Implications of Alternative Fuel Use and Regulations in the Mountain Plains Region

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ABSTRACT

The objective of this study is to provide an overview of alternative fuel use and potential in the Mountain Plains Region (MPR) as well as benefit/cost analysis of switching from traditional to alternative fuels (such as ethanol and biodiesel) for a specific university in the region. The study will analyze users that would be affected by alternative fuel policy mandates and also examine potential demand for such products. Included will be a comparison of existing alternative fuels and related effects on the transportation sectors, as well as an overview of associated mandates/incentives that have been implemented in other states.

1. INTRODUCTION

Fuel shortages and increased dependency on foreign oil during the 1970s, the Persian Gulf War in the 90s, the second Gulf War in 2003, natural disasters such as hurricane Katrina, periodic disruptions and other crises have regenerated interest in renewable fuel sources. Regulations and air quality guidelines of the Environmental Protection Agency (EPA) have also created the awareness and need to switch to cleaner burning fuels for a cleaner environment. Taking effect in 2006 for example, the EPA requires a significant reduction in the sulfur content in diesel fuels. Alternative fuels are becoming increasingly available and more readily consumed, in part due to policy mandates.

Several policies are currently in place requiring all gasoline sold in certain states contain a specific percentage of ethanol. Ethanol production in the United States has seen a steady incline starting in 1980, with annual production of approximately 175 million gallons and reaching more than 4.9 billion gallons in 2006 (Renewable Fuels Association 2007). The production and use of biodiesel is also on the rise. In just two years, from 2004 to 2006, biodiesel production expanded from 28 million gallons to 287 million gallons (Government Accountability Office 2007).

Several state and private vehicle fleets have been experimenting with various percentages of biodiesel blends. Minnesota became the first to successfully implement a statewide B2 program which requires almost all diesel fuel sold to have a blend of at least 2% biodiesel. Other states seem certain to follow. The first statewide law of this kind will likely not be the last to significantly impact transportation, particularly vehicle fleets and the trucking industry. At the present time, alternative fuels are gaining popularity but not commonly used by transportation service providers in the MPR. This study will include an overview of alternative fuel use and availability in the MPR as well as determining and outlining the key factors influencing the use or non-use of alternative fuels like ethanol and biodiesel by transportation service providers in the region. The study will also offer estimates of direct and indirect costs and benefits associated with switching to alternative fuel use in a case study of North Dakota State University facility vehicles. Other alternative fuel case study examples are also included.

2. FEDERAL GUIDANCE AND PROVISIONS

The Air Pollution Control Act of 1955 was the first federal law that identified air pollution as a national concern. In 1963, the first Clean Air Act was passed by Congress with successive amendments to the Act in 1965, 1966, 1967, 1970, and 1990. Subsequent Clean Air Acts have provided a progressive framework to meet the goals of reduced greenhouse gas emissions and air quality standards in the United States.

On October 24, 1992, Congress passed the Energy Policy Act of 1992 (EPAct). The goals of EPAct of 1992 were aimed toward reducing the United States' dependence on foreign oil and increasing preservation of environmental quality. The EPAct of 1992 takes into account all aspects of energy supply and demand, common forms of energy, nuclear power, alternative fuels, renewable energy, and energy efficiency. According to the U.S. Department of Energy (USDOE), their mission is to decrease the nation's dependence on foreign oil by replacing 30% of petroleum-based motor fuels by the year 2010. The Act provides the USDOE necessary assistance by mandating the purchase and use of alternative fuel vehicles for federal, state, and alternative fuel provider fleets. Under the EPAct of 1992, 75% of new, light-duty vehicles that are part of federal or state fleets must be alternative fuel vehicles (AFVs) and 90% of light-duty vehicles acquired by alternative fuel providers must be AFVs. Compliance is required by state and alternative fuel provider fleets that operate, lease, or control 50 or more light-duty vehicles (vehicles that have gross vehicle weight ratings of 8,500 lb. or less) within the United States.[1] Fleets earn credits for each vehicle purchased. Credits earned in excess of requirements can be banked or traded with other fleets. According to the USDOE, the system gives fleets flexibility in meeting their requirements.

For vehicles with diesel engines, the Energy Conservation Reauthorization Act (ECRA) of 1998 amended the EPAct to allow fleets to generate one AFV acquisition credit for every 450 gallons of 100% biodiesel (B100), which is the equivalent to 2,250 gallons of 20% biodiesel (B20), purchased for use in diesel vehicles more than 8,500 lb GVWR. To receive credit for an AFV acquisition, biodiesel must be B100 or in blends that contain at least 20% biodiesel (B20). Federal fleets are allowed to use these credits only to fulfill up to 50% of their EPAct requirements, and the credits can be claimed only in the year in which the fuel is purchased for use, and they cannot be traded among fleets.

On August 8, 2005, EPAct was amended once again to include several new provisions, which offer consumers and businesses federal tax credits that began in January 2006 for purchasing fuel-efficient hybrid-electric vehicles and other energy efficient products. Most of these tax credits remained in effect through 2007 (USDOE). New provisions in the 2005 EPAct include a small producer biodiesel and ethanol credit. These credits are aimed at benefiting small agri-biodiesel producers by giving them a 10 cents per gallon tax credit for up to 15 million gallons of agri-biodiesel produced. In addition, the limit on production capacity for small ethanol producers increased from 30 million to 60 million gallons. The provision is in effective until the end of 2008. Fueling stations are also eligible to claim tax credits (30%) for the cost of installing clean-fuel vehicle refueling equipment. An example of such equipment would be E85 ethanol fueling stations. Under the provision, a clean fuel is any fuel that consists of at least 85% ethanol, natural gas, compressed natural gas, liquefied natural gas, liquefied petroleum gas, hydrogen and any mixture of diesel fuel and biodiesel containing at least 20% biodiesel. The credits to fueling stations are effective through December 31, 2010.

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[1] At the time of this report, the EPAct rule applies to the states of Colorado and Utah. Of the 50 light-duty vehicles, at least 20 must be used primarily within a single Metropolitan Statistical Area (MSA) /Consolidated Metropolitan Statistical Area (CMSA). DOE has defined covered MSA/CMSA areas by the 1980 U.S. Census population figures and by the 1990 U.S. Census MSA/CMSA area definitions. More specific information can be found at: http://www1.eere.energy.gov/vehiclesandfuels/epact/state/index.html

Tables 2.1 and 2.2 provide comparisons among states in the MPR regarding types of regulations in place and incentives available in the areas of alternative fuel production and use. These regulations and incentives can apply to producers, vendors, and/or users.

Table 2.1 Alternative Fuel State Regulations (Source: U.S. Department of Energy)

Regulations/State	**Colorado**	**Montana**	**North Dakota**	**South Dakota**	**Utah**	**Wyoming**
Acquisition Requirements	✓	✓		✓		
Fuel Taxes		✓	✓	✓	✓	
Idling Restrictions	✓				✓	
Registration Requirements	✓	✓		✓	✓	✓
Fuel Production Standards				✓		
Vehicle Driving Restrictions					✓	
Energy-Based Economic Development Plans		✓				
Renewable Fuel Mandate		✓*			✓*	

(✓=Regulations in place)

Definitions

Acquisition Requirements - Adoption policy or requirement for vehicles and equipment to be fueled with alternative fuels.
Fuel Taxes - Redemptions, reductions, and/or fees
Idling Restrictions - Time limits for idling vehicle engines
Registration Requirements - Alternative fuel user/producer/vendor reporting or licensing system
Fuel Production Standards - Requirements regarding labeling, tolerance, dispensing and other specifications
Vehicle Driving Restrictions - Low-speed vehicle access to certain highways
Energy-Based Economic Development Plans - State promotions, policy, and guidelines for energy-based economic development
*Renewable Fuel Mandate - State law for alternative fuel blend (Utah Air Quality Board - Authorized to mandate fleet vehicles to use alternative fuels if necessary in order to meet air quality standards. Montana - 10% ethanol blend must be used in motor vehicles on public roads within one year after the Montana DOT has certified the state has produced 40 million gallons of ethanol.)

Table 2.2 Alternative Fuel State Incentives (Source: U.S. Department of Energy)

Incentives/State	**Colorado**	**Montana**	**North Dakota**	**South Dakota**	**Utah**	**Wyoming**
Grants			✓		✓	
Tax Incentives	✓	✓	✓	✓	✓	✓
Rebates	✓					
HOV Lane Access	✓				✓	
Exemptions from Requirements/Restrictions	✓				✓	
Fuel Discounts	✓					
Technical Assistance	✓				✓	✓

(✓=Incentives in place)
Definitions
Grants- Production grants and/or infrastructure grants, loans and leases.
Tax Incentives - Tax credits, incentives and reductions for purchases, production and use of alternative fuel resources
Rebates - Monetary allowances for purchase of, or conversion to an alternatively fueled vehicle
High Occupancy Vehicle (HOV) Lane Access - May operate in HOV lanes regardless of the number of occupants in the vehicle.
Exemptions from Requirements/Restrictions - (Examples: Utah - Metered parking exemption. Colorado - Gross vehicle weight for alternative fuel vehicles are 1,000 pounds greater than conventionally fueled vehicles.)
Fuel Discounts - Services offered for natural gas rate reductions and infrastructure maintenance
Technical Assistance - Programs offering consultation on natural gas conversion and infrastructure.

The reader should note that federal and state regulations, provisions, and incentives are continually evolving and the information in this section is subject to change. The mandates included in the tables above are current at the time of this report.

3. UNITED STATES ALTERNATIVE FUEL TRENDS

While the trends for alternative fuels in the United States have focused on biodiesel and ethanol in recent years, there are various other options for abandonment of traditional petroleum fuels. Other options include electricity, hydrogen fuel, methanol, natural gas, propane, and P-series fuel. Alternative fuels are increasingly important for the United States in the attempt to decrease dependency on foreign oil. An alternative fuel is one made from something other than petroleum. As mentioned above, the two biggest players in the alternative fuels world today are ethanol and biodiesel. The significance of these fuels in agricultural states is manifested due to the markets they create for various commodities. Biodiesel can be made from several things, but most commonly soybeans and canola. Ethanol can be made using corn or barley, and there is continuous research for use of other renewable ingredient materials. Building alternative fuel plants in agricultural states that produce these crops can be advantageous for producers if the resulting fuel products have a substantial market.

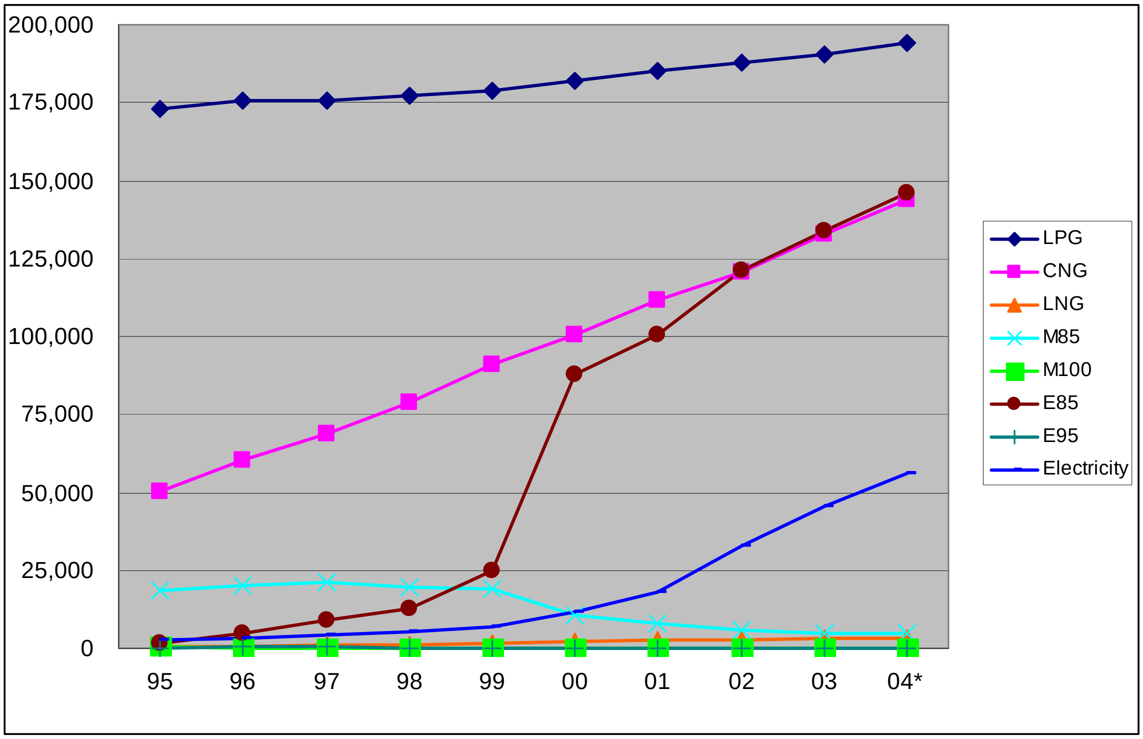
Alternative fuel vehicles (AFVs) are the users of these alternative fuels and are gaining momentum in the U.S. for various reasons. Central Texas Clean Cities summarizes the Energy Policy Act's definition of an AFV as "any dedicated, flexible-fueled, or dual-fueled vehicle designed to operate on at least one alternative fuel." (www.ci.austin.tx.us/cleancities/afterms.htm). Looking at trends in the use of alternative fuels and AFVs is useful in this topic discussion. Table 3.1 provides a legend for abbreviations of various alternative fuel types that coincide with Figure 3.1 through Figure 3.3.

