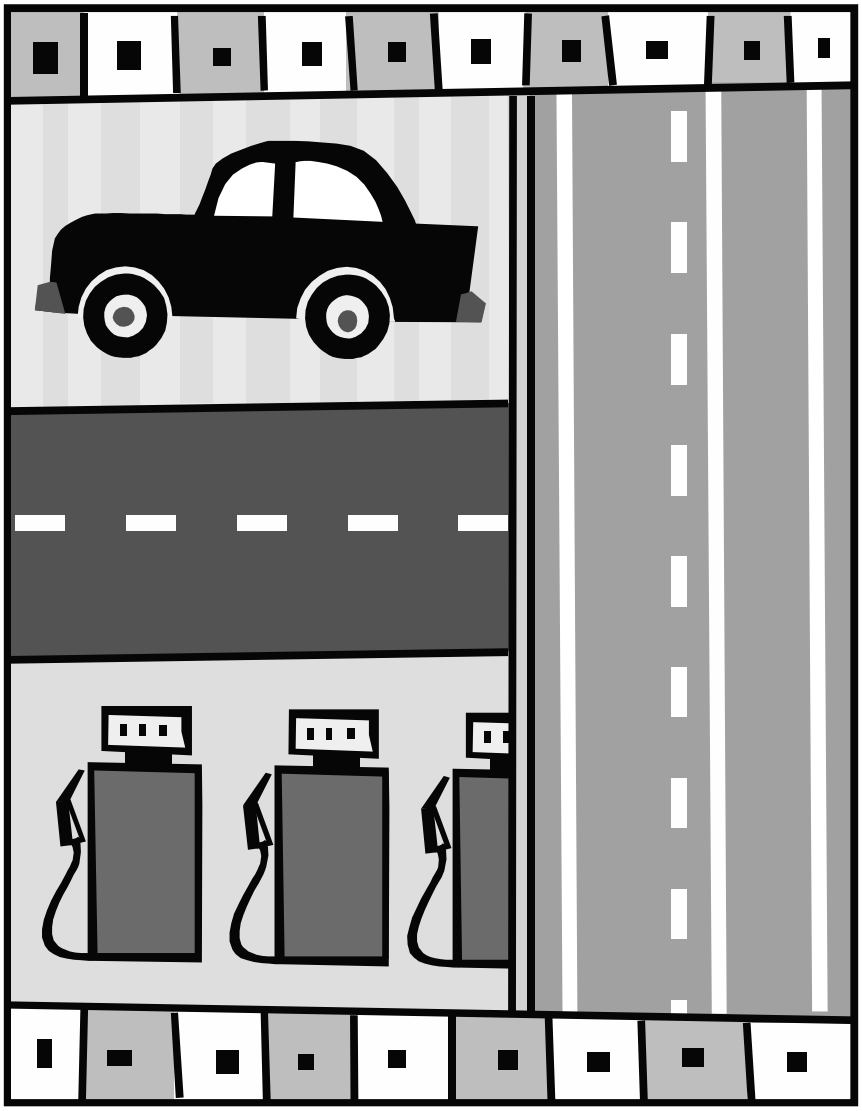
Ethanol and Biodiesel:

Questions and Answers



John G. Morgan
Comptroller of the Treasury
Office of Research
State of Tennessee

March 2005

STATE OF TENNESSEE

John G. Morgan
Comptroller

COMPTROLLER OF THE TREASURY

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March 31, 2005

The Honorable John S. Wilder
Speaker of the Senate
The Honorable Jimmy Naifeh
Speaker of the House of Representatives
and
Members of the Tennessee General Assembly

Ladies and Gentlemen:

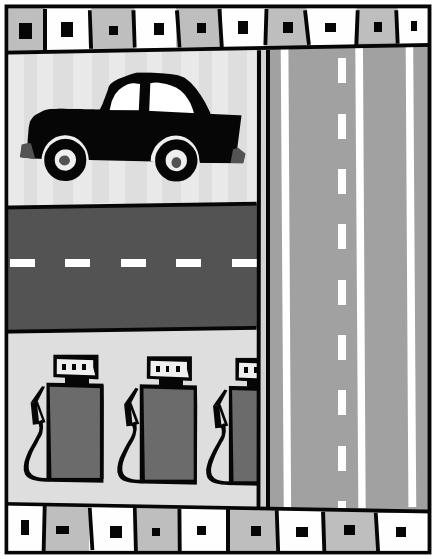
Transmitted herewith is the Office of Research's study of alternative fuels as requested by the General Assembly in Public Chapter 891 of 2004. The study looks at ethanol and biodiesel fuels in particular, and considers their potential effects on consumption of Tennessee agricultural products. The study also examines biofuels' impact on automotive emissions and infrastructure issues. I hope that this report provides useful information that will assist policymakers with decisions related to alternative fuels.

Sincerely,

John G. Morgan
Comptroller of the Treasury

Ethanol and Biodiesel:

Questions and Answers



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Office of Research

State of Tennessee

March 2005

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Executive Summary

Interest in alternative vehicles and fuels for transportation is growing because of oil price increases and the need to reduce pollutants that affect air quality and public health. Automakers are developing new vehicles able to use ethanol, biodiesel, hydrogen, low sulfur diesel, propane, compressed natural gas (CNG), liquid propane gas (LPG), and electricity to meet these needs.

Ethanol is ethyl alcohol – the same alcohol as in beer, wine, and other alcoholic beverages. In 2004, U.S. ethanol producers made more than 3,800 million gallons of ethanol. In the 1980s, Tennessee gasoline stations introduced a blend of 10 percent ethanol and 90 percent gasoline, known then as gasohol. Today, the terminology for a 10 percent ethanol blend is E10; an 85 percent blend is E85.

Biodiesel is diesel fuel made from soybeans or waste grease, also known as yellow grease. Biodiesel producers made more than three million gallons from soybeans in the United States in 2004. Producers label biodiesel blend with the letter "B"and the ratio of biodiesel to petroleum diesel. In the United States, common blends used in available diesel engine technology include B2, B5, and B20. People also use B100 in selected applications.

Tennessee legislators requested the Comptroller of the Treasury, in Public Chapter 891 of 2004, to study the use of alternative fuels, specifically gasohol and biodiesel, to enhance consumption of Tennessee agricultural products; revive economically depressed areas and create new jobs; promote the use of clean, efficient, and renewable energy; attract new industry to Tennessee; and reduce dependence on foreign oil.

The report finds:

Agriculture and oil officials told research staff that Tennessee farmers do not grow enough corn to supply an ethanol plant and that additional acreage devoted to corn production is highly unlikely. Tennessee is a net importer of corn because the state's corn production is insufficient to satisfy demand. Although some persons interviewed believe that corn farmers might receive a premium price for their crops if an ethanol plant were nearby, others said that farming is also dependent on other factors. (See pages 6-8.)

Other states have experienced economic boosts in communities where ethanol plants are located. However, ethanol producers may have to face challenges from imported Brazilian ethanol, questions about the real energy costs of raising corn and manufacturing ethanol, and environmental concerns. Also, several economic and policy considerations suggest Tennessee should exercise caution when considering subsidizing ethanol production. (See pages 8-12.)

The Energy Information Administration (EIA) reports excess production capacity in the biodiesel industry, but projects a demand for almost twice today's production in 2010 and almost three times today's production (470 million gallons) in 2020 (630 million gallons). Unless soybean oil prices decline dramatically, producers cannot make

biodiesel in large quantities at a cost competitive with petroleum diesel. By several measures, biodiesel blends perform better than petroleum diesel, but its relatively high production costs and the limited availability of raw materials continue to limit its commercial use. Biodiesel made from yellow grease is closer to being cost competitive with petroleum diesel than is biodiesel from soybean oil, but the available supply of yellow grease will probably limit its use for biodiesel production. The largest market for biodiesel probably will be as a fuel additive, especially for school and transit buses, to reduce emissions of particulates and unburned hydrocarbons. (See pages 12-14.)

Experts disagree as to whether using E10 improves or worsens Tennessee's particular air pollution problems. E10 works well in areas with carbon monoxide problems. Tennessee has no carbon monoxide nonattainment areas, but some areas of the state do not comply with other EPA standards. Nitrogen oxides cause pollution problems in the southeastern states. E85, however, used in engines designed for it has been shown to reduce nitrogen oxides. (See pages 14-15.)

Most experts concur that biodiesel use does, in fact, reduce nitrogen oxides and particulate matter. Heavy duty diesel vehicles are the major source of these emissions. Biodiesel is the first alternative fuel to have fully completed the health effects testing requirements of the Clean Air Act. (See pages 15-16.)

Experts disagree on whether ethanol pollutes groundwater. A 2001 report prepared by the New England Interstate Water Pollution Control Commission and the Northeast States for Coordinated Air Use Management expressed some concerns about ethanol, saying that ethanol can make other gasoline components more soluble in groundwater and it can delay the degradation of more toxic components in gasoline when present in a gasoline spill. However, a study for the Governor's Ethanol Coalition concluded that ethanol poses no threat to surface and groundwater, saying that ethanol rapidly biodegrades. (See pages 16-17.)

Experts disagree on whether using E10 harms engines. Some say that vehicles built since 1994 will tolerate E10, while others caution that it may harm rubber and plastic components. Some automakers advise that distributors must take care to ensure that blends contain no more than 10 percent ethanol to avoid damaging the engines of cars that are not flexible fuel vehicles. (See pages 17-18.)

B20 generally will not harm an engine. All major U.S. diesel engine manufacturers endorse biodiesel use. It is low in sulfur and adds lubricity, which reduces engine wear. However B100 has some shortcomings, including its thickening in cold weather and making engines difficult to start and its lesser fuel efficiency. (See pages 18-19.)

Unlike many midwestern states, Tennessee lacks an infrastructure to distribute ethanol. Experts disagree on the best method to transport ethanol. Producers can transport biodiesel through the current diesel distribution system. (See pages 19-21.)

Forty-three states have a variety of incentive options to consider for promoting biofuels. Tennessee offers no incentives. However, a report by the National Conference of State Legislatures says that state alternative fuel incentives have not stimulated widespread conversion to alternative fuels in the US. (See pages 21-26.)

Legislative Recommendations (See page 27.)

The General Assembly should evaluate the viability of markets and infrastructures when considering state subsidies for ethanol or biodiesel production. According to several persons interviewed, Tennessee farmers do not produce enough corn to support a substantial plant for renewable fuels. The higher ethanol-producing states grow extensive corn crops to provide feedstock for their plants. Additionally, unless soybean oil prices decline dramatically, producers cannot make biodiesel in large quantities at a cost that is competitive with petroleum diesel.

If the General Assembly decides to provide incentives for ethanol or biodiesel, it may wish to include incentives for consumers. Providing incentives to consumers will help create markets for renewable fuels. Small numbers of vehicles will not make a difference in overall air quality. Alternative fuel vehicles have yet to make major inroads into the mainstream public vehicle fleet.

Administrative Recommendations

The following administrative recommendations would allow the state to pilot the use of renewable fuels to test the feasibility of alternative fuel options to reduce the state's reliance on petroleum products:

The Division of Energy within the Department of Economic and Community Development should encourage local governments to begin using biodiesel in their diesel vehicles whenever feasible.

State departments, such as Transportation, should use biodiesel in their diesel vehicles whenever possible.

The Department of General Services should consider finding sources of E85 for each grand division of the state and encourage employees driving the state's flexible fuel vehicles to purchase E85 when possible.

See Appendix E for responses from the Departments of Agriculture, Economic and Community Development, Environment and Conservation, and Transportation, and the Oak Ridge National Laboratory.

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"The fuel of the future is going to come from fruit like that sumac out by the road, or from apples, weeds, sawdust – almost anything," he said.

Henry Ford to a New York Times reporter in 1925

Introduction

Interest in alternative vehicles and alternative fuels for transportation is growing across the world because of oil price increases and the need to reduce pollutants that affect air quality and public health. Automakers are developing new vehicles able to use ethanol, biodiesel, hydrogen, low sulfur diesel, propane, compressed natural gas (CNG), liquid propane gas (LPG), and electricity to meet these needs. Tennessee legislators requested the Comptroller of the Treasury, in Public Chapter 891 of 2004, to study the use of alternative fuels, specifically gasohol and biodiesel, to enhance consumption of Tennessee agricultural products; revive economically depressed areas and create new jobs; promote the use of clean, efficient, and renewable energy; attract new industry to Tennessee; and reduce dependence on foreign oil.

