Evaluation of Biodiesel Fuel:

Field Test

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This report summarizes phase 2 of a Montana Department of Transportation (MDT) research project examining technical issues related to the usage of biodiesel in the state. The results of a small-scale field test involving the use of 20 percent biodiesel (B20) fuel in select MDT maintenance vehicles are presented. Operations and maintenance experience were generally positive, and MDT personnel were receptive to using biodiesel in the future. Based on that experience, this report reviews other aspects that may influence the state's biodiesel policy, including increasing use of finer rating engine fuel filters, microbial contamination, and potential evasion of biodiesel fuel by long-haul motor carriers. Biodiesel production aspects are examined in detail, especially feedstock availability, to determine the potential for development of a biodiesel industry in Montana. Federal policies and laws enacted by other states are reviewed, in order to better understand external factors that may affect Montana's biodiesel industry. Several policy alternatives are presented, with their strengths and weaknesses subjectively analyzed. Finally, several avenues for future research are identified that may help the state in determining future biodiesel policy.

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GLOSSARY OF ABBREVIATIONS

AFV	Alternative Fuel Vehicles
ASTM	American Society of Testing & Materials
CARB	California Air Resources Board
CMSA	Consolidated Metropolitan Statistical Area
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DOE	U.S. Department of Energy
EIA	Energy Information Administration
EMA	Engine Manufacturers Association
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act
EPS	Extracellular Polymeric Substance
HFRR	High-Frequency Reciprocating Rig
IDOT	Iowa Department of Transportation
LDV	Light-Duty Vehicles
MCA	Montana Code Annotated
MDT	Montana Department of Transportation
MSA	Metropolitan Statistical Area
NO_x	Nitrogen Oxides
OEM	Original Equipment Manufacturers
PM	Particulate Matter
PM1	Preventative Maintenance 1
PM2	Preventative Maintenance 2
ppm	Parts per million
RFS	Renewable Fuel Standard
SO_2	Sulfur Dioxide
TEA-LU	Transportation Equity Act: A Legacy for Users
VMT	Vehicle Miles of Travel

ABSTRACT

This report summarizes phase 2 of a Montana Department of Transportation (MDT) research project examining technical issues related to the usage of biodiesel in the state. The results of a small-scale field test involving the use of 20 percent biodiesel (B20) fuel in select MDT maintenance vehicles are presented. Operations and maintenance experience were generally positive, and MDT personnel were receptive to using biodiesel in the future. Based on that experience, this report reviews other aspects that may influence the state's biodiesel policy, including increasing use of finer rating engine fuel filters, microbial contamination, and potential evasion of biodiesel fuel by long-haul motor carriers. Biodiesel production aspects are examined in detail, especially feedstock availability, to determine the potential for development of a biodiesel industry in Montana. Federal policies and laws enacted by other states are reviewed, in order to better understand external factors that may affect Montana's biodiesel industry. Several policy alternatives are presented, with their strengths and weaknesses subjectively analyzed. Finally, several avenues for future research are identified that may help the state in determining future biodiesel policy.

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1. INTRODUCTION

The Montana Department of Transportation (MDT) was asked by the Transportation Committee of the Montana House of Representatives to initiate a research project focusing on the viability of using biodiesel as an alternative fuel in MDT's vehicle fleet. To undertake this study, MDT has implemented this project in two phases: first, a review of relevant literature regarding the performance of biodiesel in motor vehicles; and second, a test application using a B20 blend (20 percent oilseed-based biodiesel, 80 percent conventional diesel) in select MDT vehicles housed in Missoula and three housed in Havre.

This document concludes phase 2 of the research effort. It describes a field test that was conducted using MDT vehicles fueled with B20 over a six-month period between December 2003 and June 2004. With this as background, this document explores potential biodiesel policy alternatives that may be pursued.

Chapter 2 provides a brief re-cap of phase 1 of this research. Chapter 3 describes the methodology of the field test, including documentation on repair and fueling, and surveys of user perceptions. The results of the field test from each location are summarized in Chapter 4. Chapter 5 examines other issues that were raised by the technical panel, relating to engine filter specifications, microbial contamination, and potential evasion of fueling stations in Montana. Chapter 6 looks at potential biodiesel production and demand, with an emphasis on Montana feedstocks that may be used in biodiesel production. Chapter 7 provides an overview of Federal and state policies that may influence biodiesel usage, and reviews policies adopted by other states with respect to biodiesel, which may be useful in shaping Montana's own policy. Chapter 8 presents and assesses a variety of policy alternatives that may be used regarding biodiesel. Chapter 9 summarizes this project, and outlines next steps.