Table 3.1 Alternative Fuels Legend Key

Abbreviation	Complete Name
LPG	Liquefied Petroleum Gases
CNG	Compressed Natural Gas
LNG	Liquefied Natural Gas
M85	Methanol, 85%
M100	Methanol, Neat
E85	Ethanol, 85%
E95	Ethanol, 95%
Electricity	excludes hybrids

Figure 3.1 reveals yearly statistics for the number of AFVs in use in the United States over a 10-year period with a projected number for 2004. Liquefied petroleum gas (LPG) vehicles have outnumbered all other AFVs in the United States over the 10-year period. The number of compressed natural gas (CNG) vehicles ranked second behind LPG until 2002 when E85 vehicles reached and outnumbered CNG vehicles 120,951 to 120,839 (Energy Information Association, 2007). E85 vehicles have shown the greatest annual growth rate (more than 78%) over the 10-year period, with the most significant increase during the 1999 to 2000 period. A reason for the large increase in E85 vehicles is related to the interest and increased production in ethanol in the United States. Annual growth rates for all but M85, M100, and E95 have been positive. M85 has shown a negative 14% growth rate over the 10-year period. M100 and E95 have had zero growth.

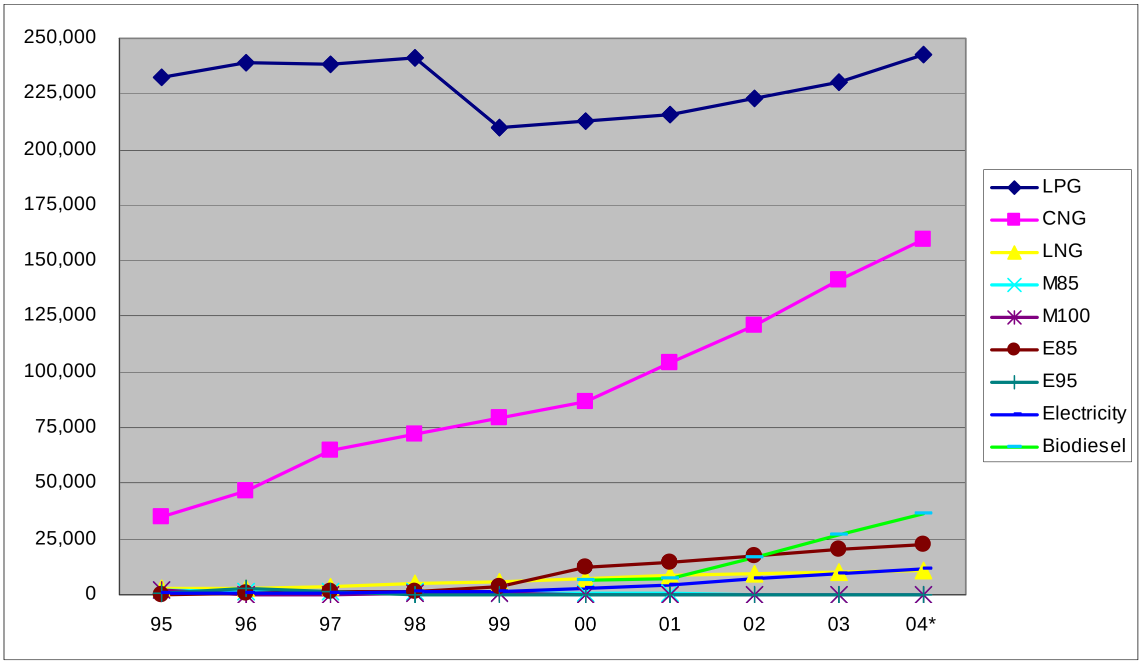
Figure 3.1 Alternative Fuel Vehicles, U.S.



Source: Energy Information Association, U.S. Department of Energy
Note: 2004* number are projections

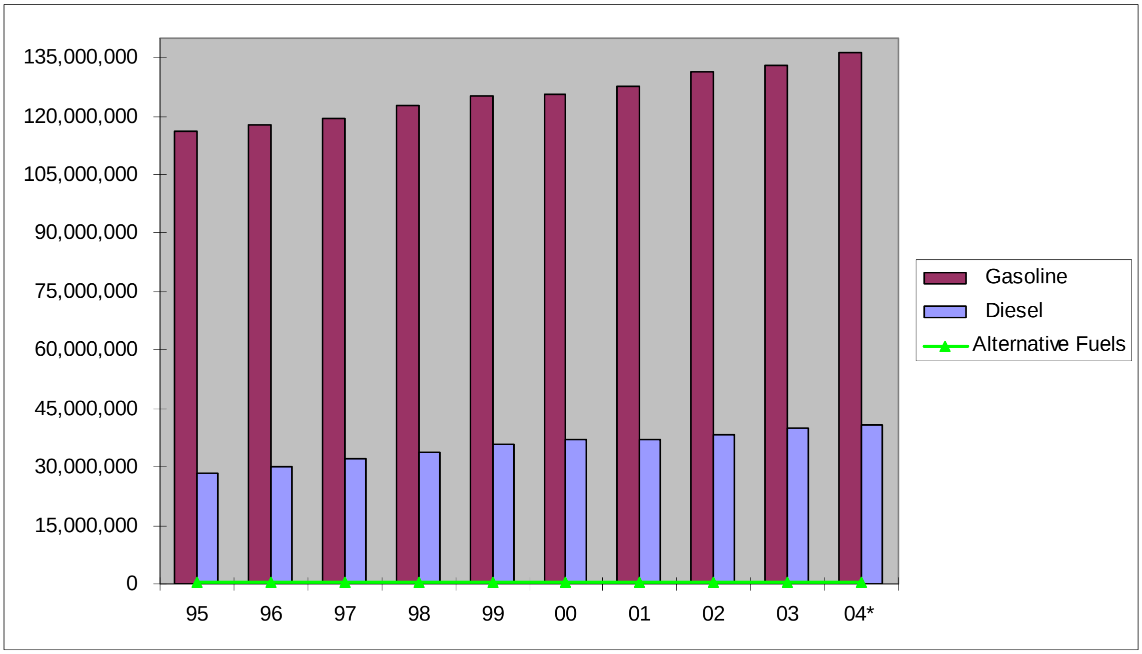
Figure 3.2 illustrates increases in all types of alternative fuel use with the exception of M85, M100, and E95. Figure 3.3 provides a comparison of traditional fuel and alternative fuel usage. As shown, alternative fuel consumption, although a growing trend in the United States, is diminutive in comparison to that of traditional gasoline and diesel. In order to comprise a substantial portion of fuel use in this country, major changes would need to occur in legislation and consumer thinking regarding vehicle fuel purchases. Supply and demand of fuel to meet transportation needs in the United States would be nearly impossible to meet solely with the ethanol and biodiesel markets that are currently on the rise.

Figure 3.2 Alternative Fuel Use (1,000 gasoline equivalent gallons)



Source: Energy Information Association, U.S. Department of Energy

Figure 3.3 U.S. Fuel Consumption, Traditional versus Alternative (all alternative fuels combined) (1,000 gallons)



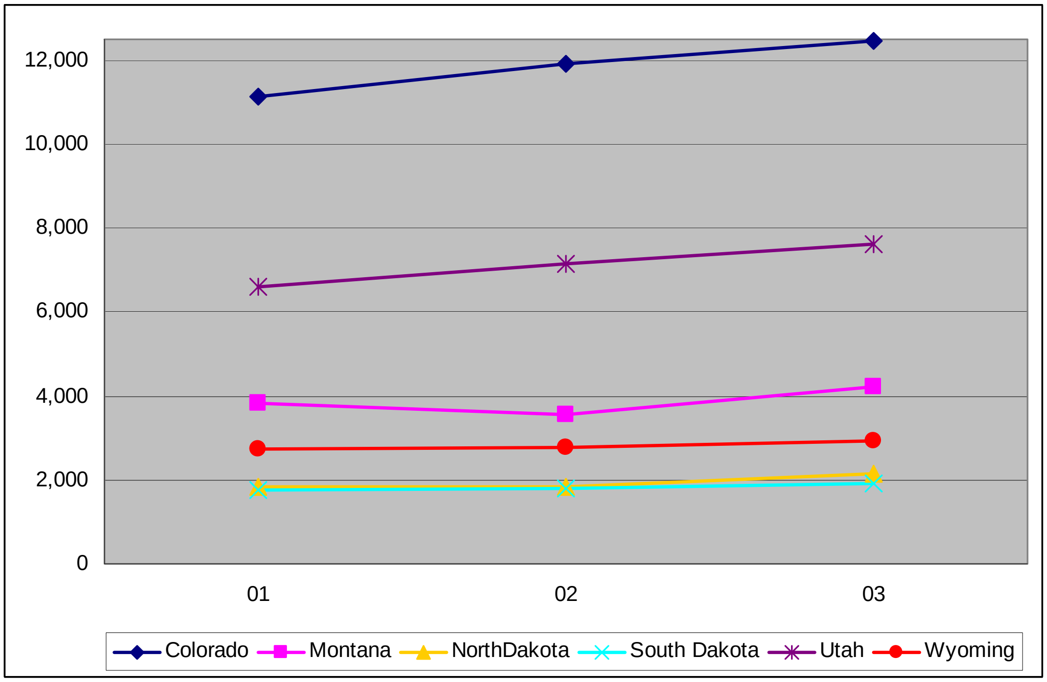
Source: Energy Information Association, U.S. Department of Energy

4. MOUNTAIN PLAINS REGION ALTERNATIVE FUELS OVERVIEW AND TRENDS

The MPR is comprised of the following states: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming plus 27 tribal nations. Most of the land in these states is rural and sparsely populated. Agriculture plays an important role in the MPR states, and the growth trend in alternative fuels presents an opportunity for these states to contribute energy for transportation.

Figure 4.1 shows the number of AFVs in use in MPR states from 2001 to 2003. There has been an increase in all six states, although most substantially in Colorado and Utah, which again are the most populous states in this region. In 2003, the total number of AFVs reached over 12,000 in Colorado and nearly 8,000 in Utah. The urban centers in these two states, including Denver and Salt Lake City, offer a driving environment more conducive to today's AFV technology. On the other end of the spectrum, the totals for South and North Dakota were roughly 2,000 AFVs for the same year.

Figure 4.1 Alternative Fuel Vehicles in MPR States



Source: Energy Information Association, U.S. Department of Energy, http://www.eia.doe.gov/cneaf/alternate/page/datatables/aft1-13_03.html

While total numbers are important for determining trends, it is helpful to look at the number of AFVs per driver in each state for relative comparisons of alternative fuel use. The numbers in Figure 4.1 show total numbers of vehicles, which may be irrelevant to the discussion of the MPR states because of the low-populations in most of the states. Table 4.1, therefore, compares the number of AFVs per licensed driver. That is, taking the 2003 number of AFVs per 2004 licensed driver, as stated by the 2004 Highway Statistics (FHWA 2005). When comparing the states using these numbers, the highest ratios are seen in Wyoming and Montana. AFV per 1000 licensed drivers in Wyoming is nearly 7.7 and in Montana it is 5.9. In other words, there is about one AFV per 130 people driving in Wyoming; while in Montana, there is one AFV per approximately every 170 drivers in the state. Last on the list is South Dakota with a ratio of 3.3, meaning there is one AFV for every 300 drivers.