Ethanol is ethyl alcohol – the same alcohol as in beer, wine, and other alcoholic beverages. In 2004, U.S. ethanol producers made more than 3,800 million gallons of ethanol. In the 1980s, Tennessee gasoline stations introduced a blend of 10 percent ethanol and 90 percent gasoline, known then as gasohol. Today, the terminology for a 10 percent ethanol blend is E10; an 85 percent blend is E85. Although E85 is available to several entities with fleet vehicles that have their own fuel supplies, the only station selling E85 to the public in Tennessee is located in Nashville. A glossary is in Appendix C.

The Energy Information Administration predicts that by 2025, petroleum demand will increase by 47 percent and the renewable energy supply will increase by 65 percent. Ethanol production increases each year. Twenty states have 85 plants and Tennessee currently ranks 10th in statewide production. According to the American Farm Bureau Federation, as of August 2004, farmers owned 39 of the 85 plants as well as nine of 12 plants under construction. Dozens of additional plants are in various stages of production; the majority are farmer-driven projects.[1]

Biodiesel is diesel fuel made from soybeans or waste grease, also known as yellow grease. Biodiesel producers made more than three million gallons from soybeans in the United States in 2004. Producers label biodiesel blend with the letter "B" and the ratio of biodiesel to petroleum diesel. In the United States, common blends used in available diesel engine technology include B2, B5, and B20. People also use B100 in selected applications. B20 is publicly available at a few stations in east Tennessee.

According to the National Biodiesel Board, as of December 2004, the United States has 29 active biodiesel plants in 13 states. Investors have proposed another 25 plants in 17 states, including ones in Sevierville and Moscow, Tennessee.[2] A representative of Tennessee

[1] Presentation to the Tennessee Farm Bureau, Council of Presidents, by Troy Bredenkamp, Director, Congressional Relations, American Farm Bureau Federation, August 14, 2004.

[2] Current and Potential Biodiesel Production, http://www.biodiesel.org/buying biodiesel//producers_marketers/producersmap-existingandpotential.pdf. Accessed February 35, 2005.

Soybeans shared recent information about additional plant proposals for Trimble, Knoxville, and Manchester.[3]

Legislation

In 1982, the General Assembly passed Public Chapter 912, providing a four cent per gallon tax break to consumers buying what people then called gasohol. The federal government also provided a five cent per gallon tax break. The public chapter provided that the state tax break would expire in December 1988.

In 2003 and 2004, legislators once again introduced legislation to encourage ethanol use. HB3067 (Hagood)/SB2664 (McLeary), would have established the Tennessee Agricultural Ethanol Production Act of 2004 to:

1. encourage the use of corn and other agricultural products for energy purposes and thereby encourage the establishment of a substantial market for agricultural products in Tennessee;
2. revive economically depressed areas and create a significant number of new jobs;
3. encourage participation of the private sector in the development of a production system for alcohol fuels within the state of Tennessee;
4. promote the use of clean, efficient and renewable energy in the state of Tennessee and the United States;
5. attract new industry to Tennessee and thereby encourage the investment of capital in Tennessee; and
6. reduce the dependence of the state of Tennessee and the United States on imported petroleum by using alternate, renewable energy sources.

The bill as introduced would have appropriated $6 million to the Department of Revenue for FY2004-05 to pay incentives of 30 cents per gallon for ethanol producers who purchase Tennessee grain to make motor fuel that contains at least 10 percent ethanol (E10). Gasoline tax revenues would have funded the appropriation. The bill also would have appropriated to the Department of Revenue an amount sufficient to administer the program.

House and Senate amendments No. 1 would have appropriated $6 million to the Department of Revenue, plus an amount to administer the bill, from the state general fund. The amendment would have provided a 30 cent per gallon incentive to jobbers (distributors) for each gallon of E10 sold to a retailer. The incentives would be available to jobbers, rather than producers, who provided ethanol made from corn grown in Tennessee unless Tennessee corn was not available.

Senate amendment No. 2 would have made the act applicable only if the Air Pollution Control Board implemented an ethanol program to obtain compliance with air standards set by the Environmental Protection Agency and if the General Assembly appropriates the necessary funds to implement the act by June 30, 2005.

House amendment No. 2 and Senate amendment No. 3 added biodiesel to the bill.

[3] Email to the author from Parks Wells, Executive Director, Tennessee Soybeans, November 9, 2004.

House amendment No. 3 and Senate amendment No. 4, which became Public Chapter 891 of 2004, deleted the language from all previous versions of the bill and required the Comptroller to submit a report by February 1, 2005 with the following objectives:

- to review the use of alternative fuels such as biodiesel and gasohol as a means to enhance consumption of Tennessee products;
- to include an explanation of any practical, technical, and scientific benefits for using biodiesel and gasohol in reducing air pollutants and emissions;
- to include an explanation of the effects of biodiesel and gasohol on contemporary motor vehicle engines;
- to include an analysis and recommendations concerning how to facilitate industries that would manufacture, produce, and distribute biodiesel and gasohol in Tennessee; and
- to include a plan for using any available funds for implementing a program for the encouragement of the production, distribution, and use of biodiesel and gasohol and the cost benefits of such a plan.

Methodology

The report is based on:

- Review of state and federal statutes,
- Interviews with legislators and officials of state departments, including Agriculture, Environment and Conservation, Transportation, and Economic and Community Development, and the University of Tennessee Center for Profitable Agriculture,
- Interviews with proponents and opponents of increasing biofuels and their production or use in Tennessee,
- Review of studies, newspaper articles, and other literature,
- Site visits to a gasoline terminal and an ethanol plant, and
- Technical assistance from the U.S. Department of Energy through Oak Ridge National Laboratory.

Background

Federal Legislation

In 1990, Congress amended the Clean Air Act to establish two programs for reducing air pollution from road-going vehicles by requiring changes in the fuel formulation sold in certain designated areas. The Reformulated Gasoline Program (RFG) intended to reduce smog-forming pollutants such as nitrogen and sulfur oxides. The Oxygenated Fuels Program was to reduce emissions of carbon monoxide, which is more prevalent in winter. Meeting the requirements of both programs meant that gasoline refiners selling in the affected markets had to add oxygenates to their fuels.

In the late 1980s studies showed that ethanol and other oxygenates dramatically reduced automotive carbon monoxide emissions and to a lesser degree hydrocarbon emissions. As a result, several western states adopted requirements to use oxygenated gasoline to reduce carbon monoxide emissions.

The two substances most widely used as oxygenates are methyl tertiary butyl ether (MTBE) and ethanol. MTBE is made from methanol and is cheaper. However, after a decade, it has

shown some disadvantages. One is its tendency to leak from storage tanks and contaminate groundwater. Another is that MTBE evaporates readily and breathing its fumes is unhealthy and may even lead to cancer.[4] Although the Environmental Protection Agency has not banned MTBE, some states (such as California, Connecticut, and New York) have, resulting in a demand for ethanol, the only practical substitute.

Congress passed the Energy Policy Act (EPAct) in October 1992 to enhance the nation's energy security and improve environmental quality. The act addresses energy supply and demand, including energy efficiency, alternative fuels, and renewable energy, as well as the more traditional energy forms such as coal, oil, and nuclear power.

Several titles of the EPAct encourage the use of alternative fuels not derived from petroleum that could help reduce dependence on imported oil for transportation. The EPAct defined alternative fuels to include:

- methanol, ethanol, and other alcohols,
- blends of 85 percent or more of alcohol with gasoline,
- natural gas and liquid fuels produced domestically from natural gas,
- propane,
- coal-derived liquid fuels, and
- hydrogen and electricity.

The EPAct's alternative fuels activities use both voluntary and regulatory approaches to encourage changes for a self-sustaining alternative fuel market. The Department of Energy's Clean Cities program implements the EPAct's voluntary activities to create markets for alternative fuels and alternative fuel vehicles through public/private partnerships in more than 80 cities. Tennessee has two Clean Cities programs, one each in east and middle Tennessee. As of January 2005, East Tennessee has five public biodiesel stations located in Alcoa, Maryville, Newport, Chattanooga, and Loudon. Additionally, several Tennessee entities, including Oak Ridge National Laboratory, Eastman, Alcoa, Sevier Farmers Co-op, Waste Management of Knoxville, and the Knoxville Utilities Board, have converted all or most of their fleet vehicles to E85 or biodiesel.

The EPAct also requires certain entities that operate fleets of light duty vehicles to purchase alternative fuel vehicles:

- State governments and alternative fuel providers,
- Federal government, and
- Private entities and local governments.

The State and Alternative Fuel Provider Program requires state governments and alternative fuel provider fleets to purchase alternative fuel vehicles as a percentage of their annual light duty vehicle acquisitions. Additionally, fuel provider fleets must fuel their vehicles with alternative fuel whenever possible. Fleets must report annually to the Department of Energy on their compliance with the regulations. This program applies only to fleets with more than 50 light duty vehicles located in one of 125 designated metropolitan areas.

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[4] Steve Thompson, "Clean Air Act Kickstarted Ethanol," *Rural Cooperatives*, July/August 2004, p. 16.

The EPAct requires 75 percent of a federal fleet's new light duty vehicle purchases to be alternative fuel vehicles. An April 2001 Executive Order establishes a goal of reducing petroleum use by 20 percent by 2005, compared to 1999.

The EPAct gave the Department of Energy the authority to impose requirements on private and local government fleets. Covered fleets could potentially include those with more than 50 vehicles, including urban buses and law enforcement vehicles within 125 designated metropolitan areas.[5]

In January 2004, the Department of Energy published a final rule announcing its decision not to implement an alternative fuel vehicle mandate for private fleets. The Department of Energy determined that implementation of the rule would not achieve the EPAct's petroleum replacement goals because it would not appreciably increase the percentage of transportation motor fuel that is an alternative replacement fuel.[6]

One EPAct challenge is a lack of infrastructure to provide alternative fuels. Nashville has the sole gas station in the state that provides E85. East Tennessee has four stations that sell biodiesel. Tennessee governmental entities (state, local, and utilities) own about 8,000 fleet vehicles that can operate on a variety of fuels, mostly E85 and natural gas. Tennessee state government owns approximately 1,000 of these vehicles. Few local governments use alternative fuels.[7]

Federal Subsidies and Incentives

In 1986, Congress passed legislation amending the EPAct that provided a 54 cent per gallon tax credit to ethanol blenders (Section 29 of the IRS Code), as well as a motor fuel excise tax credit. The IRS tax credit does not extend to farmers for producing corn or to ethanol production facilities unless the facility blends its product with gasoline. Gasoline distribution facilities generally blend the fuels.

The 108th Congress introduced several ethanol-related bills to address rural revitalization, restrictions on ethanol imports, incentives for alternative fuels and alternative fuel vehicles, and to encourage and accelerate production, sale, and use of fuels and vehicle technologies. Some have passed while others are pending.[8]

Title II of the Energy Tax Incentives Act of 2003 provides alternative motor vehicle and fuel incentives. Title VIII of the Act supports and builds upon an IRS tax credit for ethanol blenders passed in 1986 by providing tax incentives for renewable energy. Title VIII also provides a new credit for qualified biodiesel fuel mixtures and creates an ethanol excise tax credit.

In October 2004, the President signed the American Jobs Creation Act of 2004, introduced as H.R. 4520, which included a biodiesel tax incentive to increase demand. The credit equates to

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[5] EPAct Fleet Information and Regulations, US Department of Energy, Office of Transportation Technologies, Fact Sheet, April 2001.

[6] *http://www.eere.energy.gov/vehicleandfuels/epact/pdfs/plf_final.pdf*. Accessed August 12, 2004.

[7] Interview with Cynthia Oliphant and Terry Ellis, Division of Energy, Department of Economic and Community Development, and Dave Pelton, Clean Cities of Middle Tennessee, August 8, 2004.

[8] Renewable Fuels Association, http://www.ethanolrfa.org/leg.shtml. Accessed October 27, 2004.

one penny per percent of biodiesel in a fuel blend made from agricultural products. The incentive goes to blenders, but is to be passed on to the consumer. The Jobs Act provisions include both qualified ethanol and biodiesel fuel mixtures.[9]

Questions and Answers

Agricultural Issues

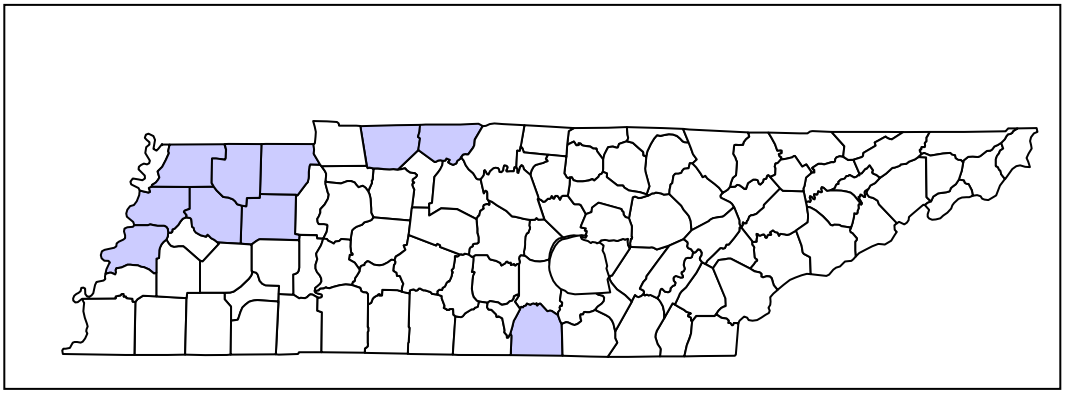
Ethanol from corn

Q: Would ethanol production in Tennessee help the state's farmers?

