100	460	250	280	310	340	360	380	410	1,800
	Owner-occupied mortgage subsidies	210	220	230	230	240	250	260	1,210	660	740	820	910	970	1,020	1,100	4,820
	Rental housing	40	50	50	50	50	50	50	250	140	150	170	190	200	210	230	1,000
	Airports, docks, and similar facilities	170	170	180	180	190	200	200	950	520	580	650	710	760	800	860	3,780
	Student loans	60	60	60	60	70	70	70	330	180	200	230	250	270	280	300	1,330
	Private nonprofit educational facilities	140	150	150	160	160	170	170	810	440	490	550	600	650	680	730	3,210
	Hospital construction	290	300	310	320	330	340	350	1,650	910	1,020	1,130	1,240	1,320	1,400	1,500	6,600
	Veterans' housing	10	10	10	10	10	10	10	50	30	30	40	40	40	50	50	220
	Credit for holders of zone academy bonds	50	80	90	100	100	100	100	490								

[1] In addition, the partial exemption from the excise tax for alcohol fuels results in a reduction in excise tax receipts (in millions of dollars) as follows: 2002 $1,070; 2003 $1,140; 2004 $1,230; 2005 $1,320; 2006 $1,370; 2007 $1,400; and 2008 $1,430.

[2] The figures in the table indicate the effect of the child tax credit on receipts. The effect of the credit on outlays (in millions of dollars) is as follows: 2002 $5,060; 2003 $5,870; 2004 $5,860; 2005 $5,700; 2006 $7,630; 2007 $7,630; and 2008 $7,500

[3] The figures in the table indicate the effect of the earned income tax credit on receipts. The effect of the credit on outlays (in millions of dollars) is as follows: 2002 $27,830; 2003 $30,610; 2004 $31,380; 2005 $32,090; 2006 $33,450; 2007 $34,480; and 2008 $35,380.

Note: Provisions with estimates denoted normal tax method have no revenue loss under the reference tax law method. All estimates have been rounded to the nearest $10 million. Provisions with estimates that rounded to zero in each year are not included in the table.

United States
Department of
Agriculture

Office of
the Chief
Economist

Office of
Energy Policy
and New Uses

Agricultural
Economic
Report
Number 814

USDA

The Energy Balance of Corn Ethanol: An Update

Hosein Shapouri
James A. Duffield
Michael Wang

Provided by Senator Con Bunde

The Energy Balance of Corn Ethanol: An Update. By Hosein Shapouri, James A. Duffield, and Michael Wang. U.S. Department of Agriculture, Office of the Chief Economist, Office of Energy Policy and New Uses. Agricultural Economic Report No. 814.

Abstract

Studies conducted since the late 1970s have estimated the net energy value (NEV) of corn ethanol. However, variations in data and assumptions used among the studies have resulted in a wide range of estimates. This study identifies the factors causing this wide variation and develops a more consistent estimate. We conclude that the NEV of corn ethanol has been rising over time due to technological advances in ethanol conversion and increased efficiency in farm production. We show that corn ethanol is energy efficient as indicated by an energy output:input ratio of 1.34.

Keywords: Ethanol, net energy balance, corn production, energy.

About the Authors

Shapouri and Duffield are with USDA's Office of Energy Policy and New Uses, 300 7th Street, S.W., Room 361 Washington, DC 20024. Wang is with the Center for Transportation Research, Energy Systems Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, IL 60439. For more information about this report, call James Duffield, at 202-401-0523; Fax (202) 401-0533; E-mail: *Jduffield@oce.usda.gov*

July 2002

used in the production of corn-ethanol. We use both approaches in our analysis.

The energy balance issue first surfaced in the mid-1970s when ethanol began to receive attention as a gasoline extender. Studies during that time that analyzed the energy benefits of substituting ethanol for gasoline generally concluded that the net energy value (NEV, defined as energy content of ethanol minus fossil energy used to produce ethanol) of corn ethanol was slightly negative (Ethanol Study Committee, 1979; Chambers et al., 1979). In the late 1980s, the U.S. desire to reduce air pollution placed ethanol in the spotlight once again and energy balance studies resurfaced. About the same time, studies estimating the emissions of greenhouse gases from ethanol began to appear in the literature (DeLuchi, 1991; Ho, 1989; Marland and Turhollow, 1990). Although these studies focused on estimating the greenhouse gases associated with ethanol relative to gasoline, some of these studies also reported the NEV of ethanol. However, there was a considerable amount of variation in the findings of these reports. This wide variation relates to various assumptions about farm production and ethanol conversion. Furthermore, the various researchers used data from different time periods. Studies using older data tended to overestimate energy use because ethanol manufacturing and farm production technologies have become increasingly energy efficient over time. To make matters worse, it is often difficult to determine why results differ from study to study because the reports often lack certain details on their calculation procedures. The purpose of this paper is to identify the methodological differences creating the inconsistencies among study results and provide a more consistent estimate for the NEV of corn ethanol.