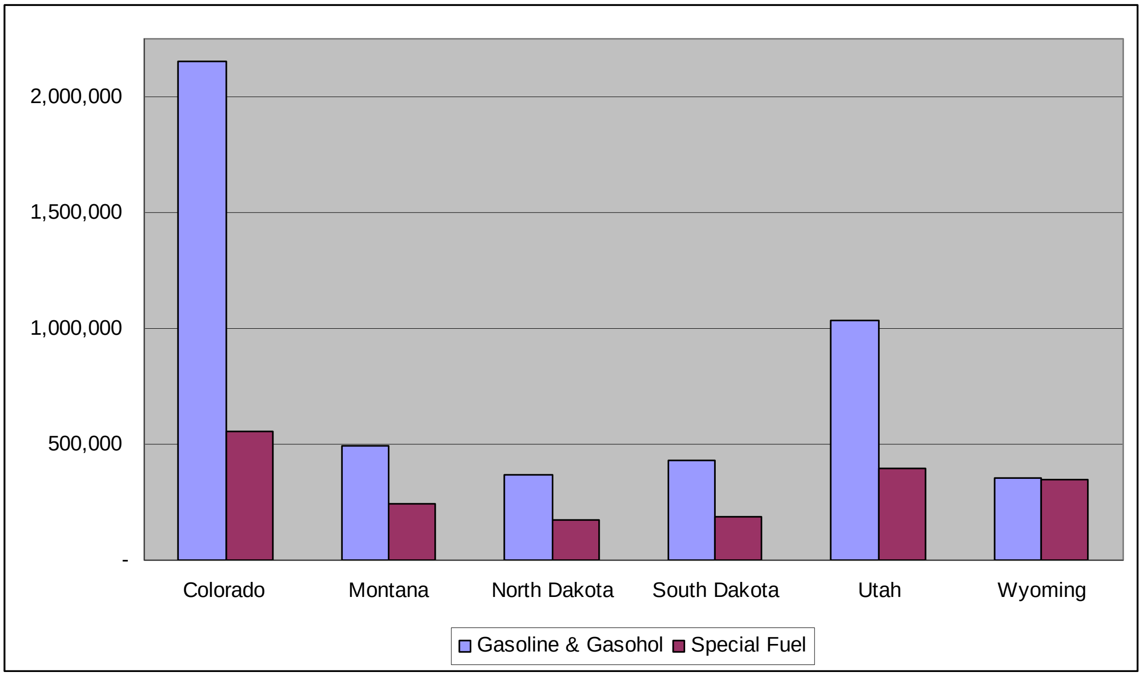
Table 4.1 Alternative Fuel Vehicle Comparison, MPR States

State	Drivers	AFVs - 2003	AFVs per 1000 drivers
Wyoming	380,180	2,924	7.69
Montana	712,880	4,228	5.93
Utah	1,582,599	7,621	4.82
North Dakota	461,780	2,133	4.62
Colorado	3,205,054	12,447	3.88
South Dakota	563,298	1,906	3.38

Sources: Energy Information Association, U.S. Department of Energy,
http://www.eia.doe.gov/cneaf/alternate/page/datatables/aft1-13_03.html
Federal Highway Administration, 2004 Highway Statistics, http://www.fhwa.dot.gov/policy/ohim/hs04/dl.htm

Figure 4.2, Table 4.2, and Table 4.3 summarize the states in the MPR and their associated use of motor fuels for the year 2005. Gasoline and gasohol is separated from special fuels in these tables. The special fuels category, according to the FHWA, is composed of mostly diesel fuel, but also includes liquefied petroleum gas. Numbers included are total number of gallons used in each state, number of drivers in each state, and ratio of gallons per driver. The ratio enables a state-to-state comparison despite the differences in land area and population. The tables have ranked the states in order from top to bottom with the top states using the least gas or special fuels per driver. Gas use is highest in the state of Wyoming, where the gallons per driver is 1,133. North Dakota is the second highest in the MPR with 766 gallons per licensed driver. The states with the least amount of gas used per driver are South Dakota (652 gallons per driver) and Utah (655 gallons per driver). Wyoming and North Dakota also rank highest when looking at special fuels per licensed driver, with 910 gallons and 373 gallons of diesel per driver, respectively. On the other end, Colorado and Utah come in number one and two, with 173 and 249 gallons per driver use of diesel fuel, respectively.

Figure 4.2 Motor Fuel Use, MPR States (1,000 gallons)



Source: FHWA, Highway Statistics 2005

Table 4.2 Gasoline and Gasohol Use, MPR States 2005

State	Gasoline & Gasohol gallons	Drivers	Gasoline/Driver Ratio
South Dakota	367,259,000	563,298	652
Utah	1,035,953,000	1,582,599	655
Colorado	2,149,600,000	3,205,054	671
Montana	493,946,000	712,880	693
North Dakota	353,831,000	461,780	766
Wyoming	430,597,000	380,180	1,133

Source: FHWA, Highway Statistics 2005

Table 4.3 Special Fuels Use, MPR States 2005

State	Special Fuels* gallons	Drivers	Special Fuels/ Driver Ratio
Colorado	554,018,000	3,205,054	173
Utah	393,790,000	1,582,599	249
South Dakota	186,913,000	563,298	332
Montana	246,433,000	712,880	346
North Dakota	172,253,000	461,780	373
Wyoming	346,054,000	380,180	910

Source: FHWA, Highway Statistics 2005

Note* - Special fuels *are primarily diesel* with some liquefied petroleum gas

5. MOUNTAIN PLAINS REGION BIODIESEL AND ETHANOL OVERVIEW

Currently the United States has 105 biodiesel production facilities and 77 under construction. The MPR has six biodiesel plants that are currently in production as well as four under construction as of January 2007 (www.biodiesel.org). Total production capacity for biodiesel plants that are currently producing in the MPR is 43 million gal. per year. This total capacity number is based on maximum production capacity, not actual production. Table 5.1 lists biodiesel plants in the MPR that are currently producing fuel or are under production.

Table 5.1 Mountain Plains Region Biodiesel Plants, 2007

State	Company	City	Production Capacity mgy	Feedstock (main)	Status
CO	American Agri-Diesel LLC	Burlington	6,000,000	Soybean Oil	Currently producing
CO	Bio Energy of America	Denver	8,000,000	Soybean Oil	Currently producing
CO	Bio Energy of America	Commerce City	10,000,000	Soybean Oil	Currently producing
CO	Rocky Mountain Biodiesel Industries, LLC	Berthoud	3,000,000	Multi Feedstock	Currently producing & expansion
SD	Midwest BioDiesel Producers, LLC	Alexandria	7,000,000	Soybean Oil	Currently producing
UT	Domestic Energy Partners	Spanish Fork	9,000,000	Multi Feedstock	Currently producing
CO	Great White Bottling, Inc.	Denver	4,000,000	Soybean Oil	Under construction
ND	ADM	Velva	85,000,000	Canola Oil	Under construction
ND	All American Biodiesel	York	2,000,000	Soybean Oil	Under construction
ND	Dakota Skies	Minot	30,000,000	Canola Oil	Under construction

Source: National Biodiesel Board 2007, www.biodiesel.org
Note* To the best of our knowledge at time of report

Ethanol production has dramatically increased since the 1980s. In 1980, United States ethanol production was roughly 175 million gal. That number rose to 870 million gal. in 1990 and in 2006 it was estimated to be more than 4.9 billion gal. (Renewable Fuels Association 2007). Due to the geographic concentration of corn production, ethanol production has traditionally been in or around the agricultural states of Iowa, Nebraska, Illinois, South Dakota, Minnesota, Indiana, and Kansas as well as a few other corn-producing states. However, ethanol plants have been constructed outside these states in the past few years. As of February 2007, there were 114 ethanol refineries in the United States and 78 under construction according to the Renewable Fuels Association.

The MPR has 20 ethanol plants that are currently producing fuel, five under construction and four whose status is unknown. Using those plants that are currently producing ethanol in the MPR, a maximum production capacity for the region is 842.5 million gal. per year. Table 5.2 lists ethanol plants in the MPR region. Another important logistics element for ethanol is E85 station locations. The number of E85 stations for each MPR state is listed in Table 5.3.

Table 5.2 Mountain Plains Region Ethanol Plants, 2007

State	Company	City	Production Capacity mgy	Feedstock (main)	Status
CO	Merrick & Company	Golden, CO	3	Waste beer	Currently producing
CO	Front Range Energy, LLC	Windsor, CO	40	Corn	Currently producing
CO	Sterling Ethanol, LLC	Sterling, CO	42	Corn	Currently producing
CO	Yuma Ethanol	Yuma, CO	40	Corn	Under Construction
ND	Alchem Ltd. LLLP	Grafton, ND	10.5	Corn	Currently producing
ND	Blue Flint Ethanol	Underwood, ND	50	Corn	Currently producing
ND	Red Trail Energy, LLC	Richardton, ND	50	Corn	Currently producing
ND	Archer Daniels Midland	Wallhalla, ND		Corn/barley	Currently producing
ND	US BioEnergy Corp.	Hankinson, ND		Corn	Unknown
ND	Yellowstone Ethanol LLC	Williston, ND	50		Unknown
ND	Spirit Ethanol LLC	Spiritwood, ND	100		Unknown
ND		Casselton, ND	100		Unknown
SD	Heartland Grain Fuels, LP*	Aberdeen, SD	9	Corn	Currently producing
SD	Broin Enterprises, Inc.*	Scotland, SD	11	Corn	Currently producing
SD	Heartland Grain Fuels, LP*	Huron, SD	12 (15 E)	Corn	Currently producing & expansion
SD	North Country Ethanol, LLC*	Rosholt, SD	20	Corn	Currently producing
SD	Dakota Ethanol, LLC*	Wentworth, SD	50	Corn	Currently producing
SD	Glacial Lakes Energy, LLC*	Watertown, SD	50 (50 E)	Corn	Currently producing & expansion
SD	Great Plains Ethanol, LLC*	Chancellor, SD	50	Corn	Currently producing
SD	James Valley Ethanol, LLC	Groton, SD	50	Corn	Currently producing
SD	Northern Lights Ethanol, LLC*	Big Stone City, SD	50	Corn	Currently producing
SD	Sioux River Ethanol, LLC*	Hudson, SD	50	Corn	Currently producing
SD	Prairie Ethanol, LLC	Loomis, SD	60	Corn	Currently producing
SD	VeraSun Energy Corporation	Aurora, SD	230 (330 E)	Corn	Currently producing & expansion
SD	Aberdeen Energy*	Mina, SD	100	Corn	Under Construction
SD	Millennium Ethanol	Marion, SD	100	Corn	Under Construction
SD	Missouri Valley Renewable Energy, LLC*	Meckling, SD	60	Corn	Under Construction
SD	Redfield Energy, LLC *	Redfield, SD	50	Corn	Under Construction
WY	Renova Energy	Torrington, WY	5	Corn	Currently producing

Source: Renewable Fuels Association 2007, www.ethanolrfa.org & NDDOT
Note* To the best of our knowledge at time of report

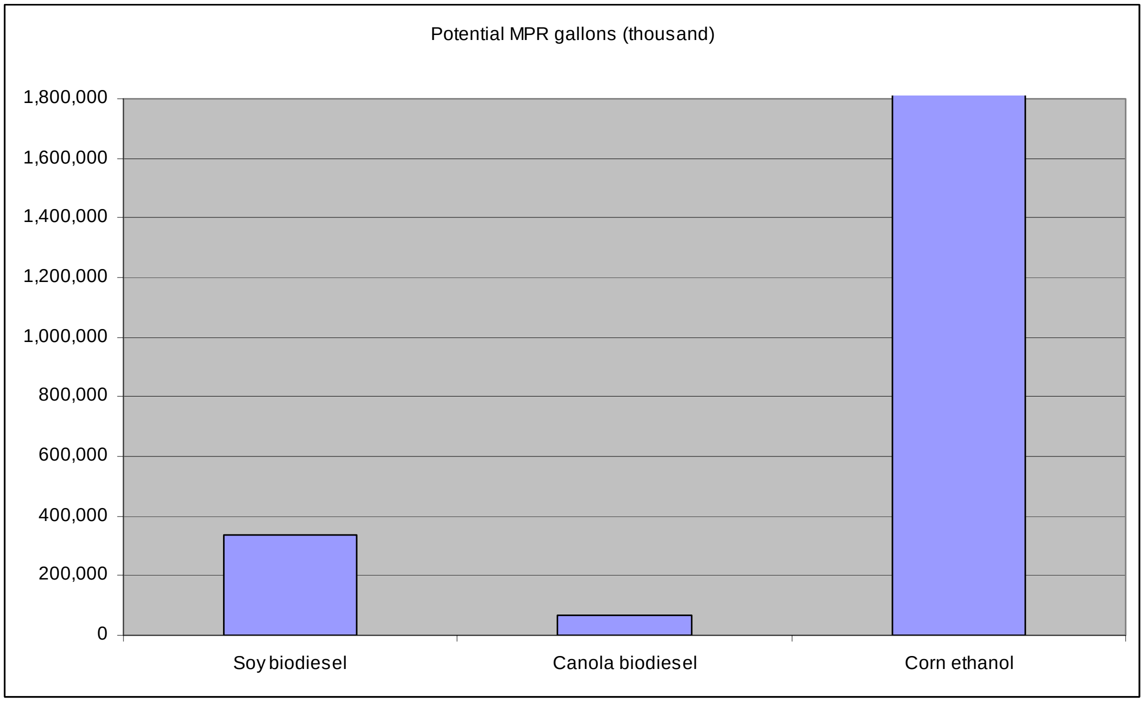
Table 5.3 Mountain Plains Region Number of E85 Stations (March 2007)

State	E85 Stations	
ND	24	
SD	59	
WY	6	
CO	25	
MT	3	
UT	4	
MPR	**121**	**10.4% of U.S. Total**

Source: Energy, Efficiency and Renewable Energy, U.S. Department of Energy, www.eere.energy.gov
Note* To the best of our knowledge at time of report

As mentioned previously, agriculture plays an important role in the MPR states. With the production of many commodities, there is potential for economic growth in the area of transportation. Corn, soybeans, and canola are the agricultural products used in this study because of the focus on ethanol and biodiesel. With the trends in alternative fuels presented, the opportunity for these states to contribute energy for transportation is clear. Figure 5.1 shows the maximum biodiesel (both from soybeans and canola) as well as the maximum ethanol made from corn that would be possible using total production of those three commodities from the MPR states.[2] The production estimates are a five-year average (2002 through 2006) from National Agricultural Statistics Service.