A: Agriculture and oil officials told research staff that Tennessee farmers do not grow enough corn to supply an ethanol plant and that additional acreage devoted to corn production is highly unlikely. Tennessee is a net importer of corn because the state's corn production is insufficient to satisfy demand. Although some persons interviewed believe that corn farmers might receive a premium price for their crops if an ethanol plant were nearby, others said that farming is also dependent on other factors.

The traditional crop mix in Tennessee is corn and soybeans, which farmers rotate each year. Tennessee ranked 17th in corn grain production in 2002 with 66,340,000 bushels and 27th in corn silage production with 825,000 tons. Most Tennessee corn is used for livestock feed. The top corn producing counties were Obion, Weakley, Gibson, Henry, Dyer, Robertson, Carroll, Franklin, Lauderdale, and Montgomery. See Exhibit 1. Exhibit 2 shows Tennessee's top agricultural products, with corn and soybeans responsible for eight and nine percent respectively.[10]

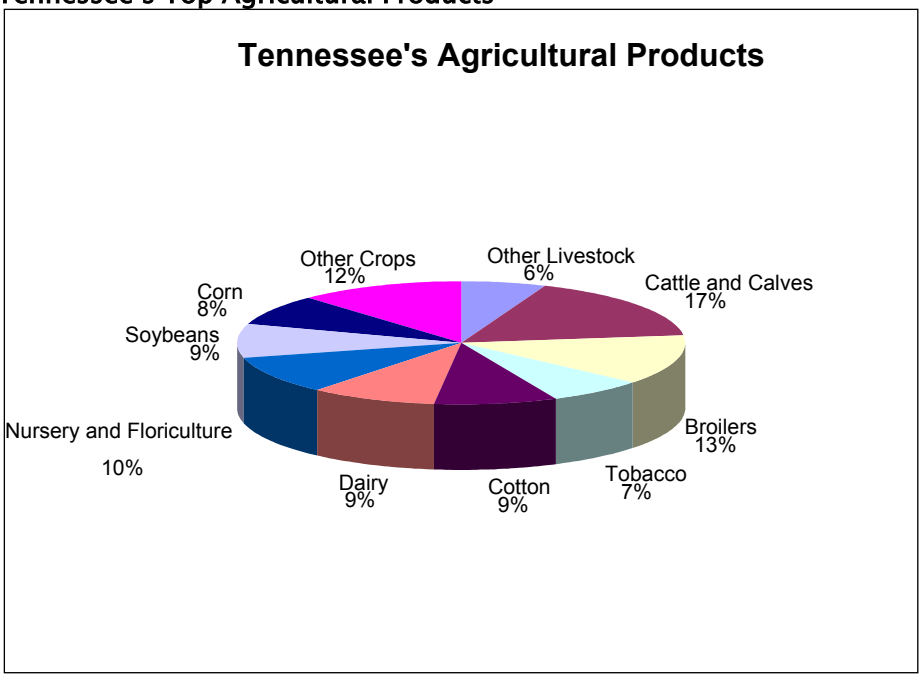
Exhibit 1: Tennessee's Top Corn Producing Counties



Source: Tennessee Agriculture 2003, Department Report and Statistical Summary.

[9] Committee on Ways and Means, "Conference Report on H.R. 4520, The American Jobs Creation Act of 2004."
[10] *Tennessee Agriculture 2003*, Department Report and Statistical Summary, pp. 17-20.

Exhibit 2: Tennessee's Top Agricultural Products



Source: Tennessee Department of Agriculture website, http://www.state.tn.us/agriculture/agricult/index.htm.

Exhibit 3 shows the number of acres planted with corn from 2000 to 2004. Representatives from the Department of Agriculture and the Farm Bureau told research staff that Tennessee farmers probably will not increase the number of acres planted in corn.

Exhibit 3: Tennessee Acres Planted with Corn

Year	Corn
2000	650,000
2001	680,000
2002	690,000
2003	710,000
2004	680,000

Source: Farm Facts, Tennessee Agricultural Statistics, July 23, 2004, and Farm Facts, Volume 05, Number 02, January 25, 2005.

Some farmers in east Tennessee could grow corn, but not in areas where they currently grow tobacco because the terrain is not conducive to corn. Tobacco and cotton farmers could convert some land in middle and west Tennessee to corn and soybeans, but it is not likely. Tobacco farmers in middle Tennessee could change their crops, but land planted in tobacco gets a better yield, thus income, per acre than would corn or soybeans. Farm Bureau officials believe that cotton farmers in west Tennessee are unlikely to change crops because of their investment in machinery to grow and gin cotton.[11]

[11]Interview with Julius Johnson, Rhedona Rose, Stefan Maupin, Joe Pearson, and Nathan Coleman, Tennessee Farm Bureau, August 9, 2004.

Two principal co-products of ethanol production are:

- Distillers' dried grains, sometimes known as DDGS, and
- Carbon dioxide (CO^2), which the poultry industry uses to make dry ice to quick freeze chickens to reduce shrinkage.[12]

A.E. Staley, a Loudon County business, produces ethanol as a co-product of high fructose corn syrup, the plant's primary product. However, the Staley company buys its corn from Illinois because it is easier and less expensive for the company to obtain its feedstock by train or barge than from Tennessee farmers. A Staley representative told research staff that the plant once used some Tennessee corn, but stopped because the corn had stress fungus.[13]

Department of Agriculture and Farm Bureau officials told Office of Research staff that additional ethanol production would raise the price of corn by three to 20 cents a bushel or at least stabilize the price. However, the price of corn fluctuates frequently, mainly because farming is weather-dependent. Additionally, the amount of corn planted annually depends on futures sold the previous year by the Chicago Board of Trade.

Although farmers would likely not grow additional corn for ethanol, they could receive premium prices for their corn as well as additional income for the ethanol if they owned the plant and controlled the commodity and the marketing agreements. Additionally, they would still receive their feed sales. Scientists are researching use of distillers' dried grains as livestock feed for dairy cattle. Farmers now use it for beef cattle and laying chickens. An ethanol plant would not reduce the feed availability for livestock, nor should it raise the price of feed because ethanol producers use the same corn for both ethanol and feed. Cattle farmers might benefit from an ethanol plant because distillers' dried grains could be cheaper than the whole grain they currently use.[14]

Ethanol plants

Q: Should Tennessee government subsidize ethanol production?

A: Other states have experienced economic boosts in communities where ethanol plants are located. However, ethanol producers may have to face challenges from imported Brazilian ethanol, questions about the real energy costs of raising corn and manufacturing ethanol, and environmental concerns. Also, several economic and policy considerations suggest Tennessee should exercise caution when considering subsidizing ethanol production:

- The ethanol industry depends heavily on the federal Volumetric Excise Tax Credit. If Congress eliminated or decreased this tax credit, ethanol demand would almost certainly decline significantly.

- It is debatable economically whether state government should enact special subsidies that favor one specific crop (corn) or a specific industry (ethanol)

[12] Interviews with Ed Harlan, Agribusiness Development Coordinator, Tennessee Department of Agriculture, July 28, 2004 and September 23, 2004.
[13] Telephone conversation with Mike Slimbarski, plant manager, A.E. Staley Company, December 13, 2004.
[14] Interviews with Ed Harlan, Agribusiness Development Coordinator, Tennessee Department of Agriculture, July 28, 2004 and September 23, 2004.

over others, especially because just 10 companies produce about 64 percent of ethanol nationally. The five largest companies produce about 52 percent of all ethanol.

- Although ethanol subsidies may lead to higher prices for corn farmers, these higher corn prices will be paid by consumers.

- One goal of ethanol subsidies is often to support or increase the price of corn while increasing corn production. However, ethanol demand is highly dependant on its price relative to gasoline. Higher corn prices resulting from ethanol subsidies may lead to over-production of corn, thus stabilizing or decreasing corn prices. However, if corn production remains constant, higher corn prices may lead to a higher cost for ethanol relative to gasoline, which may decrease demand for corn to produce ethanol.

In 2004, the General Assembly passed a Cooperative Processors' bill (Public Chapter 534), which establishes a new business structure similar to a limited liability company, in anticipation of farmers building an ethanol plant as well as for dairy farmers and other farm cooperatives.[15]

An ethanol plant should produce 40 million gallons a year to be profitable and would use between 15 million and 16 million bushels of corn a year.[16] The Department of Agriculture expected Tennessee's average corn yield in 2004 to be 140 bushels per acre.[17] One bushel of corn yields 2.5 to 2.7 gallons of ethanol from the starch component of corn.

As shown in Exhibit 4, as of January 2005, the U.S. projected annual ethanol production capacity was almost 4,400 million gallons per year. Tennessee ranks tenth in the country in ethanol production capacity with the Staley plant's current capacity of 67 million gallons per year. Tennessee farmers do not produce enough corn to support a substantial plant for renewable fuel. The higher ethanol-producing states grow extensive corn crops to provide feedstock for their plants.

Exhibit 4: Ethanol Production Capacity Ranked by State as of January 2005

Rank	State	Ethanol Production Capacity (million gallons/year)
1	Iowa	1,262.5
2	Illinois	816
3	Minnesota	523.6
4	Nebraska	523
5	South Dakota	456
6	Wisconsin	210
7	Kansas	149.5
8	Indiana	102
9	Missouri	100

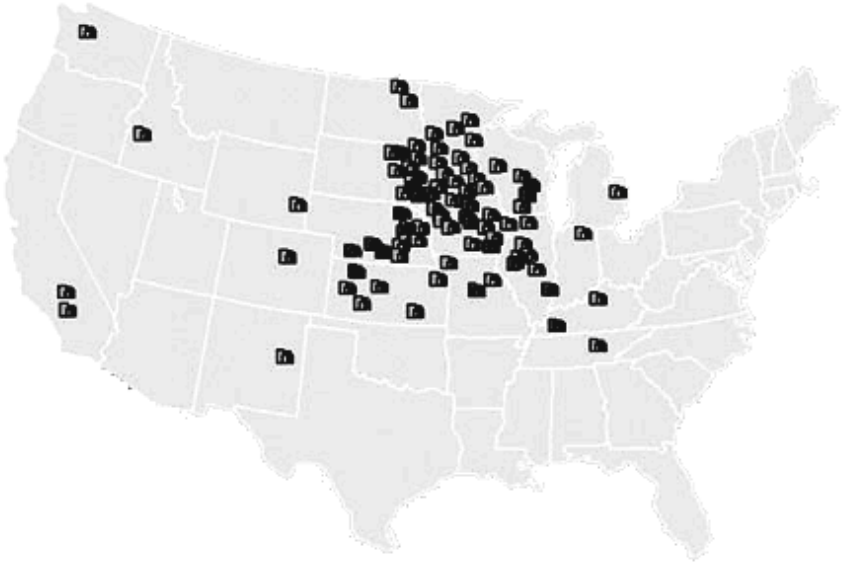
[15] Interview with Julius Johnson, Rhedona Rose, Stefan Maupin, Joe Pearson, and Nathan Coleman, Tennessee Farm Bureau, August 9, 2004
[16] Staff interviews with agricultural and ethanol production experts.
[17] *Farm Facts,* Tennessee Agricultural Statistics, November 23, 2004.

10	**Tennessee**	**67**
11	Michigan	50
12	North Dakota	33.5
13	Texas	30
14	New Mexico	30
15	Kentucky	27
16	California	6.4
17	Wyoming	5
17	Ohio	4
18	Colorado	1.5
19	Washington	.7
	United States Total	4,397.7

Source: http://www.neo.state.ne.us//statshtml/121/htm. Accessed February 3, 2005.

Exhibit 5 shows the locations of ethanol plants in the United States.

Exhibit 5: U.S. Ethanol Production Facilities



Source: Renewable Fuels Association, Growing Homeland Energy Security, Ethanol Industry Outlook 2004.