2. REVIEW OF PHASE 1

On February 12, 2003, the Transportation Committee of the Montana House of Representatives heard testimony on House Bill 502, which proposed that all diesel fuel sold for use in internal combustion engines contain at least 2 percent biodiesel fuel by volume. The bill was discussed but tabled by the committee because of "unanswered questions surrounding this relatively new technology." Specific concerns included:

?? "the effects of biodiesel blends on engine performance – specifically fuel economy, torque, and power – as compared to diesel;

?? cold weather product storage and potential for gelling;

?? sulfur, carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxide (NO_x), and other emissions; and

?? potential for engine damage." (1)

MDT was asked by the House Transportation Committee to initiate a research project focusing on the viability of using biodiesel as an alternative fuel in MDT's vehicle fleet. To undertake this study, MDT has implemented this project in two phases: first, a review of relevant literature regarding the performance of biodiesel in motor vehicles; and second, a test application using a B20 blend (20 percent oilseed-based biodiesel, 80 percent conventional diesel) in select MDT vehicles housed in Missoula and three housed in Havre.

2.1. Phase 1 Findings

The literature review was completed in February 2004 (2). The primary findings of the literature review are as follows.

?? In general, engine performance has not appeared to suffer because of the introduction of biodiesel. There is some variation in study reports: some claim no effect, others claim no significant effect, and yet others show a reduction in vehicle performance.

?? Cold weather product storage for low biodiesel blends (B20 or less) should not be a problem. Biodiesel blends are already used on a widespread basis in several cold weather locations, including Yellowstone National Park, Glacier National Park, Grand Teton National Park and Malmstrom Air Force Base. Moreover, biodiesel has been approved by the U.S. Environmental Protection Agency (EPA) as a fuel additive (B2 or less). At least one public fueling station in Montana blends biodiesel into its conventional diesel.

?? Numerous emissions studies have been conducted, and ably summarized by EPA. Most tests have been done with B20 biodiesel blends. The percent change in emissions tends to increase with increasing proportions of biodiesel. The net conclusions on specific pollutants are as follows:

  - ?? Biodiesel has essentially no sulfur, so sulfur oxide (SO_x) emissions are lower in biodiesel blends. This is also an important benefit because the EPA will require lower sulfur fuels to be used by diesel vehicles starting in 2006.

  - ?? Carbon monoxide (CO) emissions are lower. CO is a poisonous yet invisible and odorless gas which is a major air pollutant. According to EPA studies, as much as 95 percent of the carbon monoxide in typical U.S. cities comes from mobile sources.

  - ?? Carbon dioxide (CO_2) emissions are not currently regulated by EPA.

  - ?? Hydrocarbon (HC) emissions are lower. HC emissions are a precursor to ground-level ozone, a serious air pollutant in cities across the United States. A key component of smog, ground-level ozone is formed by reactions involving HC and nitrogen oxides (NO_x) in the presence of sunlight.

  - ?? Nitrogen oxide (NO_x) emissions are slightly higher (~2%) than conventional diesel. Some studies have indicated that NO_x emissions with a biodiesel blend can be made equivalent to conventional diesel through changes in engine timing or additions of fuel emulsions. Regardless, in our examination of related air quality and regional haze regulations, this would not affect Montana's conformity with national air quality standards.

- ?? The biggest concern regarding potential engine damage is when an engine alternates between different fuel types. Conventional diesel leaves deposits in engines that biodiesel, as a solvent, will clean out. This can mean additional costs for replacing fuel filters initially, but these are not necessary over time. This is less of an issue if a low biodiesel blend is used, or if biodiesel were used as an additive (B2).

- ?? There appear to be no significant motor fuel tax revenue implications from increasing the use of biodiesel in Montana.