Figure 5.1 Mountain Plains Region Ethanol & Biodiesel Production Potential



Source: NASS, http://www.nass.usda.gov/index.asp

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[2] Estimates are based on the following conversions: A)1 bu. soybeans produces 1.49 gal. biodiesel (Gray 2006), B) 1 bu. corn produces 2.7 gal. ethanol (Gray 2006), C) 1 cwt. canola equals 4.97 gal. biodiesel (FAPRI).

Table 5.4, Table 5.5, Figure 5.2, and Figure 5.3 are based on three areas: 1) Fuel use (2002 through 2006) in the MPR, 2) maximum ethanol and biodiesel production capacity based on corn, soybean, and canola production trends in the MPR, and 3) current ethanol and biodiesel production capacity in the MPR. Table 5.4 summarizes the amount of gasoline and diesel used in the MPR states in a one-year period (2005). Comparing these quantities to maximum potential production (which means using all corn production for gasoline and all soybean and canola production for biodiesel in the MPR states), shows the MPR states potentially could produce 38% of all gasoline used in the region and 21% of all diesel used in the region. The next set of numbers compares total fuel quantities used in the MPR states with the maximum total current facility production numbers. That is, using all the current ethanol and biodiesel facilities currently under production in the MPR, 17% of all gasoline used in the region could be produced (ethanol) and just over 2% of diesel could be produced (biodiesel).

Table 5.4 Mountain Plains Region Alternative Fuels Maximum Potential from Agricultural Production (1,000 gallons)

	2005		**Based on ag production average 2002-2006**			**Based on current facility production capacity**		
Fuel Type	MPR use [1]	U.S. use [1]	Potential MPR Alternative Fuels [2]	% MPR use	% U.S. use	Current Maximum MPR Production[3]	% MPR use	% U.S. use
Gasoline	4,831,186	139,988,554	1,851,558	38.33	1.32	842,500	17.44	0.60
Diesel*	1,899,461	39,110,963	403,802	21.26	1.03	43,000	2.26	0.11

Note* Diesel use are from “special fuels” and are *primarily diesel* with some liquefied petroleum gas

Note* Potential biodiesel gallons are based on soybean and canola biodiesel. Potential ethanol gallons are based on ethanol from corn

Sources:

[1] FHWA, Highway Statistics, http://www.fhwa.dot.gov/policy/ohim/hs05/motor_fuel.htm

[2] NASS, www.nass.usda.gov/index.asp

[3] Source: Renewable Fuels Association 2007, www.ethanolrfa.org & National Biodiesel Board 2007, www.biodiesel.org

Figure 5.2 Mountain Plains Region Current Ethanol Production Capacity and Maximum Potential Capacity as Percent of Current Gas Use in the Region

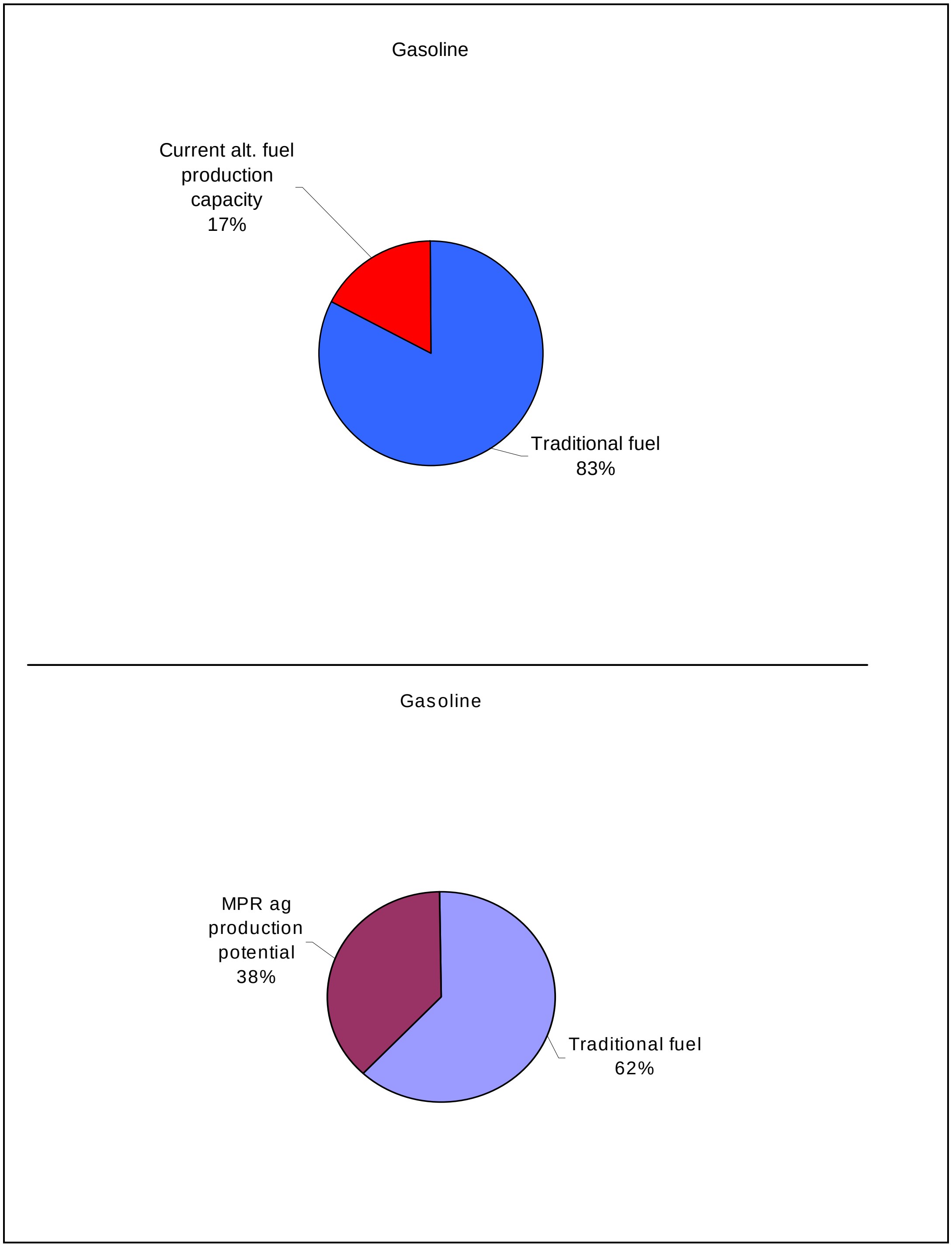

Figure 5.3 Mountain Plains Region Current Biodiesel Production Capacity and Maximum Potential Capacity as Percent of Current Diesel Use in the Region

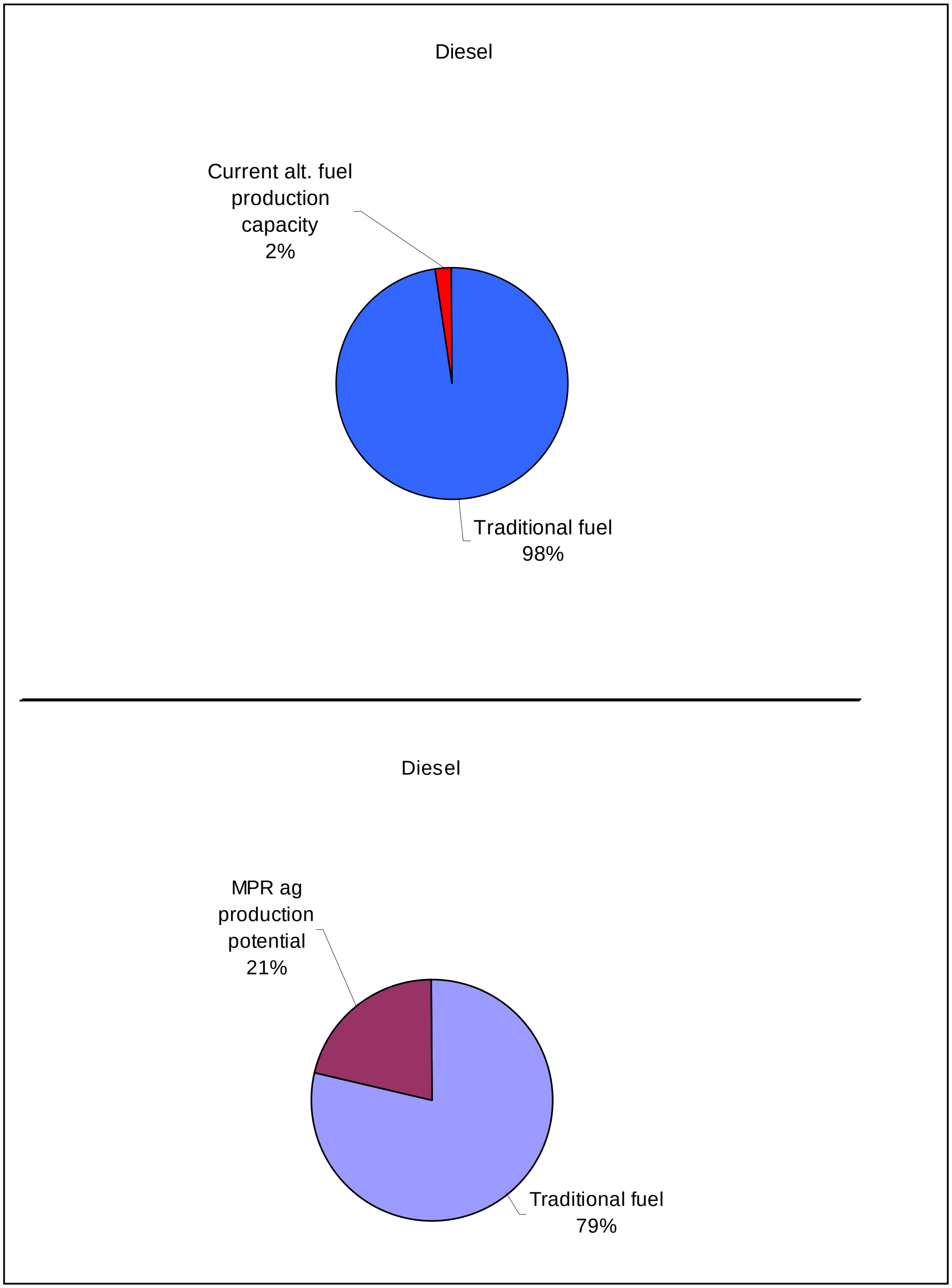

Table 5.5 Mountain-Plains Region Alternative Fuels Potential Range from Agricultural Production (1,000 gallons)

	Soybeans & canola	Corn	Biodiesel		Ethanol	
Percent of agricultural production	**Potential biodiesel gallons**	**Potential ethanol gallons**	**% MPR use**	**% U.S. use**	**% MPR use**	**% U.S. use**
100	403,802	1,851,558	21.26%	1.03%	38.33%	1.32%
75	302,852	1,388,668	15.94%	0.77%	28.74%	0.99%
50	201,901	925,779	10.63%	0.52%	19.16%	0.66%
25	100,951	462,889	5.31%	0.26%	9.58%	0.33%
10	40,380	185,156	2.13%	0.10%	3.83%	0.13%

Note* Potential biodiesel gallons are based on soybean and canola biodiesel. Potential ethanol gallons are based on ethanol from corn.
Sources:
[1] FHWA, Highway Statistics, http://www.fhwa.dot.gov/policy/ohim/hs05/motor_fuel.htm
[2] NASS, www.nass.usda.gov/index.asp

Using commodity production data from the MPR region, the maximum, ethanol-producing number from ethanol plants currently producing fuel (842.5 mgy), would use up 45.5% of all corn produced in the region (using a five-year production average).