Out of state companies and/or individuals have contacted the Department of Agriculture about building ethanol plants at Cate's Landing in Lake County, New Johnsonville in Humphreys County, the Hardin/Wayne County area, Obion County, Hawkins County, and Jasper in Marion County. A group of investors started a plant in Jasper, but it never went into production.

The investor interested in Cate's Landing could use corn from the surrounding nine counties, which produce about 36,200,000 bushels a year. The investor interested in Hardin/Wayne County would use biomass made from waste wood. All investors are interested in incentives from the state.[18]

According to Brian Jennings, executive vice president of the American Coalition for Ethanol, 90 percent of all U.S. ethanol comes from corn and 10 percent from sugar. He says that technology allows producers to use low value products, such as cellulose in wood chips, rice hull, or trees, but they are not commercially viable yet in the United States.

To succeed an ethanol plant must:

- be close to adequate supplies of feedstocks,
- have a good marketing strategy,
- have good roads to haul feedstock,
- be close to an adequate water supply and energy source,
- have 50 to 80 acres of land, and
- have capital investments between $50 million and $60 million.[19]

An ethanol plant has positive economic impacts on the community. According to Mr. Jennings, "There is a one time booster shot in the arm of over $140 million. On an annual basis, on average, an ethanol facility will spend over $50 million in your community." Some of that would come from purchasing feedstocks and buying supplies and services. The coalition projects that an ethanol plant could create between 35 and 40 new highly skilled, high paying jobs.[20] Ethanol production adds $4.5 billion to the United States farm economy annually.[21]

Foreign producers, however, could challenge ethanol production in Tennessee. The Cargill Corporation plans to import ethanol from Brazil, the number one producer of ethanol in the world, via El Salvador. Brazil uses half of its sugar crop to produce ethanol. El Salvador is one of the countries covered by the Caribbean Basin Initiative, which allows for duty-free importing of goods manufactured in participating nations. Importers can bring in up to seven percent of a previous year's domestic ethanol output under current laws. Up to 230 million gallons could have entered the United States under the tariff barrier in 2004.

By producing ethanol in Brazil from sugar cane, Cargill can lower the production cost by more than half. Brazilian ethanol costs about 60 cents per gallon, while ethanol prices in the midwest in early July 2004 averaged about $1.80 per gallon. Refining ethanol to fuel grade in El Salvador means that Cargill could not only further undercut costs, but avoid duty payments, allowing it to underbid domestic producers easily.[22]

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[18] Interviews with Ed Harlan, Agribusiness Development Coordinator, Tennessee Department of Agriculture, July 28, 2004 and September 23, 2004.
[19] Elton Robinson, "Ethanol Fueling Community Development," *The Farm Press*, March 9, 2004.
[20] Ibid.
[21] Renewable Fuels Association, *Ethanol and Agriculture*, http://www.ethanolrfa.org/factfic_ag.html. Accessed September 8, 2004.
[22] Steve Thompson, "Great Expectations," *Rural Cooperatives*, July/ August 2004, p. 15.

One persistent objection to ethanol and other alternative fuels has been the amount of energy it takes to produce a unit of fuel. David Pimentel, a Cornell University agricultural scientist and former Audubon board member, has studied the economics, efficiency, and alleged environmental benefits of ethanol and chaired a U.S. Department of Energy panel that investigated these same issues. Pimentel calculated the real energy costs of raising corn, including high amounts of fossil fuels required to power irrigation pumps, run planting and harvesting machinery, cook the corn in the fermentation/ distillation process, and make the fossil fuel-based nitrogen fertilizer. Without even factoring in the fuel that is required to ship ethanol to blending sites, he estimates that producing ethanol requires 29 percent more energy than it yields. Figuring in state and federal subsidies, Pimentel found that ethanol costs $2.24 a gallon to produce, compared with 63 cents for gasoline.[23]

Dr. Pimentel also argues that ethanol production increases environmental degradation. He says that corn production causes more total soil erosion than any other crop and that corn production uses more insecticides, herbicides, and nitrogen fertilizers than any other crop. All these factors degrade the agricultural and natural environment and contribute to water and air pollution.[24]

Researchers at Dartmouth College, Oak Ridge National Laboratory, and other institutions challenge Dr. Pimentel's studies and ways he accounts for energy inputs and outputs. Today the energy efficiency ratio for the production of ethanol is 1.67, according to the U.S. Department of Agriculture. This is the ratio of energy units used to produce ethanol to energy units produced by ethanol, and means that making ethanol takes less energy than it produces. It takes 45,800 BTUs to make a gallon of ethanol, including energy needed to plant, raise, and harvest the corn. A gallon yields 76,300 BTUs, including a credit for energy used to produce salable byproducts. That is nearly double gasoline's efficiency ratio of .81 and the diesel efficiency ratio of .84 after extracting, refining, and transporting.[25]

Biodiesel from soybeans

Q: Should Tennessee government subsidize biodiesel production?

A: The Energy Information Administration (EIA) reports excess production capacity in the biodiesel industry, but projects a demand for almost twice today's production in 2010 and almost three times today's production (470 million gallons) in 2020 (630 million gallons). Unless soybean oil prices decline dramatically, producers cannot make biodiesel in large quantities at a cost competitive with petroleum diesel. By several measures, biodiesel blends perform better than petroleum diesel, but its relatively high production costs and the limited availability of raw materials continue to limit its commercial use. Biodiesel made from yellow grease is closer to being cost competitive with petroleum diesel than is biodiesel from soybean oil, but the available supply of yellow grease will probably limit its use for biodiesel production. The largest market for

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[23] Ted Williams, Drunk on Ethanol, *National Audubon Magazine(on-line),* August 2004, http://magazine.audubon.org/incite/incite0408.html.

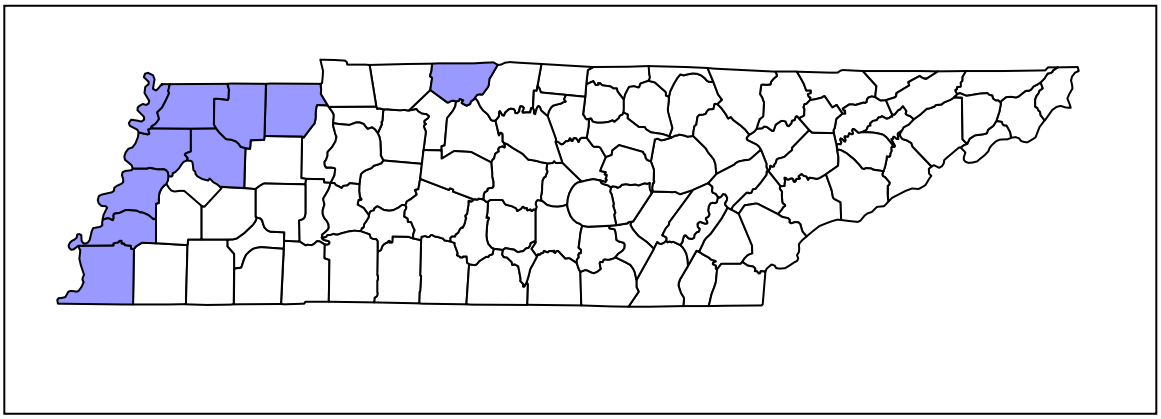
[24] David Pimentel, "Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts are Negative," *Natural Resources Research, Vol. 12, No. 2, June 2003,* International Association for Mathematical Geology.

[25] Hosein Shapouri, *The 2001 Net Energy Balance of Corn Ethanol (Preliminary),* U.S. Department of Agriculture, Office of the Chief Economist and *The Kiplinger Agriculture Letter,* July 9, 2004.

biodiesel probably will be as a fuel additive, especially for school and transit buses, to reduce emissions of particulates and unburned hydrocarbons.[26]

Biodiesel is primarily produced from soybeans and yellow grease (used vegetable oil), but producers can also use other plant and animal fats. Tennessee ranked 16th in the nation in soybean production in 2002, with 34,720,000 bushels. Tennessee's top soybean producing counties were Dyer, Obion, Gibson, Lauderdale, Weakley, Lake, Tipton, Henry, Shelby, and Robertson.[27] See Exhibit 6.

Exhibit 6: Tennessee's Top Soybean Producing Counties



Source: Tennessee Agriculture 2003, Department Report and Statistical Summary.

Exhibit 7: Acres Planted with Soybeans

Year	Soybeans
2000	1,180,000
2001	1,070,000
2002	1,160,000
2003	1,150,000
2004	1,210,000

Source: Farm Facts, Tennessee Agricultural Statistics, July 23, 2004 and Farm Facts, Volume 05, Number 02, January 25, 2005.

Tennessee has no biodiesel production facilities. The nearest are in Cold Spring, Kentucky, near Cincinnati, Ohio, and Rome, Georgia. Tennessee also does not have a soybean processing mill. Milling soybeans enables producers to make them into a variety of products, such as food, soybean meal, and glycerin for soap.

In the early 1980's, Tennessee had three soybean processing plants, but the state did not produce enough soybeans for the plants to be profitable. Tennessee farmers now send more

[26] Anthony Radich, *Biodiesel Performance, Costs, and Use,* Energy Information Administration.
[27] *Tennessee Agriculture 2003*, Department Report and Statistical Summary, pp. 17-20.

than 90 percent of their soybeans to New Orleans for exporting because the export market has been a better draw for their crops.[28]

Biodiesel producers, both dedicated plants and oleochemical producers such as Proctor and Gamble, generate about 280 million gallons per year. Because soybean diesel producers have overcapacity and a product that meets the highway diesel sulfur limit in 2007, they do not need to invest in more plants.

Pollution and Emissions Issues

See Appendix D for a description of various pollutants.

Impact of ethanol on emissions

Q: Will using E10 help bring Tennessee into compliance with the Clean Air Act and make the air healthier?

A: Experts disagree as to whether using E10 improves or worsens Tennessee's particular air pollution problems.

According to automobile manufacturers, many vehicles built since 1994 can use E10 with no adverse impact on engines. E10 has been shown to reduce some emissions and pollutants. More recently, U.S. auto manufacturers have been building flexible fuel vehicles (FFVs), which can accept 85 percent ethanol blends (E85) or run on regular gasoline. E85 has a greater impact on pollutant reduction than E10.

Ethanol use impacts three pollutants:

- carbon monoxide
- volatile organic compounds (VOCs)
- nitrogen oxides

E10 works well in areas with carbon monoxide problems. E10 reduces carbon monoxide because it is an octane enhancer, which results in more complete combustion, and therefore, cleaner emissions. When one starts a cold engine, it needs oxygen for a cleaner burn so that it produces carbon dioxide rather than carbon monoxide. Tennessee has no carbon monoxide nonattainment areas, but some areas of the state do not comply with other EPA standards.

Gasoline is a mixture of many hydrocarbons, some of which are hazardous air pollutants (HAPs). Ethanol has no HAPs, so it reduces the amount of HAPS released into the air.

Studies have shown that a reaction of volatile organic compounds produced by petroleum, and nitrogen oxides create ozone. Ethanol evaporates more quickly than gasoline and puts more volatile organic compounds into the air.

However, controlling carbon monoxide and volatile organic compounds will not be effective in the southeastern states. Tennessee must control nitrogen oxides to manage its ozone problem. High temperature and high pressure in engines create nitrogen oxides. The alcohol in E10 can create more nitrogen oxides because it burns at a higher temperature than gasoline.

[28] Email to the author from Parks Wells, Executive Director, Tennessee Soybeans, January 10, 2005.

Low levels of ethanol such as E10 would have little impact in Tennessee and other southeastern states because of the abundance of natural volatile organic compounds, produced biogenically, mainly from deciduous trees. On the other hand, E85 in an engine designed for E85 can lower nitrogen oxides.[29]

According to the Pew Center on Global Climate Change, increasing vehicle energy efficiency will achieve the most significant reductions in greenhouse gas emissions from U.S. transportation in the next 15 years. This would preserve both the characteristics of conventional vehicles and the investments in the existing infrastructure for producing, distributing, and retailing conventional petroleum fuels.[30]

Additionally, a study conducted by the National Academy of Science concluded that the use of common oxygenates (ethanol and MTBE) has little impact on improving ozone air quality and has some disadvantages.[31]

However, a 2003 report by the United States Department of Transportation indicates that only a few alternative fuels appear to offer the potential to reduce greenhouse gas emissions from light duty vehicles, regardless of the vehicle and engine technology in use. These include ethanol, diesel fuels derived entirely from petroleum or partly biodiesel, hydrogen, and possibly electricity. Within the next decade, wider use of diesel, biodiesel, ethanol, and electricity appear to offer the potential for modest reductions in greenhouse gases at realistic levels of gasoline replacement. Among these gasoline substitutes, however, only petroleum diesel appears to be cost effective.[32]

Impact of biodiesel on emissions

Q: Does the use of biodiesel improve air quality?