Table 1 shows the wide variation in the NEV estimates of several studies. Some studies use lower heating values (LHV) for measuring energy and others use higher heating values (HHV). Higher heating value, also called gross heating value, is the standard heat of combustion referenced to water in combustion exhaust as liquid water. Lower heating value, also called net heat of combustion, is the standard heat of combustion referenced to water in combustion exhaust as water vapor. In other words, the difference between HHV and LHV is the energy associated with condensation of the water vapor in the combustion products. Although these two methods can produce slightly different results, either approach can be used. However, once a method is chosen, it should be used consistently throughout the study for all energy calculations.

Table 1—Energy input assumptions of corn-ethanol studies

Study/year	Corn yield	Nitrogen fertilizer application rate	Nitrogen fertilizer production	Corn ethanol conversion rate	Ethanol conversion process	Total[1] energy use	Coproducts[1] energy credits	Net[1] energy value
	Bu/acre	*lb/acre*	*Btu/lb*	*gal/bu*	*Btu/gal*	*Btu/gal*	*Btu/gal*	*Btu/gal*
Pimentel (1991)	110	136	37,551	2.50	73,687	131,017 (LHV)	21,500	-33,517
Pimentel (2001)	127	129	33,547	2.50	75,118	131,062 (LHV)	21,500	-33,562
Keeney and DeLuca (1992)	119	135	37,958	2.56	48,470	91,196 (LHV)	8,078	-8,438
Marland and Turhollow (1990)	119	127	31,135	2.50	50,105	73,934 (HHV)	8,127	18,154
Lorenz and Morris (1995)	120	123	27,605	2.55	53,956	81,090 (HHV)	27,579	30,589
Ho (1989)	90	NR	NR	NR	57,000	90,000 (LHV)	10,500	-4,000
Wang et al. (1999)	125	131	21,092	2.55	40,850	68,450 (LHV)	14,950	22,500
Agri. and Agri-Food Canada (1999)	116	125	NR	2.69	50,415	68,450 (LHV)	14,055	29,826
Shapouri et al. (1995)	122	125	22,159	2.53	53,277	82,824 (HHV)	15,056	16,193
This study (2002)	125	129	18,392	2.66	51,779	77,228 (HHV)	14,372	21,105

NR: Not reported
LHV: Low heat value = 76,000 Btu per gallon of ethanol. Keeney and DeLuca used 74,680 Btu per gallon of ethanol.
HHV: High heat value = 83,961 Btu per gallon of ethanol. Lorenz and Morris used 84,100 Btu per gallon of ethanol.
[1] The midpoint or average is used when studies report a range of values.

Conclusions

We conclude that the NEV of corn-ethanol is positive when fertilizers are produced by modern processing plants, corn is converted in modern ethanol facilities, and farmers achieve average corn yields. Our NEV estimate of over 21,000 Btu per gallon could be considered conservative, since it was derived using the replacement method for valuing coproducts, and it does not include energy credits for plants that sell carbon dioxide. Corn ethanol is energy efficient, as indicated by an energy ratio of 1.34; that is, for every Btu dedicated to producing ethanol there is a 34-percent energy gain. Furthermore, producing ethanol from domestic corn stocks achieves a net gain in a more desirable form of energy, which helps the United States to reduce its dependence on imported oil. Ethanol production utilizes abundant domestic energy feedstocks, such as coal and natural gas, to convert corn into a premium liquid fuel. Only about 17 percent of the energy used to produce ethanol comes from liquid fuels, such as gasoline and diesel fuel. For every 1 Btu of liquid fuel used to produce ethanol, there is a 6.34 Btu gain.

When looking at past NEV studies, it appears that energy requirements for producing a gallon of ethanol are falling over time. One of the primary factors for this increase in energy efficiency is the increase in U.S. corn yields. When ethanol first emerged as a gasoline extender in the 1970s, corn yield was averaging about 90 bushels per acre. This study used 1995-97 average corn yield of 125 bushels per acre, which is about 39 percent greater than the yields of the 1970s. Corn yields continue to rise in the United States—the average corn yield per acre for the past 3 years (1999-2001) was about 135 bushels per acre. If the 1999-2001 average corn yield were used in this analysis, the total energy used to produce a bushel of corn would decline by more than 4,200 Btu. As corn yields increase over time, we can expect the energy balance of corn ethanol to increase, as well. Other major factors causing this increase in energy efficiency are related to the energy-saving technologies adopted by ethanol producers and manufacturers of fertilizers and other farm inputs. Higher energy costs will likely continue to provide incentives for these industries to become more energy efficient, which will continue to push the NEV of corn ethanol higher.