The MPR biodiesel plants that are currently producing fuel have a maximum production capability of 43 mgy. Using 31 mgy based on soybean biodiesel, and 12 mgy from canola (based on the biodiesel.org data indicating primary feedstock, and using canola for "multi feedstock" and soybeans for soybean oil feedstock), 9.1% of MPR's soybean production and 17.9% the region's canola production would be used up with current biodiesel plant capacity for the MPR.[3] The question added to the mix is: How much of these commodities can realistically be used for production of alternative fuels? Even if legislation was in effect, as well as purchasing behavior lining up with biodiesel and ethanol use, these commodities are needed in other markets. In addition, while a large amount of the region's agricultural production could be utilized to make ethanol and biodiesel fuels, the quantities produced would account for only small percentages of what is truly used in the region (see Figure 5.2 and Figure 5.3). Putting all these elements together makes the alternative fuel issue even more complex.

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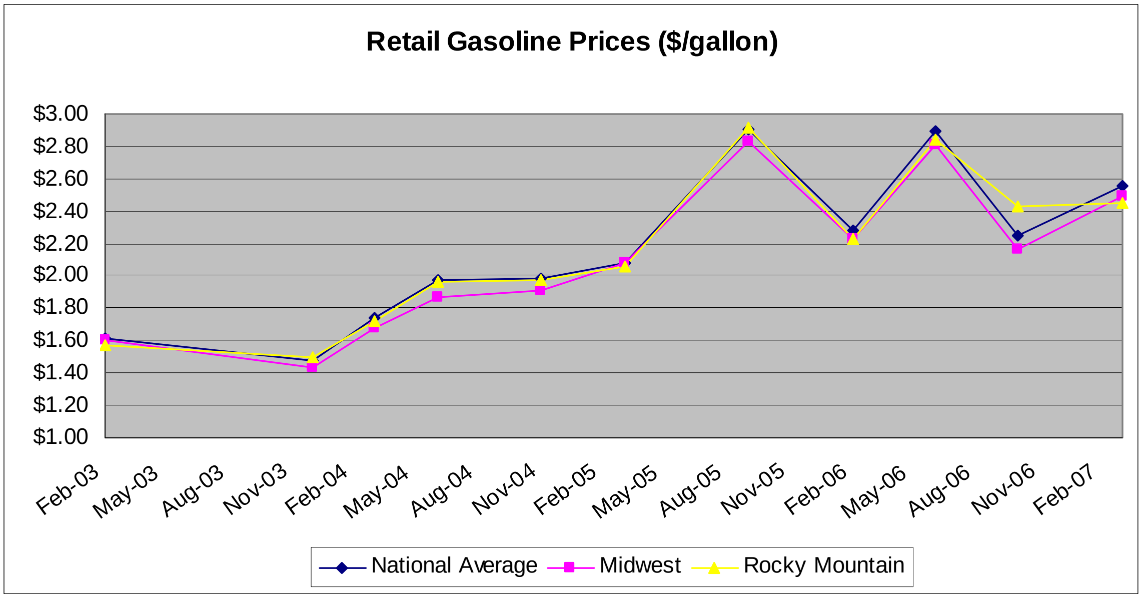
[3] Assuming 1 bu. corn = 2.7 gallons ethanol, 1 bu. soybeans = 1.49 gal. biodiesel, and 1 cwt. canola = 4.97 gal. biodiesel, and NASS production statistics from 2002-2006.

6. ALTERNATIVE FUEL PRICES

The price differential between traditional fuels and alternative fuels is important in the discussion of fuel use and success. A five-year price history shows cost trends for both types. The price information for gasoline and diesel (Figures 6.1 and 6.2) is from the Energy Information Administration, U.S. Department of Energy. Data is shown for the Midwest Region and Rocky Mountain region (as well as for the nation) because those are the two regions into which the Mountain Plains Region states fall.[4] Figures 6.3 through 6.6 depict price information for alternative fuels (biodiesel, ethanol, CNG, and propane) from the Alternative Fuels Data Center, U.S. Department of Energy.

Figure 6.2 Midwest, Rocky Mountain and National Average Retail Gasoline Prices per Gallon



Source: Energy Information Administration http://tonto.eia.doe.gov/dnav/pet/hist/mg_rt_usM.htm

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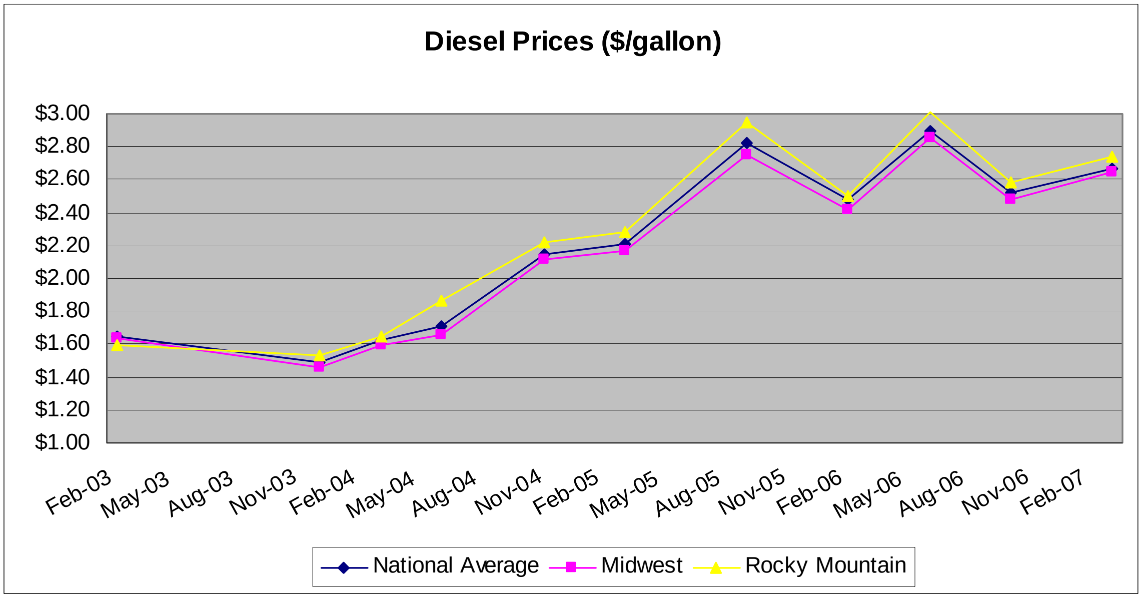
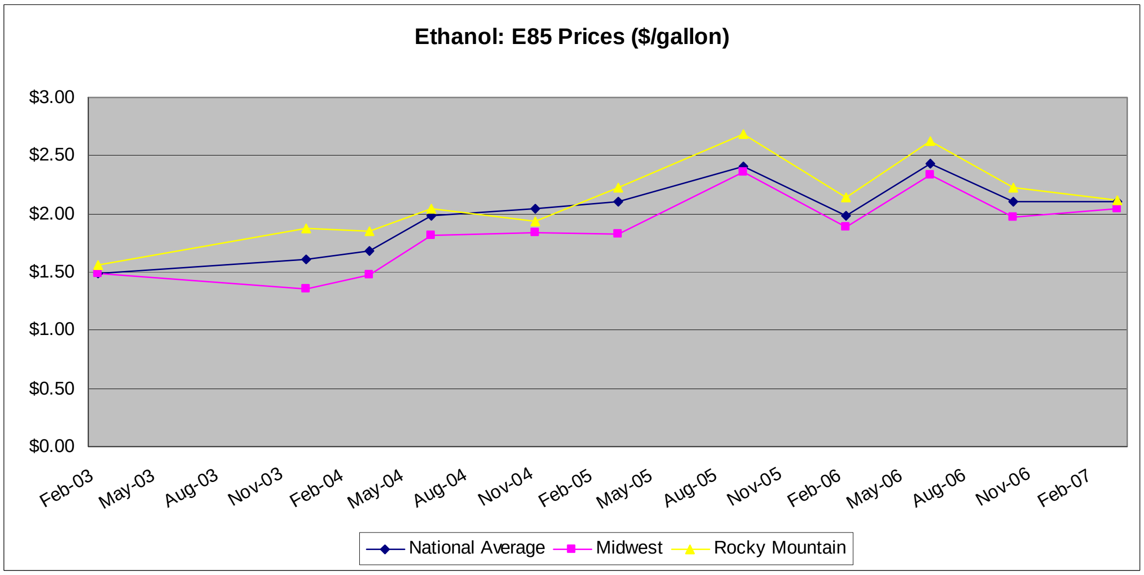
[4] The Energy Information Administration regions used here are those that contain the MPR states. The Rocky Mountain Region includes: Montana, Idaho, Wyoming, Utah and Colorado. The Midwest Region includes North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio, Kentucky, and Tennessee.

Figure 6.2 Midwest, Rocky Mountain and National Average Retail Diesel Prices per Gallon



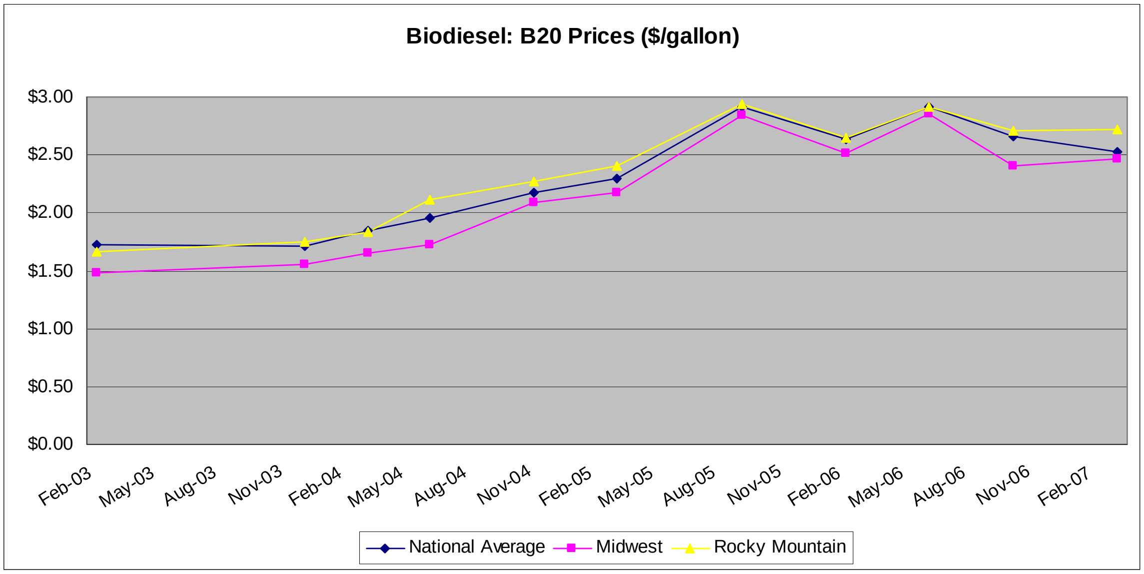
Source: Energy Information Administration, http://tonto.eia.doe.gov/dnav/pet/hist/ddr001M.htm

Figure 6.3 Midwest, Rocky Mountain and National Average Retail E85 Ethanol Prices per Gallon