A: Most experts concur that biodiesel use does, in fact, reduce nitrogen oxides and particulate matter. Heavy duty diesel vehicles are the major source of these emissions.[33]

Using biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide, and particulate matter. Nitrogen oxide emissions are either slightly reduced or slightly increased depending on the duty cycle and testing methods. Using biodiesel decreases solid carbon fraction particulate matter, eliminates the sulfate fraction, while the hydrocarbon fraction stays the same or is increased. Increasing the percentage of biodiesel blended with petroleum diesel fuel progressively eliminates sulfates. Biodiesel works well with new technologies such as catalysts, particulate traps, and exhaust gas

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[29] Interview with Quincy Styke, Deputy Director, Air Pollution Control Division, Department of Environment and Conservation, August 18, 2004.

[30] *Reducing Greenhouse Gas Emissions from U.S. Transportation,* The Pew Center on Global Climate Change, p. 13, http://pewclimate.org. Accessed October 8, 2004.

[31] Committee on Ozone-forming Potential of Reformulated Gasoline, Board on Environmental Studies and Toxicology, Board on Atmospheric Sciences and Climate, Commission on Geosciences, Environment, and Resources, and the National Research Council, *Ozone-forming Potential of Reformulated Gasoline,* National Academy Press, 2000, http://books.nap.edu/catalog/9461.html. Accessed December 14, 2004.

[32] *Fuel Options for Reducing Greenhouse Gas Emissions from Motor Vehicles,* The DOT Center for Climate Changes and Environmental Forecasting, September 2003, pp. 11-13.

[33] *Emission Inventories and Potential Emission Control Strategies for Ozone Early Action Compact Areas in Tennessee,* Draft Report prepared for the Tennessee Department of Transportation and Department of Environment and Conservation by the University of Tennessee, Department of Civil and Environmental Engineering, April 13, 2003, p. 4.

recirculation. Soy biodiesel reduces carbon dioxide by 78 percent on a life cycle basis. Biodiesel is the first alternative fuel to have fully completed the health effects testing requirements of the Clean Air Act.[34]

Biodiesel emits some pollutants, but does not negatively affect air quality from the exhaust. The only problem with manufacturing biodiesel would be an odor if the plant uses animal renderings.[35]

Ethanol and groundwater pollution

Q: Some states have banned the oxygenate MTBE because it pollutes groundwater. Does ethanol also pollute groundwater?

A: Experts disagree on whether ethanol pollutes groundwater.

A 2001 report prepared by the New England Interstate Water Pollution Control Commission and the Northeast States for Coordinated Air Use Management expressed concern about the transport properties of ethanol:

- At high concentrations, ethanol can make other gasoline components more soluble in groundwater.
- When present in a gasoline spill, ethanol can delay the degradation of other, more toxic components in gasoline.
- Ethanol can cause greater lateral spread of the layer of gasoline on top of the water table.

The breakdown of ethanol in surface waters could potentially consume significant quantities of dissolved oxygen in the water. This could kill fish, depending on conditions in the surface water and the amount of ethanol. Because of its high solubility, treatment technologies that rely on the physical separation of ethanol from water, such as absorptive filters, will not be effective. It is premature to speculate on how the presence of ethanol blends will affect soil and groundwater remediation costs because several significant factors regarding the fate and transport of ethanol in the environment are unknown.[36]

However, a 1999 study conducted for the Governors' Ethanol Coalition concluded that ethanol poses no threat to surface and ground water. The study says that ethanol is rapidly biodegraded in surface water, groundwater, and soil. According to the report, ethanol is a naturally occurring substance produced during the fermentation of organic matter that should rapidly biodegrade in essentially all environments.[37] The Coalition was formed in September 1991 when Nebraska's governor asked other governors interested in creating a group devoted to the promotion and increased use of ethanol to meet with him.[38] Tennessee joined the

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[34] *Interesting Facts about Biodiesel*, http://www.biodiesel.org/markets/gen/. Accessed August 11, 2004.
[35] Interview with Quincy Styke, Deputy Director, Air Pollution Control Division, Department of Environment and Conservation, August 18, 2004.
[36] *Health, Environmental, and Economic Impacts of Adding Ethanol to Gasoline in the Northeast States, Volume 1*, prepared by the New England Interstate Water Pollution Control Commission and the Northeast States for Coordinated Air Use Management, July 2001, pp. 4-5.
[37] Renewable Fuels Association, *Ethanol and the Environment*, http://www.ethanolrfa.org/factfic_envir.html. Accessed September 8, 2004.
[38] *www.ethanol-gec.org/aboutus/history.htm*. Accessed July 23, 2004.

Coalition in February 2004. Governor Bredesen appointed Agriculture Commissioner Ken Givens to represent the state.

Effect on Vehicles

Ethanol

Q: Will E10 harm a car's engine?

A: Experts disagree on whether E10 harms engines. Some say that vehicles built since 1994 will tolerate E10, while others caution that it may harm rubber and plastic components. Some automakers advise that distributors must take care to ensure that blends contain no more than 10 percent ethanol to avoid damaging the engines of cars that are not flexible fuel vehicles.

Some car owners have used ethanol since Henry Ford designed the 1908 Model T to operate on alcohol. According to the Renewable Fuels Association, ethanol blended fuels account for approximately 30 percent of all automotive fuels sold in the United States. The Association indicates that ethanol keeps fuel systems clean because it does not leave gummy deposits. When gasoline with ethanol or other detergents replaced leaded gasoline in the mid 1980s, drivers experienced some initial problems as the fuel systems flushed deposits. Today all gasolines sold in the United States include detergents that keep fuel systems clean. Cars can now use ethanol blended fuels and are warranted for its use. Manufacturers have upgraded fuel system components to handle ethanol fuels.

The Renewable Fuels Association also addressed a controversy over ethanol's propensity to attract moisture. The Association states that all of today's automotive fuel systems are closed systems and cannot attract moisture. The most likely cause for water in gasoline today is from service station storage tanks, which is rare. Ethanol can help absorb moisture in a fuel system and carry it out in suspension as engines consume it, preventing frozen fuel lines in the winter. Gasoline with ethanol needs no de-icer. If water contamination becomes too high, it will separate and fall to the bottom of the vehicle's tank. If this happens, it is best to remove the water contaminated fuel and refill the tank with ethanol blended fuel, which will absorb any trace amounts of water that remain.[39]

However, a representative of the National Automobile Dealers Association advised research staff that owners' manuals inform vehicle owners if their vehicles will tolerate E10. He cautioned that automobiles not designed as flexible fuel vehicles cannot accept higher levels of ethanol than a 10 percent blend. He warned that companies should blend ethanol with gasoline at the terminal for an accurate 10 percent blend; splash blending is not always accurate and the fuel may end up being E15, which can foul car engines. He also advised that sediment stirred up by ethanol in a retailer's underground storage tank could end up in a vehicle's tank and clog filters. Ethanol used in the summer can cause vapor lock. Some car components can break down with ethanol use. He believes that neither ethanol nor biodiesel

[39] Renewable Fuels Association, *Ethanol and Engine Performance*, http://www.ethanolrfa.org/factfic_enperf.html. Accessed September 8, 2004.

are cost efficient and both use more energy to make than they produce. He believes that ethanol would not be a big commodity if it weren't heavily subsidized by government.[40]

A representative from Ford Motor Company agreed that if incorrect blending procedures are followed, vehicles will encounter drivability problems such as vapor lock or difficult cold starting. He cited a recent study conducted for the California Air Resources Board that concluded that ethanol can increase permeation emissions through elastomers (plastic and rubberlike components). He also stated that he believes the need for oxygenated fuels to improve emissions has passed because of current air/fuel control monitors and complex computers controlling nearly every aspect of combustion.[41]

On the other hand, a General Motors representative states that GM has validated all its products on E10 since the early 1980s and the owners' manuals recommend the use of oxygenated gasoline such as E10. Because ethanol has a lower energy content than gasoline, customers can expect a one to two percent loss in fuel economy, but it is barely measurable. As long as oil companies formulate the base gasoline for ethanol blending, exhaust emission effects are minimal. [42] However, he also cited a report to the California Air Resources Board that addressed permeation evaporative emission effects of ethanol blended gasoline, stating that low ethanol blends can substantially increase emissions permeation through fuel system components and tanks.[43]

A number of gasoline ingredients can affect elastomer swelling and deterioration, so it is not clear that ethanol alone is responsible for the emissions permeation. Studies have shown that gasoline aromatics such as benzene, toluene, and xylene have detrimental effects on some fuel system elastomers. Gasolines sold today have a higher level of aromatics than those sold before the 1980s. But 10 percent volume ethanol contributes less swelling than the amount of additional aromatics needed to obtain the same increase in octane number.[44]

Biodiesel

Q: Will biodiesel harm vehicle engines?

A: B20 generally will not harm an engine.

People can use biodiesel in vehicles with existing motor vehicle technology because it meets American Society for Testing and Materials (ASTM) specifications to ensure that consumers will not experience operational problems from using the fuel. People use B2, B5, and B20 blends in the United States. Biodiesel is low in sulfur, meeting the low sulfur diesel standards that will take effect in 2007.

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[40] Interview with Douglas Greenhaus, Director of Environment, Health, and Safety, National Automobile Dealers Association, September 13, 2004.
[41] Email to the author from Dominic DiCicco, Ford Motor Company, Vehicle Energy Planning, September 13, 2004.
[42] Email to the author from Gary Herwick, GM Global Headquarters, September 13, 2004.
[43] *Fuel Permeation from Automotive Systems,* Final Report, CRC Project No. E-65, Prepared for the California Air Resources Board and the Coordinating Research Council, Inc. by Harold Haskew and Associates, Inc. and Automotive Testing Laboratories, September 2004.
[44] Robert Reynolds, Downstream Alternatives, Inc., *Gasoline Ethanol Blends – Coming to Hawaii,* an informational workshop for the motoring public, http://www.hawaii.gov/dbedt/ert/reynolds/reynolds.html. Accessed September 22, 2004.

According to the director of the National Conference of State Legislatures' Energy Project, the best blend for biodiesel is B20. B100 has very little sulfur content and adds lubricity, which reduces engine wear, but also has drawbacks that B20 avoids:

- B100 becomes thick in cold weather, making engines difficult to start (viscosity).
- One hundred percent biodiesel has less energy content, resulting in about 10 percent less fuel efficiency, so a vehicle requires a larger tank or more frequent refueling.
- New petroleum diesel technology provides a cleaner and more efficient fuel, but makes biodiesel more expensive than petroleum diesel.
- The United States market for biodiesel is small.
- No one knows how much feedstock producers could convert to biodiesel without creating shortages in other markets; if producers used all available feedstocks, they could produce only about two to three billion gallons of biodiesel.[45]

All major U.S. manufacturers of diesel engines endorse the use of biodiesel.[46] Biodiesel is not simple vegetable oil. Using unmodified vegetable oils in diesel engines can cause excessive carbon buildup in combustion chambers and reluctance to start. Biodiesel burns more cleanly than petroleum diesel and is a better lubricant and detergent. However, its high detergency can loosen debris in fuel systems that formerly used petroleum diesel, clogging fuel filters. At higher concentrations, it can also degrade parts made of certain kinds of rubber commonly found in vehicles built before 1994. However, people usually use biodiesel as an additive in petroleum diesel at a 10 percent ratio (B10), at which level it causes few problems.

The EPA is promulgating regulations to drastically reduce the amount of sulfur in diesel fuel. Sulfur can be a lubricant for fuel injection pumps and other diesel fuel system components. Removing sulfur means that vehicles will emit few components of acid rain in their exhausts, but companies will need to put in new additives to restore the necessary lubricity. Biodiesel added to diesel fuel restores this lubricity and results in lower emissions.[47]

Infrastructure Issues

Using about two billion gallons of gasoline a year, Tennessee is the 14th largest user of gasoline in the United States because of its location and volume of interstate traffic. About 95 percent of Tennessee's gasoline comes into the state's terminals through pipelines, with the remaining five percent delivered via truck, rail, or barge.

Q: What challenges would the oil industry encounter to provide ethanol-blended fuels and biodiesel to the public in Tennessee?

A: Unlike many midwestern states, Tennessee lacks an infrastructure to distribute ethanol. Experts disagree on the best method to transport ethanol. Producers can transport biodiesel through the current diesel distribution system.