- ?? A significant barrier to broader implementation of biodiesel is its price. This is a difficult issue to resolve at this time since much of the cost of biodiesel is attributable to the feedstock and transportation, and not to production. Given a higher price, it would be important to consider how biodiesel might be superior to diesel. Biodiesel's primary benefits are increased lubricity, domestic production, and reduced emissions. Only some instances have shown that biodiesel has significant performance advantages compared to conventional diesel.

2.2. Recommendations for Phase 2 Testing

In assessing laboratory and field experience with biodiesel to date, the literature review assessed that "there seems to be a broad consensus that biodiesel is a safe and reliable fuel that can be used in limited quantities in biodiesel blends with minimal or no additional accommodation." The report noted, however, that there are questions related to biodiesel blend rate, user acceptance and cost (2).

The literature review recommended that the phase 2 field test "should provide an important screening for user acceptance of the fuel. … [The test also] should focus on fuel economy, which can be easily measured, along with anecdotal evidence regarding fuel transportation, handling and storage, and engine maintenance. Operator and maintenance staff surveys will be important to gauge overall user acceptance." (2)

However, the literature review noted that price considerations may be "a more critical question regarding the future of biodiesel in the state." It stated, "More detailed analysis regarding the economic impacts of biodiesel – positive impacts for farmers in general and Montana farmers in particular and negative impacts in terms of increased fuel prices that are directly or indirectly absorbed by consumers – would be essential when considering long-term policy regarding biodiesel." (2)

2.3. Review of Phase 2 Goals

The purpose of phase 2 of this research project is to conduct a field test using MDT vehicles that answers the questions of the House Transportation Committee. Because many questions have been substantially answered in the literature already, this study will focus on those aspects where there is ambiguity. Specific phase 2 tasks include the following:

- assisting in implementation of a small-scale field test of B20 with MDT vehicles at the Havre and Lolo South maintenance facilities;
- collecting and analyzing information related to performance of the test vehicles, including fuel economy data and maintenance records;
- surveying MDT vehicle operators and maintenance personnel at Havre and Lolo South regarding their experiences in maintaining, fueling and driving vehicles with and without biodiesel; and
- developing a set of potential policy alternatives, with assessments of their advantages and disadvantages.

3. METHODOLOGY

The purpose of the field test component of this research project was to provide a local example of biodiesel usage that could help in determining an appropriate course for biodiesel policy in the state. The field test consisted of a six-month test where a 20 percent blend biodiesel (B20) fuel was used in selected vehicles at two Montana Department of Transportation (MDT) maintenance facilities: Lolo South and Havre. This chapter details the data that was collected and the test sites used for this project.

3.1. Data Sources

The purpose of the field test was to evaluate user acceptance, as well as to document any maintenance or performance characteristics where biodiesel differed from conventional diesel. Researchers analyzed maintenance records, fuel economy, and driver surveys.

3.1.1. Maintenance Records

During the field test, MDT performed the same scheduled maintenance activities on the B20-fueled vehicles as vehicles fueled with conventional diesel. MDT practice calls for trucks to have a preventative maintenance 1 (PM1) procedure every 3,000 miles. For most vehicles, PM1 includes an oil change; for vehicles equipped with a Sentinel system, a technology that recirculates used oil into the engine, PM1 includes greasing the system and re-filling the oil reservoir as needed. MDT also conducts a more extensive preventative maintenance 2 (PM2) procedure every 20,000 miles. PM1 activities occur at locations where vehicles are housed, whereas PM2 activities occur at larger maintenance area and district shops.

For PM2 activities, MDT keeps paper and computerized records of repairs done at the area and district maintenance shops. These records document the problem that was reported, and all diagnostic and corrective actions that were taken to address the problem. They also indicate when vehicles are sent to outside facilities for more specialized repair. For PM1 activities, MDT only records the date of service unless something unusual is noticed.

3.1.2. Fuel Economy

One quantitative measure of vehicle performance for which data would be easy to collect is fuel economy. WTI developed forms for the B20-fueled vehicles assigned to each maintenance site. The forms included spaces for the odometer reading when the vehicle was fueled, and the number of gallons required to fuel the vehicle. The forms, included in Appendix A, differed slightly between the two maintenance sites because it was believed that Havre might be more likely to use different base fuels and fuel additives due to colder weather.