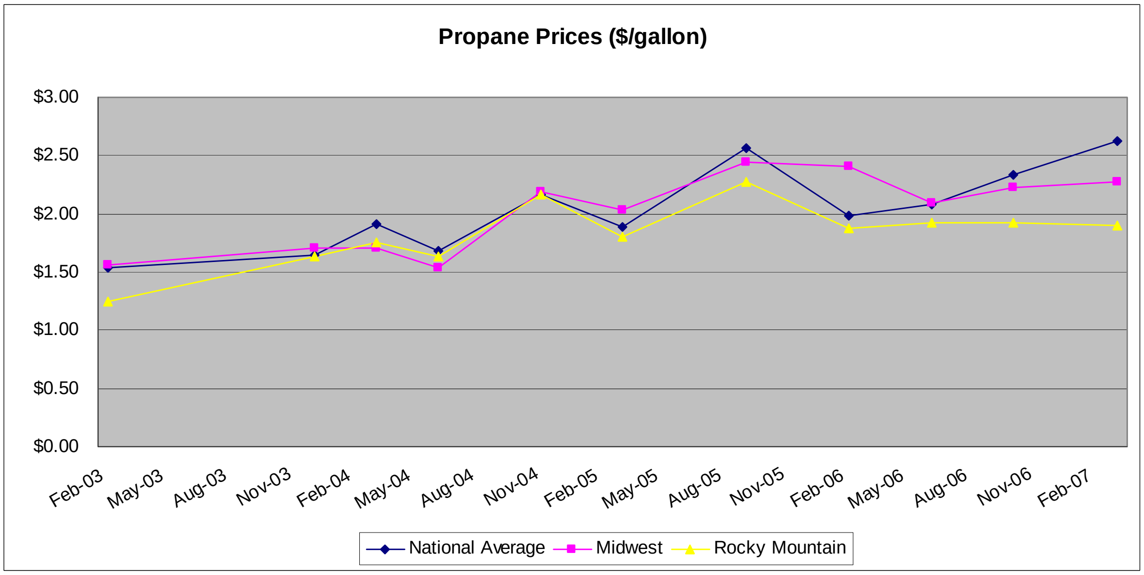
Source: Clean Cities Alternative Fuel Price Report, U.S> Department of Energy, Energy Efficiency and Renewable Energy, http://www.eere.energy.gov/afdc/resources/pricereport/price_report.html

Figure 6.4 Midwest, Rocky Mountain and National Average Retail B20 Biodiesel Prices per Gallon



Source: Clean Cities Alternative Fuel Price Report, U.S> Department of Energy, Energy Efficiency and Renewable Energy, http://www.eere.energy.gov/afdc/resources/pricereport/price_report.html

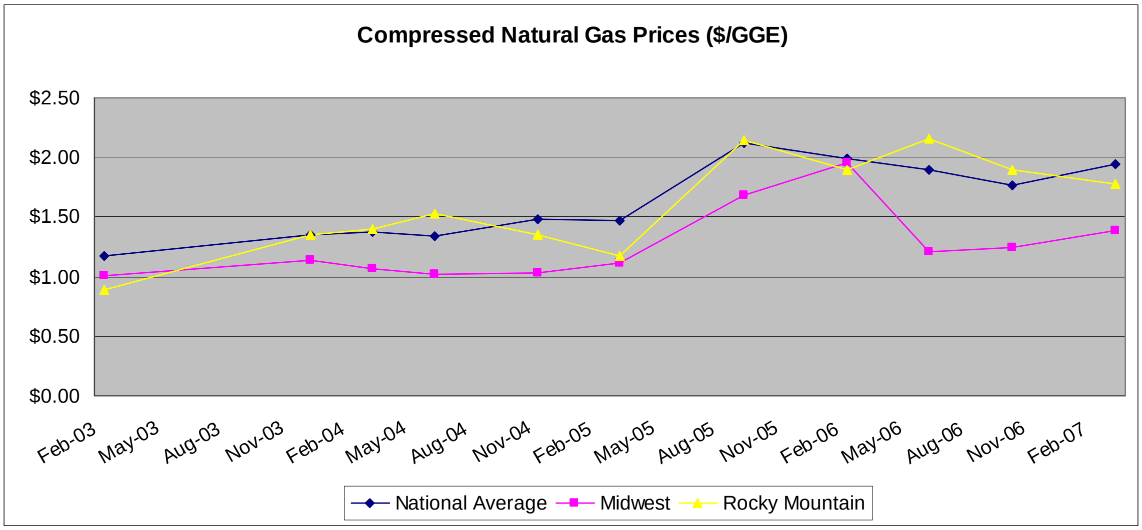
Figure 6.5 Midwest, Rocky Mountain and National Average Retail Propane Prices per Gallon



Source: Clean Cities Alternative Fuel Price Report, U.S> Department of Energy, Energy Efficiency and Renewable Energy, http://www.eere.energy.gov/afdc/resources/pricereport/price_report.html

Compressed natural gas (CNG) is commonly measured in kilograms because it is a gas, not a liquid like most fuels. However, it can be expressed in a gasoline gallon equivalent (GGE), which is the volume of fuel that is equal to the energy content of a gallon of gas. For example, according to the Alternative Fuels data center, “The GGE of CNG is 2.60 kg and its volume has the same energy content as one gallon of gasoline (based on 44,682 Btu/kg of CNG and 116,090 Btu/gal. of gasoline).” (“Frequently asked questions” Accessed online June 3, 2007). Compressed natural gas prices are displayed in Figure 6.6.

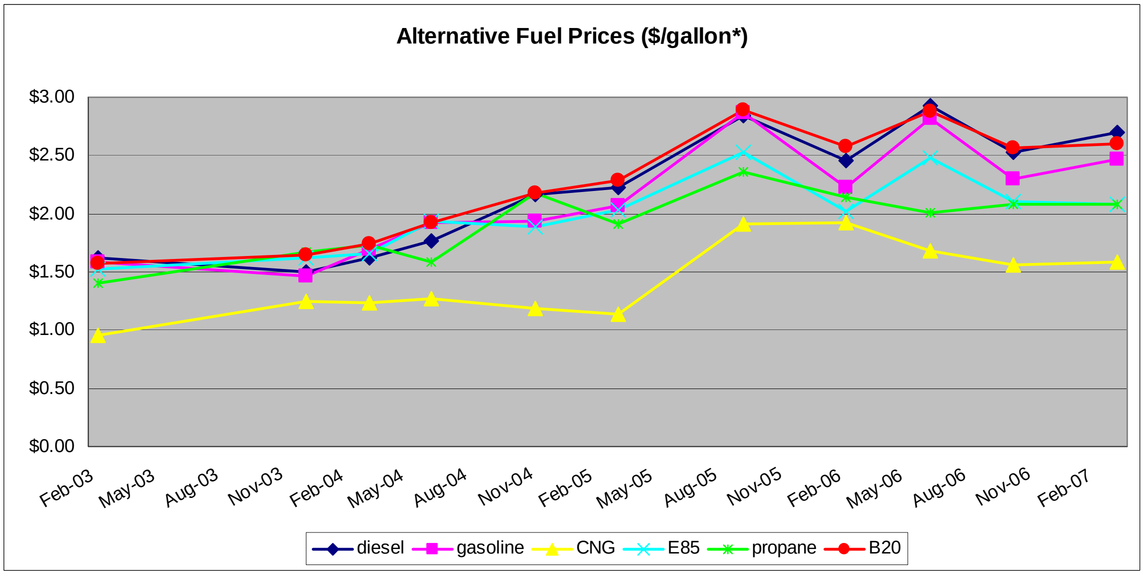
Figure 6.6 Midwest, Rocky Mountain and National Average Retail Compressed Natural Gas Prices per Gasoline Gallon Equivalent



Source: Clean Cities Alternative Fuel Price Report, U.S> Department of Energy, Energy Efficiency and Renewable Energy, http://www.eere.energy.gov/afdc/resources/pricereport/price_report.html

Figure 6.7 compares all fuel prices for the five-year period 2003 to 2007. The fuels are all expressed in dollars per gallon except for CNG, which is in GGE. In order to compare prices most representative of the MPR, prices for the Midwest and Rocky Mountain regions were averaged.

Figure 6.7 Five Year Comparison of Fuel Prices (All Fuels)



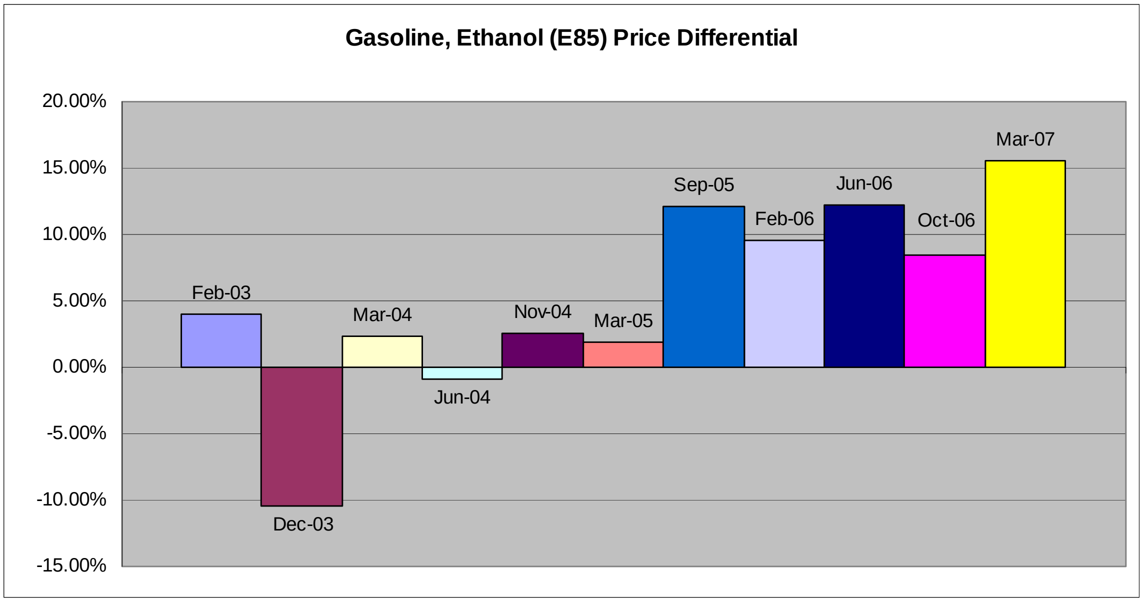
* Unit for CNG is GGE

Sources: 1. Energy Information Administration, http://tonto.eia.doe.gov/dnav/pet/hist/ddr001M.htm
2. Clean Cities Alternative Fuel Price Report, U.S> Department of Energy, Energy Efficiency and Renewable Energy, http://www.eere.energy.gov/afdc/resources/pricereport/price_report.html

7. PRICE DIFFERENTIAL

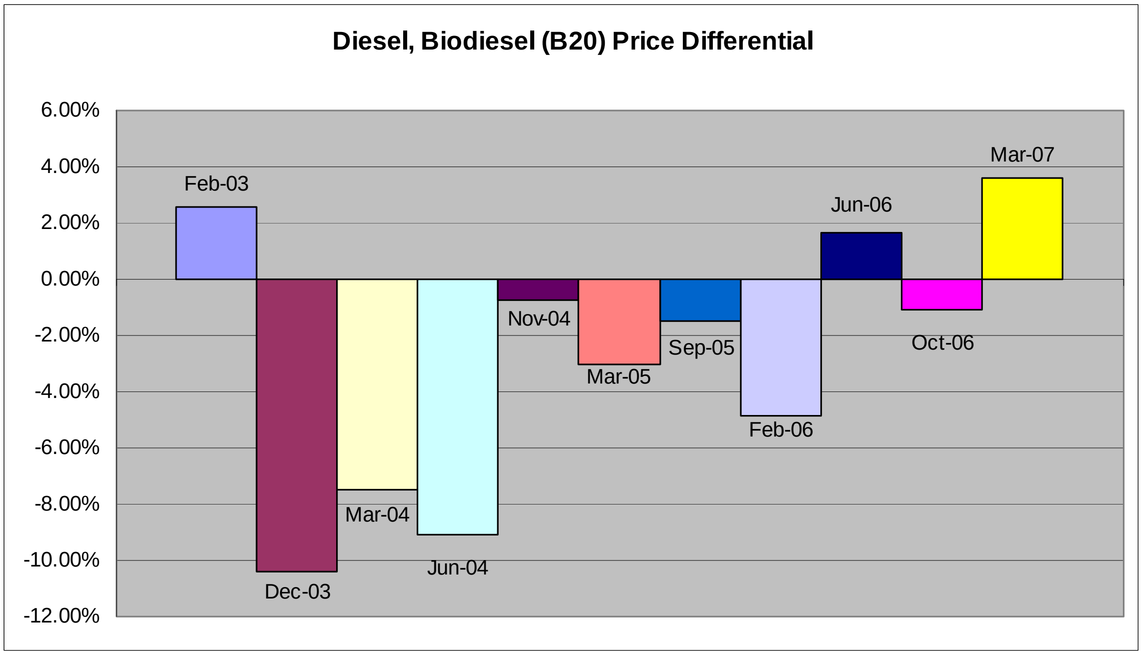
The two alternative fuels of main focus in this paper are ethanol and biodiesel. A more in-depth comparison of these fuels is shown in Figures 7.1 and 7.2. The price differentials for gasoline and ethanol are mostly positive (gasoline price minus ethanol price), meaning gas prices have mostly been higher than prices for E85 (Clean Cities Fuel Report & EIA.gov). Looking at Figure 7.1, the three most recent year differentials have increased substantially as gasoline prices have been high. This shows that ethanol has been competitive as an alternative fuel, making a good substitute economically for consumers in this region. The positive price differential can be attributed to a variety of factors besides high gas prices. There has been an increase in flexible fuel vehicles, which are those that can use E85 fuels. The availability of E85 stations also is a factor. While they are still sparse in places, the number of stations is growing. Again, the prices used for this comparison are the averages for the Midwest and Rocky Mountain regions because those are the Energy Information Administration (EIA) regions that include the states of the MPR.