The executive director of the Tennessee Petroleum Council and representatives of a Nashville area oil terminal told research staff that if Tennessee mandates E10 fuel, oil companies would

[45] Interview with Matthew Brown, Director of NCSL Energy Project, National Conference of State Legislatures, July 29, 2004.
[46] "Biodiesel: the 10 percent solution," *Rural Cooperatives*, July/August 2004, p. 17.
[47] Ibid.

be challenged to set up a distribution system, find the source for ethanol, build separate tanks, purchase blending equipment and additional trucks to transport the E10, and train their employees to use the blending equipment.

Scientists in some government-funded studies have concluded that ethanol is expensive, difficult to manufacture and transport, and costs hundreds of millions in tax subsidies annually. These studies say that ethanol increases the cost of refining gasoline. Oil companies pass along these costs to consumers. Even if ethanol supplies are readily available, refiners must remove huge quantities of heavy gasoline components, such as butane and pentane, to accommodate the ethanol, which also raises costs by about five cents per gallon. Additionally, oxygenates such as ethanol may also cut gas mileage, thus increasing costs.[48]

Because of ethanol's affinity for water, producers cannot transport gasoline containing ethanol through existing pipelines. Oil companies must transport and store it separately from gasoline until loading into tanker trucks for delivery to retail stations. Distribution terminals would need segregated ethanol storage tanks and new blending equipment.

A study conducted for the northeastern states by the New England Interstate Water Pollution Control Commission and the Northeast States for Coordinated Air Use Management stated that designing and building such an infrastructure could cost the northeast $30 million and take two or more years to establish. Siting difficulties and regulatory issues may present challenges to those designing an infrastructure.

The northeastern states' study also pointed out that barge, rail, and truck facilities would need to be added or expanded at bulk terminal and port facilities to accommodate the amount of ethanol required to meet demand. Tanks made before January 1, 1984, as well as gaskets, sealants, adhesives, and other component materials, may not be compatible with ethanol. Degrading noncompatible materials may lead to leaks. Ethanol will enhance the suspension of water and loosen rust and deposits from the interior walls of storage systems. Water and scoured deposits could cause or contribute to premature failure of some leak monitoring systems, submersible pumps, fuel dispensers, piping, hoses, nozzles, and swivels.[49]

Representatives from a Nashville terminal agreed that to initially accommodate ethanol, they would need to build new tankage with pumps, gas loading heads, piping, special valves, diaphragm, and an injection system (the blending equipment). Terminals could not use existing injection systems used for injecting other additives. The terminal would need to obtain permits and hire special contractors to build additional tankage. They estimated that the cost for each terminal to accommodate ethanol would be at least $2.5 million to $3 million. They believe that a terminal would probably never see a return on its investment and is unlikely to offer ethanol unless high incentives are in place.[50]

The terminal representatives told research staff that oil companies would have to truck ethanol into Tennessee's 33 terminals because they cannot ship it through the pipeline carrying other

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[48] Melita Marie Garza and Douglas Holt, "Ethanol: What it is, and isn't," *The Chicago Tribune.*
[49] *Health, Environmental, and Economic Impacts of Adding Ethanol to Gasoline in the Northeast States, Volume 1*, prepared by the New England Interstate Water Pollution Control Commission and the Northeast States for Coordinated Air Use Management, July 2001, pp. 5-6.
[50] Interview with Mike Easterday and Ron Prater, Marathon Ashland Petroleum LLC, September 15, 2004.

petroleum products. Conversely, the Alternative Fuels Association states that Brazil ships millions of gallons of ethanol by pipeline every year. The Association also points out that ethanol has been successfully shipped via pipeline in the United States. Williams Energy Services, a major pipeline company, has submitted testimony to Congress about their successful tests of ethanol pipeline shipments, but a company representative said that transporting ethanol is not commercially feasible for the short distances the product is shipped in the United States. Pipeline companies would likely limit shipments to niche situations as demand for ethanol grows outside the midwest.[51]

The Alternative Fuels Association also states that the market for alternative fuels such as E85 is growing. Because of consumer demand, auto manufacturers are working to produce more flexible fuel vehicles compatible with E85. There are now more than three million flexible fuel vehicles in the United States. The number of E85 fueling stations is growing rapidly nationwide. While the majority of ethanol production and consumption is in the midwest, oil companies in nearly every state blend ethanol in gasoline.[52]

Biodiesel does not require special storage. It can be stored wherever petroleum diesel is stored except in concrete-lined tanks. It handles like diesel and uses the same infrastructure to transport, store, and use.[53] However, B20 costs about 15 to 20 cents more per gallon than petroleum diesel.[54] Given the rising costs of petroleum products, biodiesel may some day become more cost competitive.

Incentives

Q: How have other states encouraged the use of ethanol and/or biodiesel?

A: Forty-three states have a variety of incentive options to consider for promoting biofuels. Tennessee offers no incentives. However, a report by the National Conference of State Legislatures concluded that state alternative fuel incentives have not stimulated widespread conversion to alternative fuels in the US.

States generally offer two groups of incentives: application incentives and production incentives. Application incentives provide benefits for the sale, distribution, and use of biofuels and alternative fuel vehicles. Production incentives include direct payments, tax credits, grants, loans, and other benefits for biofuel producers. Forty-one states offer application incentives; 23 states offer production incentives; and 21 states offer both production and application incentives.

Application incentives include market mandates requiring ethanol or biodiesel blends in all or most transportation fuels. Fuel tax exemptions; grants, loans, rebates, and tax credits to purchase alternative fuel vehicles; and legislative or administrative directives requiring state government or other public fleets are examples of application incentives.

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[51] Telephone conversation with Jim Sneed, Manager of Fuel Ethanol Marketing, Williams Bio-Energy, October 6. 2004.
[52] Renewable Fuels Association, *Ethanol and Market Opportunities*, http://www.ethanolrfa.org/factfic_market.html. Accessed September 8, 2004.
[53] *Interesting Facts about Biodiesel…*, http://www.biodiesel.org/markets/gen/. Accessed August 11, 2004.
[54] "Renewable fuels: Growing our own," *ConsumerReports.org,* http://www.consumerreports.org/main/content. Accessed September 27, 2004.

In 1997, Minnesota adopted a statewide requirement for the use of E10 in all but a few limited special fuel applications, such as marine, motor racing, and collector vehicles.[55] All diesel fuel must contain at least two percent biodiesel fuel by volume.[56]

The oldest types of incentives used by states are reductions in state excise and sales taxes on biofuels. These tax incentives increase the price a fuel marketer can pay the fuel producer by reducing the marketer's tax liability, making biofuels more competitive with petroleum fuels.

Arkansas provides a rebate for the additional cost above the regular vehicle purchase cost of an alternative fuel vehicle. Illinois provides rebates for those who convert an existing conventional vehicle so that it can use ethanol or biodiesel. New Jersey reimburses eligible local governments, state colleges, universities, and governmental authorities for 50 percent, up to $50,000 per applicant, of the cost to purchase and install refueling infrastructures for alternative fuels. Louisiana offers personal and corporate state income tax credits for 20 percent of the cost of converting conventional vehicles to run on alternative fuels, 20 percent of the incremental cost of purchasing an alternative fuel vehicle, and 20 percent of the cost to construct a fueling facility.

As of November 2004, 18 states have passed various mandates for their public fleets to use alternative fuels. Missouri requires its Department of Transportation to develop a program allowing its vehicle fleet and heavy equipment to use B20 or higher. North Carolina set a goal of having at least 75 percent of its new or replacement light duty cars and trucks be alternative fuel or low emission vehicles.

Exhibit 8: States with Application Incentives as of November 2004

	Market Mandates	Fuel Tax Exemptions/ Reductions	Incentives for Distribution/ Refueling Station Installation	Incentives for Alternative Fuel Vehicle (AFV) Purchases	Incentives to Convert into AFVs	Biofuels Required for Public Fleets
Arizona				X		X
Arkansas			X	X	X	
California		X		X		
Colorado			X	X	X	
Connecticut					X	
Delaware		X				
Georgia				X	X	
Hawaii		X	X			
Idaho		X				
Illinois	X	X	X	X	X	
Indiana		X	X	X	X	
Iowa		X	X			X
Kansas			X	X	X	X
Louisiana			X	X	X	
Maine		X	X	X		

[55] *Minnesota Statutes,* § 239.791.
[56] *Minnesota Statutes,* § 239.77.

	Market Mandates	Fuel Tax Exemptions/ Reductions	Incentives for Distribution/ Refueling Station Installation	Incentives for Alternative Fuel Vehicle (AFV) Purchases	Incentives to Convert into AFVs	Biofuels Required for Public Fleets
Maryland				X		X
Massachusetts						X
Minnesota	X					X
Mississippi						X
Missouri		X				X
Montana		X			X	
Nebraska		X	X	X	X	
Nevada		X				X
New Jersey			X	X	X	X
New Mexico		X		X		
New York			X	X	X	X
North Carolina		X	X	X	X	X
North Dakota		X				
Ohio				X		
Oklahoma			X	X	X	X
Oregon			X	X	X	
Pennsylvania			X	X	X	
Rhode Island		X	X	X	X	
South Carolina						X
South Dakota		X				
Texas		X		X	X	X
Utah				X	X	
Virginia			X	X		
Washington		X	X			X
West Virginia				X	X	
Wisconsin						X

Source:U.S. Department of Energy, Energy Efficiency and Renewable energy, Clean Cities Program, http:www.eere.energy.gov/cleancities/progs/afdc/search_state.cgi?afdc/AA>.

Production incentives

Several states use production incentives to stimulate the biofuels industry, including direct payments, tax incentives, and grant/loan programs. Such incentives help producers supply biofuels at prices that are more competitive with petroleum products. Arkansas, Kansas, Minnesota, Mississippi, Missouri, North Dakota, and South Dakota offer direct producer payments, usually based on per gallon output for maximum amounts of annual production and for a maximum number of years.

States calculate income tax credits based on per gallon output or investment in production facilities and equipment. Hawaii, Indiana, Maine, North Carolina, North Dakota, Virginia, and Wyoming offer production based tax credits for ethanol and biodiesel.

Iowa, Mississippi, Montana, New Mexico, Oregon, and Texas have grant and loan programs that help in production facility projects. These funds are not usually sufficient to cover the major costs for construction, but officials often use them in the early stages to help attract financing from other sources and to cover initial project development costs.[57]

Exhibit 9: States with Production Incentives as of November 2004

	Direct Producer Payments	Income Tax Credits	Tax Exemptions	Grant/Loan Programs
Arkansas	X			
Hawaii		X	X	
Indiana		X		
Iowa				X
Kansas	X			
Maine		X		
Michigan			X	
Minnesota	X			
Mississippi	X			X
Missouri	X			
Montana				X
New Mexico				X
North Carolina		X		
North Dakota	X	X	X	
Oregon				X
Rhode Island			X	
South Carolina			X	
South Dakota	X			
Texas				X
Virginia		X		
Washington			X	
Wisconsin				
Wyoming		X		

Source:U.S. Department of Energy, Energy Efficiency and Renewable energy, Clean Cities Program, http:www.eere.energy.gov/cleancities/progs/afdc/search_state.cgi?afdc/AA>.

According to a report by the National Conference of State Legislatures, state alternative fuel incentives have not stimulated widespread conversion to alternative fuels in the U.S. because of the design of the incentives themselves, the early stage of technological development, and because alternative fuels are competing against inexpensive and well-entrenched conventional fuels. Without incentives, the industry will falter in the short-term and can hold no hope of a significant role in the nation's transportation industry in the long-term.

Some state level incentives work better than others:

- Focused on reducing emissions or petroleum use,
- Large enough to entice consumers to buy an alternative fuel vehicle,
- Grant-based in most cases,
- Easy for consumers to receive and for the state to administer, and

[57] Melissa Taylor Bell, *Biofuels,* Trends Alert, Council of State Governments, November 2004.

- Focused on developing a fueling infrastructure in addition to encouraging consumers to buy alternative fuel vehicles.[58]

Some states have created incentives that may have done little to convince people to use alternative fuels, even though the incentives convinced them to buy vehicles capable of operating on alternative fuels. Arizona developed incentives for people to buy vehicles capable of running on alternative fuels. Some people bought vehicles dedicated to alternative fuel use, but many bought vehicles capable of running on both gasoline and alternative fuel. Some of these people do not intend to run their vehicles on the alternative fuels, so the state will have spent a great deal of money on incentives with little to no guarantee that the incentives will achieve their goals.

Incentives should be large enough to offset much or all of the incremental cost of alternative fuel vehicles. Some fleet managers believe that alternative fuel vehicles have performance and operational characteristics that are inferior to conventional vehicles and will not willingly pay extra for alternative fuel vehicles, so successful incentives must make up for most or all of the incremental costs.