3.1.3. Driver Interviews

Based on the findings from Phase 1, researchers concluded that user acceptance would be a prime factor in determining long-term acceptability of biodiesel fuel. For this reason, driver interviews were another important element in the research. It was initially proposed that the project use a blind-test approach in order to eliminate potential bias in the results. However, because the project required changes in fueling procedures for vehicles and additional paperwork (i.e. keeping fuel usage logs), researchers determined that a blind-test would not be feasible.

Therefore, at the outset of the project, a member of the research team, along with one or two members of the technical panel, met with MDT maintenance personnel at both Lolo and Havre to discuss the field test, agree upon a data collection plan, and answer any questions. WTI staff provided personnel with briefing materials on biodiesel and the research project. WTI also provided a list of survey questions to maintenance supervisors at each location early in the project, so that drivers could know the types of questions that would be asked. Survey questions are summarized in Table 3-1. When the actual survey was conducted, a member of the research team had the opportunity to meet with personnel in an unsupervised setting, which permitted free expression of opinions on the advantages and disadvantages of the fuel.

Table 3-1: Questions for Driver Surveys

Survey Area	Questions
Usage	? About how much did you drive on vehicles with biodiesel during the 6-month testing period? ? Did you switch the vehicle back to regular diesel at any time during the 6-month testing period? If so, why?
Performance	? Did you notice any difference in how the vehicle ran? ? Did you take special precautions during cold weather because of the biodiesel? If so, why?
Maintenance	? Did you notice anything unusual during visual inspections of the vehicles that could be due to using biodiesel? ? Did you notice anything unusual during preventative maintenance (PM1 or PM2) of the vehicles that could be due to using biodiesel? ? Did you experience any breakdowns or mechanical difficulties as an apparent result of using biodiesel?
Summary	? Overall, how did your vehicle do with biodiesel versus conventional diesel?

3.2. Site Review

Two sites were used for this field test: Lolo South and Havre. The vehicles at each site are used for a variety of maintenance activities, with varying vehicle loads on the full range of routes in each district.

3.2.1. Lolo

The Lolo South maintenance yard is located on US 93 just south of the town of Lolo. Maintenance personnel at this yard are responsible for US 93 from Missoula to Stevensville and Secondary Highway 203 from Florence to Stevensville.

The Lolo South yard is part of the Missoula maintenance district (District 1). Personnel at Lolo South are responsible for performing PM1 activities on their vehicles, whereas PM2 activities occur at Missoula.

There are five vehicles housed in the Lolo South maintenance yard, four of which were used in the field test; these vehicles are listed in Table 3-2. These vehicles are used on a regular basis and are stored indoors when not in use. The Lolo South yard also has a single-axle truck which is stored outside and used as a relief vehicle as needed.

Table 3-2: Study Vehicles at Lolo South

Vehicle ID	Description	Engine
09-0268	2002 Dodge 1-ton	
29-4130	1991 GMC Topkick	Caterpillar 3116
29-4297	2000 Sterling w/ Sentinel System	Cummins ISM
29-4397	2000 Sterling w/ Sentinel System	Cummins ISM

Maintenance personnel normally refuel their vehicles at a commercial station off-site. For this research project, B20 was provided to an existing fuel vault at the maintenance yard, and the four vehicles used this vault for fueling through the course of the project. Staff members were authorized to decide whether to use B20 or conventional diesel in the single-axle vehicle. Researchers and participants agreed that if any significant problems occurred during the field test that were attributable to the fuel, maintenance personnel could revert to diesel to ensure that road maintenance operations would not be hindered.

3.2.2. Havre

The Havre maintenance facility is located on US 2 at the western edge of Havre. It serves as one of two maintenance areas for District 3, headquartered in Great Falls, and houses 15 to 20 vehicles. Personnel at Havre are responsible for driving routes, as well as performing PM2 and other maintenance on vehicles from throughout the area. Route coverage includes US 2 between Hingham and Chinook, US 87 south to Big Sandy, Secondary Highway 232 to the Canadian border, Secondary Highway 233 north for 22 miles, Secondary Highway 234 from Havre to Beaver Creek Park, and Secondary Highway 240 between Chinook and Cleveland.

Havre personnel chose a subset of three vehicles for the field test, as shown in Table 3-3. These vehicles were selected to include a mix of mileage levels, and also to include a vehicle with the Sentinel system to see if there were any effects of biodiesel on that technology.