Figure 7.1 Gasoline, Ethanol Price Differential



The price differential for conventional diesel and B20 biodiesel, are almost opposite when looking at the five-year trends in Figure 7.2. The percentage differential (price of diesel minus price of B20) is mostly negative, which means B20 has been more expensive than the traditional fuel for the most part in the past five years. The greatest variance occurred in the late 2003 to mid 2004 period where the difference is roughly negative 8% to negative 11%. The price trend for these seems to be turning, however, looking at the last half of 2006 and the first part of 2007. In this time frame, B20 was less than diesel or close in price to diesel. Again, the reasons for these price differences are multi-faceted. Traditional diesel prices have had high fluctuations in the past two years, while biodiesel prices have been fairly stable. The improved technologies in biodiesel production and the increased supply have driven the stability in B20 prices.

Figure 7.2 Diesel, Biodiesel Price Differential



Price differentials between traditional gasoline and ethanol as well as between traditional diesel and biodiesel are crucial in analyzing the potential of alternative fuels. Of all the factors that play into the switch from traditional to alternative fuels, price is most obvious. Consumers may accept the idea of using more environmentally-friendly fuels that help our country in becoming less dependent on foreign fuel sources, but ultimately, they will not use it if they cannot afford it. The benefits must outweigh the costs.

8. HYBRID CAR TRENDS

A hybrid vehicle uses a traditional internal combustion engine along with an electric motor for better efficiency and less pollution. More specifically, a Petroleum Electric Hybrid Vehicle (PEHV) uses a rechargeable electric system combined with fuel power. Another term used for these vehicles is hybrid electric vehicle (HEV). Using an internal combustion engine and an electric motor together, the car operates more efficiently than a traditional petroleum-based vehicle. The two obvious benefits of using these cars are good fuel efficiency (money savings) plus reduced emission (less harmful to the environment). There are various degrees of hybrid vehicles ranging from mild to full. Hybridcenter.org explains that hybrids are classified by evaluating five technological steps (hybridcenter.org). This site states that a vehicle must meet at least steps 1 through 3 to be considered a true hybrid. At that point, it is a “mild” hybrid. If steps 4 or 5 are reached, they are more superior and can be called a “full” or “plug-in” hybrid. The five steps that are used to determine the classification of a hybrid are:

1. Idle-off capability
2. Regenerative braking capacity
3. Power Assist and Engine downsizing
4. Electric-only drive
5. Extended battery-electric range

Examples of true or full hybrid cars that are readily available in the United States are the Toyota Prius, and the Ford Escape Hybrid. The Honda Civic Hybrid and the Honda Insight are just a step lower in the “mild hybrid” category, meaning the electric motor is used only to assist the gas engine.

As of May 2007, according to R. L. Polk & Co., the United States is the number one customer of hybrid vehicles, based on mass-quantity vehicle registrations in the period January through March of 2007 (Dashboard 2007). Hybrid vehicle events and sales trends for the United States have been positive so far. The first hybrid introduced in the United States was a Honda Insight, which was released in 1999 (Hybridcenter.org). Toyota introduced the hybrid Prius in 2000, and in 2001 hybrid car sales neared an annual mark of 20,000 in the United States (Hybridcenter.org). The Toyota Prius reached a new high when it was named 2004 Car of the Year by Motor Trend (Hybridcenter.org). Sales for hybrids totaled over 251,800 in 2006.

Looking at historical sales figures for hybrids in the United States more closely show a steady increase. Starting in 1999, when the first hybrid was introduced, sales were just over 10,000 (estimate from hybridcars.com). Sales doubled to 20,000 the following year. Sales continued to incline the next three years and reached about 205,000 in 2005 (hybridcenter.org & hybridcars.com). In 2006, hybrid car sales were over 250,000.

The high gas prices in 2006 prompted consumers to consider these vehicles that use significantly less fuel. High gas prices in the past few years have had a considerable impact on hybrid vehicle sales. Another factor is tax credits. The hybrid tax credit was established by Congress to support the purchase of hybrids other than the ones built by Japanese manufacturers. However, there are only approximately 60,000 vehicles that are eligible for this credit for each company. Once that number is reached, the tax credits get smaller and smaller until they are gone completely. Some companies are offering discounts or rebates to make up for the lack of tax credits. There are also tax incentives for hybrid vehicle purchases by some local and state governments. This tax credit activity has affected the sale of hybrid cars positively. However, when the credits are gone, growth may slow down.

Another popular alternative to the traditional vehicles used today by Americans on the go are flexible-fuel vehicles (FFV). An FFV is one that can use more than one type of fuel (wikepedia.org). In the United

States, most cars can run on E10, which is a combination fuel of 90% gasoline and 10% ethanol. During the past decade, an increasing number of vehicles have been manufactured with the standard capability to run on gasoline blended with up to 85% ethanol. An estimated 4.5 million (1.8% of nearly 244 million U.S. vehicles) AFVs capable of operating on ethanol blends up to E85 were in use during 2006 (Government Accountability Office 2007). Manufacturers began making certain vehicles standard with flexible-fuel engines in 1998 (2006 Purchasing Guide, E85Fuel.com). Furthermore, as discussed previously in this report, some states have introduced tax credits for owners of FFVs who use E85. As of March 2007, there were 1,161 locations in the United States where E85 was available (eere.energy.gov).

9. NORTH DAKOTA STATE UNIVERSITY - MINI COST BENEFIT ANALYSIS FOR TRANSITION TO B2O AND E85

When looking at potential growth for use of the most popular alternative fuels, B20 and E85, state fleet vehicles are an obvious choice. All states have vehicles that are owned and used solely by employees of the state. State universities have access to state fleet vehicles for use by faculty, staff, and students, and they also have vehicles for their institution to be used for work and transportation purposes. For this condensed cost benefit analysis, vehicles used solely for North Dakota State University (NDSU) – for any purpose – are considered. State fleet vehicles that are used by faculty and staff for work-related travel are not included because those are part of the North Dakota state fleet, which all employees of the state have access to. We are focusing on NDSU specifically in this part of the report. Alternative fuel use and potential use in state vehicles is important in our discussion of alternative fuel trends in the MPC region because it is a potential market, and one that can be targeted easily through legislative means.

Using NDSU fuel transactions for a one-year period, the volume and costs of associated fuels have been compared and discussed below. When looking solely at quantities and costs of diesel versus B20 and gasoline versus E85 based on transaction data from October 2006 through September 2007, the numbers are favorable to alternative fuels (NDSU Motor Pool). Actual fuel quantities and costs from NDSU are compared to correlating time-period costs of B20 and E85 from Clean Cities Alternative Fuel Price Reports in Table 9.1. The data show that use of alternative fuels (E85 and B20) would have saved NDSU just over $2,000 for the one-year period analyzed. NDSU motor pool, campus-specific vehicles used over 7,800 gal. of gasoline in the year analyzed. The cost of this fuel was $20,320. During this time period, the same amount of E85 would have been $17, 997, which is a direct cost-savings of $2,323.

In the same year, NDSU campus-specific vehicles used close to 4,000 gal. of diesel fuel. The total cost for this fuel was $10,207. During the same time period, 4,000 gallons of B20 would have cost very close to the same amount ($10,337). Use of biodiesel, in this case, would have cost NDSU about $130 more than using traditional diesel fuel. Using the alternative fuel costs together, NDSU potentially could have saved $2,194 for October 2006 through September of 2007 if they would have used B20 and E85 to fuel their motor pool, campus-specific vehicles. However, in addition to actual fuel costs, various other costs need to be considered. The costs and benefits associated with E85 and B20 are different, and will be considered separately.

Table 9.1 Traditional vs. Alternative Fuel Use: NDSU 1-year Cost Comparison (Oct. 06 through Sept. 07)

		Quantity (gallons)	Cost
Gasoline	Gas	7878.4	$20,320.49
	E85	7878.4	$17,997.03
	Difference	0	$2,323.46
Diesel	Diesel	3946.5	$10,207.92
	B20	3946.5	$10,337.14
	Difference	0	-$129.22
Total Difference		0	$2194.25

9.1 Conversion to B20: Costs and Benefits

The first consideration would be fuel accessibility. If any institution wants to convert to solely using B20 for diesel vehicles, supply of this fuel would need to be readily available. NDSU has a fueling station located on campus, and the fuel would need to be accessible at that site. Converting to use of B20 is a fairly simple process. Existing diesel storage tanks can generally be used to hold and dispense B20 (US DOE 2006). So making it available on campus would incur no additional, direct costs.

While this analysis focuses on direct economic costs, other costs and benefits need to be considered. Environmental benefits accrued through use of biodiesel are hard to price because they do not have a market value. Even though environmental quality is not regularly bought and sold in regular markets, they still have a value. Using biodiesel instead of regular diesel fuel has several environmental benefits. For example, biodiesel has a positive net energy gain at 3-4 to 1 ratio (Coltrain 2002). According to Tilman et al., (2006) biodiesel yields 93% more energy that is used in its production. Greenhouse gas emissions are reduced by 41% with use of biodiesel versus diesel (Tilman et al. 2006). Again, these environmental benefits do not have price benefits that are easily quantified, yet need to be considered.

There are also some other costs associated with using biodiesel. Biodiesel minimally reduces fuel economy. When using B20, vehicles may expect 2.2% fewer miles per gallon (Radich 2004). The cloud and pour points for biodiesel are higher than regular diesel, therefore, there is potential for gelling issues during cold winter months. Older vehicles may need different seals in their existing fuel system before using biodiesel, which is another disadvantage. Lastly, the solvent properties of the fuel may loosen existing deposits in fuel systems, causing clogged fuel lines and filters (National Biodiesel Board).

9.2 Conversion to E85: Costs and Benefits

The conversion to E85 is more complicated. First of all, only FFVs are able to run on E85. So to start the process of converting from gas to E85, all NDSU gasoline vehicles would need to be replaced with FFVs if they are not already. Specific vehicle characteristics for each vehicle were not used for this study, so the assumption will be made that all vehicles would need to be replaced. Next, an E85 station would need to be installed on the NDSU campus. As mentioned previously, use of an alternative fuel requires the fuel itself be readily available. Costs for E85 stations vary widely in accordance with location and site specifications. The Alternative Fuels data center website has examples of E85 fueling cite bids that vary from roughly $13,000 to $58,000. The highest bid from the Alternative Fuels data center will be used in this example (www.eere.energy.gove/afdc). The total cost of the highest bid is $57,922.00. This illustrates the high initial start-up costs associated with the transition from gasoline to E85.

In addition to the FFVs and the initial E85 site cost, there is the matter of fuel economy. When looking at ethanol, fuel economy is a big disadvantage. E85 has about 80 percent of the miles per gallon of gasoline (Developing Fuels). So while the cost of E85 per gallon trends less than gasoline, adjustments for a decreased fuel economy need to be made.

These costs are straightforward and necessary. However, we also must discuss benefits associated with E85. Ethanol is generally cheaper than gasoline, which is a definite plus, but as mentioned before, it decreases fuel efficiency. Like use of biodiesel, there are environmental benefits associated with use of ethanol that need to be considered. Ethanol yields 25% more energy than is used to produce it (Tilman et al. 2006). In addition, greenhouse gas emissions are reduced by 12% with use of ethanol versus gasoline (Tilman et al. 2006).