The most effective incentives are often grant-based. Non-taxable entities such as municipal governments or non-profit organizations can use grants. These are among the more promising markets for alternative fuel vehicles. Grants also offer certainty and do not depend on the size of an individual's tax liability. A tax credit, for instance, often is limited to the size of a taxpayer's tax liability in any given year. In some cases, tax incentives can work well. Examples include tax incentives incorporated into vehicle lease payments or refundable tax credits paid to the taxpayer regardless of tax liability in that year. Refundable tax credits are not helpful to non-taxable entities.

Alternative fuel vehicle advocates have long debated whether it is more important to have infrastructure or alternative fuel vehicle incentives. The NCSL report concludes that infrastructure incentives are a critical component of any government incentive program. Consumers have bought hybrid electric vehicles in part because they are priced at levels comparable to gasoline engines and in part because they can use the existing fueling infrastructure.

When gasoline prices are low, new alternative fuels must compete in a difficult environment, since most drivers see little reason to switch from a widely available, relatively inexpensive fuel.[59] Many owners of flexible fuel vehicles report that they refuel their vehicles with gasoline or diesel because of the limited refueling infrastructure.[60] Late in 2000, just over 6,000 fueling stations around the country dispensed alternative fuels, compared to over 180,000 stations that dispensed conventional vehicle fuels.

The NCSL report states that only significant penetrations of clean-burning alternative fuel vehicles are likely to make a major contribution to improving air quality. Small numbers of vehicles will not make an overall difference. However, alternative fuel vehicles have yet to

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[58] Matthew H. Brown and Leah Breckenridge, *State Alternative Fuel Vehicle Incentives: A Decade and More of Lessons Learned*, National Conference of State Legislatures, February 2001, p. ix.
[59] Ibid., p. 14.
[60] Ibid., p. 16.

make major inroads into the mainstream vehicle fleet. Much of the conventional vehicle fleet is becoming a less-polluting fleet.

If the 10 years from the early 1990s to 2000 leave any impression at all about the alternative fuel industry, it is that of a fledgling industry fighting an uphill battle in a world of inexpensive and entrenched fuel and vehicle technologies. Alternative fuel vehicle incentives have not thus far significantly reduced the nation's dependence on foreign oil.[61]

[61] Ibid., pp. 18-21.

Recommendations

Legislative

The General Assembly should evaluate the viability of markets and infrastructures when considering state subsidies for ethanol or biodiesel production. According to several persons interviewed, Tennessee farmers do not produce enough corn to support a substantial plant for renewable fuels. The higher ethanol-producing states grow extensive corn crops to provide feedstock for their plants. Additionally, unless soybean oil prices decline dramatically, producers cannot make biodiesel in large quantities at a cost that is competitive with petroleum diesel.

If the General Assembly decides to provide incentives for ethanol or biodiesel, it may wish to include incentives for consumers. Providing incentives to consumers will help create markets for renewable fuels. Small numbers of vehicles will not make a difference in overall air quality. Alternative fuel vehicles have yet to make major inroads into the mainstream public vehicle fleet.

Administrative

The following administrative recommendations would allow the state to pilot the use of renewable fuels to test the feasibility of alternative fuel options to reduce the state's reliance on petroleum products:

The Division of Energy within the Department of Economic and Community Development should encourage local governments to begin using biodiesel in their diesel vehicles whenever feasible.

State departments, such as Transportation, should use biodiesel in their diesel vehicles whenever possible.

The Department of General Services should consider finding sources of E85 for each grand division of the state and encourage employees driving the state's flexible fuel vehicles to purchase E85 when possible.

Appendix A: Persons Interviewed

MaryLee Booth
Executive Director
Tennessee Oil Marketers Association

Matthew Brown
Director of Energy Project
National Conference of State Legislators

Megan Bruch
Extension Specialist
University of Tennessee Center for Profitable Agriculture

Nathan Coleman
Intern
Tennessee Farm Bureau Federation

Mark Downing
Research Scientist
Agricultural Economist
Oak Ridge National Laboratory

Mike Easterday
Terminal Manager
Marathon Ashland Petroleum LLC

Terry Ellis
Assistant Director, Energy Division
Department of Economic and Community Development

Ken Givens
Commissioner
Department of Agriculture

Douglas Greenhaus
Director of Environment, Health, and Safety
National Automobile Dealers Association

The Honorable Jamie Hagood
Tennessee House of Representatives

Ed Harlan
Agribusiness Development Coordinator
Department of Agriculture

Mick Henderson
General Manager
Commonwealth Agri-Energy, LLC
Hopkinsville, Kentucky

Waller Henry
Research Analyst
Senate Environment, Conservation, and Tourism Committee

Ronnie Hollingsworth
Owner
Hollingsworth Oil

Randy Jennings
Motor Fuel Quality
Department of Agriculture

Julius Johnson
Chief Administrative Officer
Tennessee Farm Bureau Federation

Emily LeRoy
Associate Director
Tennessee Oil Marketers Association

Stefan Maupin
Associate Director of Pubic Affairs and Research
Tennessee Farm Bureau Federation

The Honorable Don McLeary
Tennessee Senate

Bill Nolan
Former State Representative and Lobbyist
Pilot Oil Company

Cynthia Oliphant
Director, Energy Division
Department of Economic and Community Development

Jonathan Overly
Executive Director
East Tennessee Clean Fuels Coalition

Joseph Pearson
Director of Community Activities
Tennessee Farm Bureau Federation

Dave Pelton
Executive Director
Clean Cities of Tennessee

Ron Prater
Advanced Territory Manager
Marathon Ashland Petroleum LLC

Lisa Pugh
Field Operations, Division of Underground Storage Tanks
Department of Environment and Conservation

Rhedona Rose
Director of Public Affairs
Tennessee Farm Bureau Federation

Michael Shinn
Chief of Administration
Department of Transportation

Jason Spain
Legislative Liaison
Department of Transportation

Quincy Styke
Deputy Director, air Pollution Control Division
Department of Environment and Conservation

Parks Wells
Executive Director
Tennessee Soybeans

Dan Wheeler
Executive Director
University of Tennessee Center for Profitable Agriculture

Mike Williams
Executive Director
Tennessee Petroleum Council

Appendix B

PUBLIC ACTS, 2004
CHAPTER NO. 891

AN ACT to amend Tennessee Code Annotated, Title 68, Chapter 135, to enact the "Tennessee Agricultural Ethanol Production Act of 2004." This act makes appropriations for the period of July 1, 2004 through June 30, 2005 for the purposes of funding incentive payments for the production of ethanol and of funding the administration of the act.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF TENNESSEE:

SECTION 1. By February 1, 2005, the comptroller of the treasury shall transmit to the commerce, labor and agriculture committee of the senate and the commerce committee of the house of representatives a report that:

(1) Reviews the use of alternative fuels such as biodiesel and gasohol as a means to enhance consumption of Tennessee agricultural products;

(2) Includes an explanation of any practical, technical and scientific benefits for using biodiesel and gasohol in reducing air pollutants and emissions;

(3) Includes an explanation of the effects of biodiesel and gasohol on contemporary motor vehicle engines;

(4) Includes an analysis and recommendations concerning how to facilitate industries that would manufacture, produce and distribute biodiesel and gasohol in Tennessee; and

(5) Includes a plan for using any available funds for implementing a program for the encouragement of the production, distribution and use of biodiesel and gasohol and the cost benefits of such plan.

SECTION 2. This act shall take effect upon becoming a law, the public welfare requiring it.

Appendix C: Glossary

Application incentives – financial incentives that states use to encourage growth in the biofuels sector by providing benefits for the sale, distribution, and use of biofuel powered vehicles.

Biodiesel – renewable, biodegradable fuel made from various vegetable oils, animal fats, and recycled restaurant greases (yellow grease). It is made through a chemical process called transesterification, in which glycerin is separated from the fat and vegetable oil. Soy-based biodiesel is the most commonly used form. Biodiesel can be produced in pure form or as a blend with regular petroleum diesel.

Biofuels – renewable fuels generally derived from agricultural crops such as corn, soybeans, and sugar cane, or from biomass sources such as agricultural, wood, animal, and municipal wastes and residues. Biofuels can refer to fuels for direct combustion for electricity production, but are generally known as liquid fuels used for transportation. These include alcohols, esters, ethers, or other chemicals made from biomass.

Biomass – any renewable or recurring organic matter (excluding old-growth timber). Biomass includes dedicated energy crops and trees, agricultural food and feed crop residues, wood and wood wastes and residues, aquatic plants, grasses, residues, fibers, and animal wastes, municipal wastes, and other waste materials.

Carbon dioxide – a normal, non-toxic product of burning fuel that contributes to global warming. When petroleum fuel burns, the fossilized carbon is combusted and the levels of atmospheric carbon dioxide increase. By contrast, using biofuels such as ethanol does not increase atmospheric carbon dioxide levels because of the natural carbon cycle – the carbon dioxide formed during combustion is taken back from the atmosphere during the annual growth of plants used to produce ethanol.

Carbon monoxide – a poisonous gas produced by incomplete combustion. Because more than two-thirds of this pollutant are caused by transportation, many U.S. cities have mandated the use of oxygenated gasolines, such as ethanol blends, to reduce carbon monoxide emissions.

Direct producer payments – direct state payments to qualifying producers, usually based on per gallon output for specified maximum amounts of annual production and for a specified maximum numbers of years.

E10 – a blend of ethanol which contains 10 percent ethanol and 90 percent gasoline (formerly known as gasohol).

E85 – a blend of ethanol which contains 85 percent ethanol and 15 percent gasoline; for use only in flexible fuel vehicles.

Energy balance – the amount of energy required for production versus the amount of energy yielded.

Ethanol – renewable, biodegradable fuel produced by fermenting crops that contain starch or sugars. Currently, corn is the most predominant crop in producing ethanol in the U.S. Wastes from paper mills, potato processing plants, breweries, and beverage manufacturers may also be used for producing ethanol.

MTBE – methyl tertiary butyl ether is an oxygenate widely used by the gasoline refining industry. Several years ago, MTBE was detected in water supplies, resulting in legislation that restricts or bans the use of MTBE in gasoline in 17 states.

Oxygenates – alcohols, ethers, and other compounds with molecular structure that contains oxygen. Ethanol and MTBE are examples of oxygenates. Oxygenates are used in conventional fuels to reduce polluting emissions by improving combustion efficiency.

Particulates – emissions of soot and particles of partially combusted fuel components. Diesel engines emit high levels of particulates.

Production incentives – financial incentives such as direct producer payments, tax incentives, and grant and loan programs offered to the biofuels industry to stimulate biofuels production.

Reformulated Gasoline (RFG) – gasoline that has been blended with oxygenates to burn cleaner and reduce smog-forming and toxic pollutants in the atmosphere. The Clean Air Act mandates the use of RFG in cities that have high smog pollution. The Act also specifies that RFG must contain two percent oxygen by weight. The most commonly used substances that add oxygen to gasoline are MTBE and ethanol.

Renewable Fuels Standard – proposals in Congress that address a variety of issues surrounding water pollution, air quality, and the growth of biofuels in the U.S. The proposals aim to achieve the circulation of five billion gallons of renewable fuels in the transportation fuels market by 2012 or 2015.

Appendix D: Pollutants

The Clean Air Act requires reduced emissions from unburned hydrocarbons, carbon monoxide, particulate matter, and exhaust emissions of sulfur oxide and sulfates. Hydrocarbons and nitrogen oxide are two elements that form ozone. The U.S. Departments of Energy and Agriculture have identified carbon dioxide and hydrocarbon emissions as impacting human health as well.

Ozone

Ozone is not a pollutant emitted directly into the air. Rather, it is a chemical reaction between nitrogen oxides and volatile organic compounds in the presence of heat and sunlight. Motor vehicle exhaust, industrial emissions, gasoline vapors, and chemical solvents are major sources of ozone-forming nitrogen oxides and volatile organic compounds.

Ground level ozone triggers a variety of health problems even at very low levels. It may cause permanent lung damage after long-term exposure as well as damaging plants and ecosystems.

Ozone can irritate lung airways and cause inflammation much like sunburn. Even at very low levels, ground-level ozone can aggravate asthma, reduce lung capacity, and increase susceptibility to pneumonia and bronchitis. People with respiratory problems are most vulnerable, but high ozone levels can affect even healthy people. Repeated exposure to ozone pollution for several months may cause permanent lung damage.

Ground level ozone interferes with plants' ability to produce and store food. Ozone makes plants more susceptible to disease, insects, other pollutants, and harsh weather, which can reduce crop and forest yields. It damages the leaves of trees and other plants, ruining the appearance of cities, national parks, and recreation areas.[62] Ozone is prevalent throughout Tennessee, but it is more concentrated in the Great Smoky Mountains because of prevailing winds carrying pollutants from East Tennessee.

Particulate Matter

Particulate matter is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can hang in the air for long periods. Some particles are large or dark enough to see as soot or smoke. Others are so small that individually only an electron microscope can detect them. Cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and wood burning emit some particles directly into the air. The chemical exchange of gases forms other particles in the air when gases from burning fuels react with sunlight and water vapor. These can result from fuel combustion in motor vehicles, at power plants, and in other industrial processes.

Many scientific studies have linked breathing particulate matter to significant health problems. These include aggravated asthma, coughing, difficult or painful breathing, chronic bronchitis, decreased lung function, and premature death. Particulate matter is the major cause of reduced visibility in parts of the United States, including many national parks.

[62] U.S. Environmental Protection Agency. http://www.epa.gov/air/urbanair/ozone. Accessed August 19, 2004.

The wind can carry particles long distances then settle them on the ground or water. This settling affects the diversity of ecosystems. It causes lands and streams to be acidic, changes the nutrient balance in coastal waters and large river basins, depletes nutrients in soil, and damages forests and farm crops.[63]

Carbon Monoxide

Carbon monoxide is a colorless, odorless gas formed when carbon in fuel is not burned completely. Motor vehicle exhaust contributes about 56 percent of all carbon monoxide emissions nationwide. Other nonroad engines and vehicles such as construction equipment and boats contribute about 22 percent.

Higher levels of carbon monoxide generally occur in areas with heavy traffic congestion. In cities, 85 to 95 percent of all carbon monoxide emissions come from motor vehicle exhaust. Other sources of carbon monoxide emissions include industries such as metals processing and chemical manufacturing, residential wood burning. Natural sources such as forest fires may also create carbon monoxide.

The highest levels of carbon monoxide in the outside air typically occur during the colder months of the year when inversion conditions are more frequent, trapping the air pollution near the ground beneath a layer of warm air.

The health threat from lower levels of carbon monoxide is most serious for those with heart disease. A single low-level exposure to carbon monoxide for a person with heart disease may cause chest pain and reduce a person's ability to exercise. Repeated exposures may contribute to other cardiovascular effects.

High levels of carbon monoxide can affect even healthy people. Symptoms experienced by people who breathe high levels of carbon monoxide include vision problems, reduced ability to work or learn, reduced manual dexterity, and difficulty performing complex tasks. At extremely high levels, carbon monoxide is poisonous and can cause death. Carbon monoxide also contributes to the formation of ground level ozone.[64]

Nitrogen Oxides

Nitrogen oxides are a group of highly reactive gases, all of which contain nitrogen and oxygen in various amounts. Many of the nitrogen oxides are colorless and odorless. However, nitrogen dioxide (a member of the nitrogen oxides class), along with particles in the air, can cause reddish brown layers over urban areas. Nitrogen oxides form when one burns fuel at high temperatures, as in a combustion process. The primary sources of nitrogen oxides are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.

In addition to creating ground level ozone, nitrogen oxide and sulfur dioxide react with other substances in the air to form acids that fall to earth as rain, fog, snow, or dry particles. The wind may carry these acids for hundreds of miles. Acid rain causes deterioration of cars, buildings, and historical monuments. It causes lakes and streams to become acidic and

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[63] U.S. Environmental Protection Agency. http://www.epa.gov/air/urbanair/pm. Accessed August 19, 2004.
[64] Ibid.

unsuitable for many fish. Increased nitrogen in water bodies, particularly on the coast, upsets the chemical balance of nutrients used by aquatic plants and animals. It also leads to oxygen depletion and reduces fish and shellfish populations. Nitrogen oxide reacts with ammonia, moisture, and other compounds to form nitric acid and harmful particles.

Greenhouse gas is one kind of nitrogen oxide. It accumulates in the atmosphere with other greenhouse gases, causing a gradual rise in the earth's temperature. This will lead to increased risks to human health, a rise in the sea level, and other adverse changes to plant and animal habitat. In the air, nitrogen oxide reacts with common organic chemicals, forming a variety of toxic products. Some of these may cause biological mutations. Other health concerns include respiratory system effects, damage to lung tissue, and premature death. [65]

[65] U.S. Environmental Protection Agency. http://www.epa.gov/air/urbanair/nox. Accessed August 19, 2004.

Appendix E: Response Letters

Tennessee Department of Agriculture
Ellington Agricultural Center, Box 40627, Nashville, Tennessee 37204
615-837-5100 / FAX: 615-837-5333

Ken Givens
Commissioner

Phil Bredesen
Governor

February 24, 2005

Ethel Detch, Director
Office of Research
Comptroller of the Treasury
505 Deaderick Street, Suite 1700
Nashville, Tennessee 37243-0268

Dear Director Detch:

Thank you for the opportunity to respond to study of the use of alternative fuels conducted by your research department.

The Department of Agriculture concurs with the analysis as it relates to how growth of the ethanol industry would affect both the acreage and the price of corn received by farmers in our state – the specific portion of the report that relates to our department.

We do want to express our total support and belief that renewable fuels derived from agricultural products in the manufacturing of ethanol and bio-diesel will help American agriculture overall and that in addition to reducing our dependence on foreign oil, it will contribute greatly to cleaner air which will help our quality of life and play a big role in attracting new industry to Tennessee.

Please let us know if you have additional questions.

Sincerely,

Ken Givens

KG:me

DEPARTMENT OF ENVIRONMENT & CONSERVATION
DIVISION OF AIR POLLUTION CONTROL
9TH FLOOR, L & C ANNEX
401 CHURCH STREET
NASHVILLE, TN 37243-1531

March 10, 2005

Ethel Detch, Director
Comptroller of the Treasury
Office of Research
505 Deaderick St., Suite 1700
Nashville, TN 37243-0268

Dear Director Detch,

Thank you for taking the time today to meet with us regarding your report on Ethanol and Biodiesel.

Given the revisions to the report we discussed today, we generally agree with the conclusions in the section of the report on air quality. It is important, when discussing the tailpipe emissions, that it is clear which blend of the fuel is being referred to. The different blends, and different uses and equipment, will affect the tailpipe emissions.

Again, we appreciate the opportunity to provide comments on your report.

Sincerely,

Barry R. Stephens, PE
Director, Air Pollution Control

Department of Economic and Community Development
William Snodgrass/Tennessee Tower Building, 11th Floor, 312 8th Avenue North, Nashville, Tennessee 37243
615-741-1888 / FAX: 615-741-7306

Matthew Kisber
Commissioner

Phil Bredesen
Governor

MEMORANDUM

To: Ethel Detch, M.P.A., Director
The Office of Research & Education Accountability
Comptroller's Office

From: Matthew Kisber, Commissioner
Economic & Community Development

Date: February 25, 2005

Re: Ethanol and Bio-Diesel

The Energy Division of the Department of Economic & Community Development concurs with the three recommendations in the draft report communication from the Comptroller of the Treasury (February 11, 2005) to Commissioner Matthew Kisber.

The Tennessee Department of Economic and Community Development, Energy Division began acting on the policy recommendations prepared for the Report by the Governor's Interagency Energy Policy Work Group in response to Executive Order 27.

In January 2002, forty-one Tennessee and national agencies and institutions representing the public and Tennessee business interests working in six committee work groups provided guidance and comments developing this set of policy recommendations. These work groups, with representation from the related State of Tennessee departments and agencies, presented the policy recommendations. Relying on the recommended policy for renewable fuels the Division sought federal grant opportunities for Tennessee. The total federal grant funds applied after January 2002 to these programs by the Tennessee Department of Economic and Community Development Energy Division are approximately $450,000 (to date).

The Energy Division plans to provide grants to school systems in Clean Cities and certified Three-Star Communities for the purchase of bio-diesel tanks, pumps, and card readers to be installed and used for the fueling of school bus fleets in those communities. The local government can purchase and install a totally new tank and pumping system or they can convert an existing system. The basis for the total estimated cost of a project and the implementation of the project are the responsibility of the grantee and the grant will require matching funds. The money budgeted for the bio-diesel fuel program is $1,000,000 in federal grant funds that have been earmarked for use in alternative fuel programs only.

The division has made available several other federal grants for the use of Tennessee businesses and agricultural producers considering feedstock or production of renewable fuels. It anticipates enabling the state's soybean producers access to expanding market options. Soybean production can be readily expanded with significant convenience based on existing capabilities and economic interest allowing rural Tennessee economies additional opportunities.

Tennessee's Clean Cities personnel provide these final notes from e-mail correspondence:

"The arguments for increased alternative fuel use generally fall into three categories: Economics, Energy Security and Environment.

The economics of alternative fuel use are fact dependent on the fuel, the region of the country and the volume of use. In Tennessee, Bio-Diesel (made from soybean oil and used cooking oil) and Ethanol (made from corn and agricultural waste) are the two alternative fuels most likely to be economically feasible statewide.

According to the U.S. Department of Energy (DOE), Bio-Diesel use nationwide is increasing faster than any other alternative fuel. USDA projects production and consumption will double every year for the next four years. There are three primary reasons for this success.

1. No vehicle retrofits are required.
2. In its blended B20 form, cost per gallon is in line with reasonable alternative fuel expectations.
3. Bio-Diesel reduces sulfur, particulate matter (PM) and, with the appropriate additives, Nitrogen Oxide (NOx).

Another economic strength is bio-diesel's positive impact on the agricultural community. Every gallon of domestic bio-diesel used represents money that originates locally and stays domestic. Higher demand for soybeans also means a stronger bottom line for farmers. The federal bio-diesel tax incentive signed into law for 2005 adds an extra boost to the economic structure. The United States Department of Agriculture (USDA) projects a federal tax incentive will add $7 billion to the U.S. economy over ten years and create 50,000 jobs over 5 years.

Energy Security remains a primary concern for DOE. That concern trickles down to the state and local level through concerns over everything from shipping costs that ultimately affect consumer costs to business and leisure travel to heating and cooling needs. Every major energy need in Tennessee can be traced back to some energy security risk issue. Conservation and diversity are two of the primary ways to curb that risk. Alternative fuels, like bio-diesel and ethanol, are domestic, renewable solutions.

The environmental side of alternative fuels is fuel specific. The NOx issue can be addressed with the use of E85, which, according to EPA, reduces NOx by 10% when compared side-by-side with unleaded gasoline. Low-NOx additives are also being added to Bio-Diesel to help reduce NOx by up to 9%. Bio-Diesel is a no-sulfur fuel and also reduces particulate matter (PM) that traditional diesel produces. Both NOx and PM are the top concerns for air quality non-attainment in Tennessee. Bio-diesel and Ethanol are positive solutions."

MK/bh

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
SUITE 700, JAMES K. POLK BUILDING
NASHVILLE, TENNESSEE 37243-0349
(615) 741-2848

GERALD F. NICELY
COMMISSIONER

PHIL BREDESEN
GOVERNOR

February 25, 2005

Ms. Ethel Detch
Director
Comptroller of the Treasury
Office of Research
17th Floor James K. Polk Bldg.
505 Deaderick Street
Nashville, TN 37243-0298

Dear Ms. Detch:

We thank you and your staff for the indepth study of alternative fuel. Two of the recommendations in your report affect the Tennessee Department of Transportation: 1) the recommendation for the use of biodiesel in diesel vehicles, and 2) the finding of sources for E-85 in each grand division of the state.

TDOT is the administrator of the state-wide fuel privatization contract and is currently working on the request for proposals (RFP) for a new fuel contract. The current fuel contract ends in September of this year and provides for E85, but not for biodiesel.

The new fuel contract will facilitate our efforts in complying with your recommendations. It provides for the purchase of E85 and B20 at both retail and state automated locations. In addition, there are incentive points that add to the contractor's site proposal score if they can furnish or obtain commitments to install E85 sites in the greater metropolitan areas of Knoxville, Nashville and Memphis.

As your study points out, there are a lot of unanswered questions about alternative fuel. The sources of supply, fuel availability, and effects to our equipment and mileage are but some of our immediate concerns. After transitioning from the old to the new fuel contract, we will be in a more advantageous position to begin pilot programs to test the feasibility of alternative fuels. TDOT is committed to doing its part in helping the state's economy and making improvements in air quality, whenever possible.

Please contact Mr. Lance Goad of our Finance Division if you should have any questions. He may be reached at 615-253-4275.

Sincerely,

Gerald F. Nicely
Commissioner

GFN:NH:lg

Cc: Mr. Lance Goad, W/Attach.

Offices of Research and Education Accountability Staff

Director
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Assistant Director (Research)
◆Douglas Wright

Assistant Director (Education Accountability)
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Jessica King
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Executive Secretary
◆Sherrill Murrell

◆indicates staff who assisted with this project