When looking at the costs and benefits of converting to alternative fuels on the NDSU campus, all the circumstances discussed above need to be considered. The initial costs listed in Table 9.1 show fuel prices only. In that scenario, the alternative fuel option looks favorable. However, as explained in this section, the costs and benefits associated with using alternative fuels are not so simple. This paper does not include an in-depth cost analysis to place monetary values on all the environmental factors that are relevant. However, to take the analysis one step further, fuel economy was estimated into the price equation (Table 9.2). Using the slightly less fuel efficiency estimates associated with the use of B20 (2.2% less than diesel), about 87 more gallons of fuel would be needed to fill the requirements of the NDSU facility diesel vehicles in the one-year period considered. This equates to a cost estimate of $356 more than traditional diesel fuel.

The economic impact of E85 is substantial when considering 20% decrease in fuel efficiency. Again, using the one-year time period fuel transaction data for the NDSU campus, use of E85 compared to regular gasoline would require 1,575 more gallons of fuel. This equates to approximately $1,275 more for use of E85 versus gasoline. The total monetary difference for the alternative fuels in this analysis is $1,632. The initial comparison resulted in a $2,194 price difference in favor of alternative fuels. However, simply taking fuel economies into account reverses the results and concludes that using the alternative fuels for the one-year time period would cost $1,632 more. This short analogy illustrates the complexity and various issues involved in changing from traditional to alternative fuels.

Table 9.2 Traditional vs. Adjusted Alternative Fuel Use: NDSU 1-year Cost Comparison (Oct. 06 through Sept. 07)

		Quantity (gallons)	**Cost**
Gasoline	Gas	7878.4	$20,320.49
	E85	9454.1	$21,596.43
	Difference	-1575.7	-$1,275.94
Diesel	Diesel	3946.5	$10,207.92
	B20	4033.4	$10,564.55
	Difference	-86.9	-$356.63
Total Difference		-1662.6	-$1,632.57

10. BIOFUELS CASE STUDIES/EXAMPLES

There are numerous ways that biofuels have been used successfully in the United States, and such examples are increasing. Local, state, and the federal governments have promoted the use of alternative fuels and alternative fuel vehicles by implementing programs across the country. Examples of use extend beyond the government – and now are being implemented by private companies and organizations. These examples of success act as a tool for learning as well as promotion. Success stories from across the country provide incentives and optimism for use of alternative fuels that include biodiesel, ethanol, compressed natural gas (CNG), liquefied natural gas (LNG), hydrogen, propane, and electric.

The use of biodiesel has been implemented in a variety of areas. Examples of biodiesel successes include ski resorts' maintenance equipment, school buses, transit buses, diesel machines at airports, electric utility company vehicles (trucks, bulldozers, backhoes), and support operation vehicles at national parks (http://www.eere.energy.gov/cleancities/success_stories.html).

A commendable case is that of Eastman Chemical, located in Tennessee. This company started replacing traditional diesel with a 5% blend in 2005. Soon after, it switched to a 20% blend of biodiesel in all diesel vehicles, which are approximately 200 vehicles, including dump trucks, tractor trailers, bulldozers, tractors, backhoes, trucks, and cranes. The company also uses B20 in stationary equipment like water pumps and generators. Company spokesmen have indicated that the switch to biodiesel blends is an opportunity to do something for the community and the environment. Drivers and equipment users from the company have also noted the benefits of decreased amounts of smoke and odor.

Other examples listed by the U.S. Department of Energy's Clean Cities Program as Success Stories for alternative fuels use include the use of ethanol, compressed natural gas (CNG), liquefied natural gas (LNG), propane, hydrogen, hybrid and electric vehicles (http://www.eere.energy.gov/cleancities/success_stories.html). More specific examples are listed below:

- CNG
    - Real applications: airport light-duty vehicles and buses, transit buses internal transit and trams, support operations, U.S. Postal Service vehicles, taxis, and refuse haulers
    - Specific example: Seattle Tacoma International Airport has buses, sweepers, vans, trucks, cars, plus shuttles and taxis, which all use CNG

- LNG
    - Real applications: heavy-duty delivery vehicles, buses, and refuse haulers
    - Specific example: Harris Ranch is a large agribusiness company in California. Located in the San Joaquin Valley, it operates 12 LNG Freightliner tractors that refuel at an LNG station owned by the same company.

- Ethanol
    - Real applications: government agency fleet vehicles, power company fleet vehicles, university fleet vehicles, and police department fleet vehicles
    - Specific example I: Hoover, Alabama's police fleet uses flexible fuel vehicles that run on ethanol blends. About 160 of their vehicles use E85. The Hoover Police Department uses the E85 police vehicles constantly and has an onsite fueling station at the Hoover Public Safety Facility. This facility was built using a grant from Central Alabama Clean Cities. This department uses roughly a volume of 24,000 gallons of E85 each month.

    - Specific example II: Minnesota Department of Administration, Travel Management Division (http://www.e85fuel.com/pdf/tmde85.pdf). The State of Minnesota had about 1,130 flexible fuel vehicles as of spring 2005. Additional flexible fuel vehicles are operated by individual state agencies. The vehicles run on E85, and use roughly 68,000 gallons per year.

- Electric
    - Real applications: Trams and internal transit, police fleets, airline service vehicles, transit buses, and state and national park support operation vehicles
    - Specific example: The Greater New Haven Transit District in Connecticut has four electric trolleys.

- Propane
    - Real applications: National park trams, taxi fleets, school buses, and transit buses
    - Specific example: LA DOT DASH transit buses. About 150 propane buses are operated in downtown Los Angeles and in 27 surrounding communities.

11. BIODIESEL TRANSIT FLEET CASE STUDIES

Biodiesel has become an increasingly popular alternative fuel as metropolitan areas in the MPR consider the benefits of reducing greenhouse gas emissions from buses. In addition, biodiesel benefits the local, regional, and national economy by providing farmers with an additional market for soybeans and canola.

11.1 Fargo-Moorhead Metropolitan Area Transit

The Metropolitan Area Transit (MAT) operates a public bus fleet serving the North Dakota cities of Fargo and West Fargo and the city of Moorhead, Minn. MAT provides an example of a metropolitan transit organization in the MPR that has been proactive in renewable energy use. Since June, 2006, MAT has been committed to using soy biodiesel year round to fuel the metropolitan bus fleet, which includes 37 vehicles. The fleet operates Monday through Saturday and offers 18 routes of public transportation in the Fargo-Moorhead metropolitan area.

In November, 2006, a $7 million state-of-the-art transit garage was completed to house the fleet with funding from the Federal Transit Administration and the cities of Fargo and Moorhead. The building, which is jointly owned by the two cities, spans more than 50,000 square feet and includes areas for fueling, washing, service, repair, and overnight storage. The garage includes renewable energy features, such as a recycling system for water used to wash buses, a high-performance glaze on the outside of the building that helps save on heating and cooling costs, as well as a roof designed to accommodate solar panels to generate energy. In addition, the facility has a central fueling station that allows management to mix and blend B100 with conventional diesel.

The Fargo-Moorhead metropolitan area, like many other areas in the MPR, has seasonally cool climate fluctuations. During the winter months, cold temperatures can significantly affect the combustibility of any type of diesel fuel. Soy biodiesel, like petroleum-based diesel, has the tendency to thicken and gel as the temperature drops. The point at which biodiesel clouds and thickens is approximately 32 degrees Fahrenheit compared to No.1 low sulfur petroleum diesel, which clouds and thickens at minus 35 degrees Fahrenheit (Nowatski 2007). Colder temperatures tend to have a negative impact on performance (such as clogged fuel filters) when higher concentrations of soy biodiesel are used. Therefore, the amount of B100 blended into petroleum-based diesel fuel is exceedingly dependent on the climate conditions in which the vehicles operate. Fargo-Moorhead's average annual temperature is 41 degrees Fahrenheit (CityRating.com). This makes it more difficult to use higher concentrated blends, especially during winter months when temperatures dip below freezing. The MAT fleet uses blended concentrations that vary from B5, or 5% soy biodiesel, during October-April to B20, or 20% soy biodiesel, during May through September. Fuel flow problems are mitigated by using B5 and anti-gel agents during the colder periods.

In addition to cold weather blending considerations, bacteria and fungus can also affect the performance of diesel engines. Bacteria contamination problems, much like cold weather, has the tendency to clog fuel filters, which according to officials at MAT, cuts the mileage per fuel filter changes by approximately half.

Although the MAT has not noticed any significant gains in miles per gallon of the bus fleet using biodiesel, the organization continues to use it year round because of the benefits to the environment and the community, outweighing the costs. In addition, public comments on MAT's use of biodiesel year round have been positive. One of the buses in MAT's fleet is completely stenciled with a mural of a soybean field and the phrase "On Soy Biodiesel this bus gets 250 miles per acre." The bus, nicknamed "Big Green," serves an important role for providing public transportation and promoting soy biodiesel as a renewable, environmentally friendly resource.

11.2 City of Saskatoon, Canada BioBus Project

The City of Saskatoon began exploring the use of biodiesel in transit vehicles in 2002. A two-year experiment known as the BioBus project was conducted by a team of mechanical engineers from the University of Saskatoon in conjunction with the city of Saskatoon Transit Services to promote the use of canola biodiesel as an environmentally friendly, renewable fuel and to gather scientific data on the use of canola biodiesel blends in transit vehicles. Objectives for the BioBus project included determining the impact of canola biodiesel blends on fuel economy, engine operation and wear, and emission concentrations. Four city buses were designated for the project. Two of the buses operated four-cycle diesel engines while the remaining two buses operated two-cycle diesel engines. Two-cycle buses logged between 40,000 and 50,000 km while four-cycle buses logged 60,000 km over the two year period. One to 5% (B1 to B5) canola biodiesel was used during various stages of testing. To reduce the risk of fuel gelling in colder temperatures, a maximum of B5 canola biodiesel blend was used. Average temperature during the two-year testing period was between approximately 36 and 37 degrees Fahrenheit.

Results from the project showed engine wear reductions of more than 20% in three of the four buses with one of the buses showing only an approximate 8% reduction in wear due to non-fuel related shaft bearing failure (Hertz and Munshaw 2006). Fuel consumption was found to decrease in three of the four buses. Results from the project show reductions in fuel consumption of 2.7, 2.8, and 4.3% with a fourth bus subjected to transmission problems and a bent crankcase ventilation tube, showing an increase in fuel consumption of 4%. The project results also indicated that greenhouse gas emissions decreased with the use of B5 by as much as 8.2%.

Saskatoon Transit is currently considering a Phase III Bio-hybrid study with plans to acquire four hybrid diesel/electric type buses in 2006. The proposed study would analyze hybrid buses versus conventional new buses with regard to efficiency, engine wear, and emissions testing over a two-year period.

12. SUMMARY

The growing trends, use, and innovations related to biofuels is an important and evolving topic. The high cost of fuel along with dependence on foreign oil makes this topic even more crucial. The states of the Mountain Plains Region (Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming) play an interesting role in the biofuels world due to their unique demographic characteristics and agricultural industries. While the agricultural producers continue to grow products to meet the increasing demands of the market, which are leaning more towards ethanol and biodiesel production, controversy arises over the "Food versus Fuel" debate.

In addition, it has to be noted that while the ethanol and biodiesel fuels provide an alternative source for fueling United States transportation, they cannot be solely relied on in any scenario. Even when considering use of all the corn, soybeans, and canola for making biofuels, these products would only put a dent in the fuel consumption of our nation. Other alternatives are needed to completely displace traditional fuels.

To become a steadier and viable fuel option, legislative actions will have to play a central role. The literature and legislative initiatives for alternative fuels to date indicate both federal and state legislation will be necessarily to drive the purchase of alternative fuels when the prices do not compensate the change.

There are also logistical impediments with alternative fuels. Consumers demand products that are priced according to the market, but also need to be readily available. Stations that supply E85 are not easily found at this point in time. They are hit and miss, with more stations occurring in states that are top corn producers, such as Minnesota. Consumers are not likely to map out a traveling route in order to find E85 stations, but will use it if it happens to be on their normal route (and in the price range that competes with traditional gasoline).

Using biofuels for transportation has related obstacles, but clearly also has associated advantages. The existing available data show favorable trends in alternative fuel and vehicle use in the MPR region. The agricultural economy of these states creates potential for ethanol and biodiesel markets. There are various markets where alternative fuel use has potential. The success stories examples illustrate target markets where alternative fuel use could grow. In addition, alternative fuel vehicle trends have been increasing, which is promising for the environment and decreasing our use of foreign oil. The growth and interest in this issue is evident for the MPR and further analysis and pilot projects will assist in developing successful target markets.

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