Table 3-3: Study Vehicles at Havre

Vehicle ID	Description	Engine
29-4041	1985 Ford L9000	Cummins 855
29-4234	1996 Ford Tandem	Cummins 8.3L C Series
29-4316	2000 Sterling w/ Sentinel System	Cummins ISM-11 Electronic Injection

Like Lolo personnel, Havre personnel normally fuel their vehicles off-site at commercial stations. For this research project, MDT installed an old fuel vault at Havre to provide B20 to the three vehicles included in the field test.

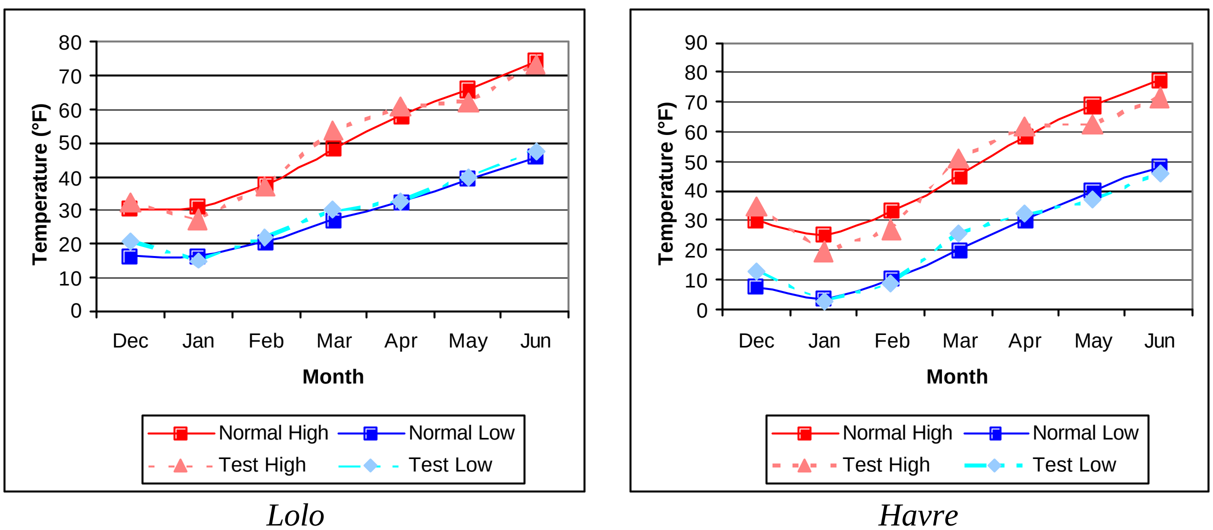
4. RESULTS

This chapter summarizes the results of the field test. First, background conditions are discussed to identify factors that may have influenced field test results, including weather during the field test and preliminary laboratory fuel testing. The subsequent sections will review the findings regarding maintenance history, fuel economy and driver perceptions of the fuel. The chapter concludes with a brief summary of the overall findings.

4.1. Background Conditions

4.1.1. Weather

The field test started in late December 2003 and concluded in June 2004. The test was scheduled during these months to ensure that the fuel would be tested under cold weather conditions, since this was a potential area of concern identified in the Phase 1 research. Figure 4-1 illustrates how the mean daily temperatures for each month during the field test compared with historical average readings for Lolo and Havre, respectively[1]. As can be seen, January and February were slightly colder than normal, while the spring months were normal or slightly warmer than normal.



(Source: 3)

Figure 4-1: Monthly Mean High and Low Temperatures, Lolo and Havre

[1] Lolo weather was collected using data collected from Missoula International Airport (MSO). According to archived records available at www.weather.com, average temperature ranges are similar between the two locations, although Lolo records about 20 percent more precipitation. Havre weather was collected at Havre City/County Airport (HVR). In both locations, the test vehicles served a far broader geographic area, and microclimates may create areas with different temperatures and precipitation levels.

Table 4-1 shows the coldest temperatures that were observed at each location during the field test. None of these temperatures were record lows for those respective days, but the weather was cold enough to provide good testing of the B20's behavior in cold weather.

Table 4-1: Coldest Temperatures Observed (°F) During Field Test

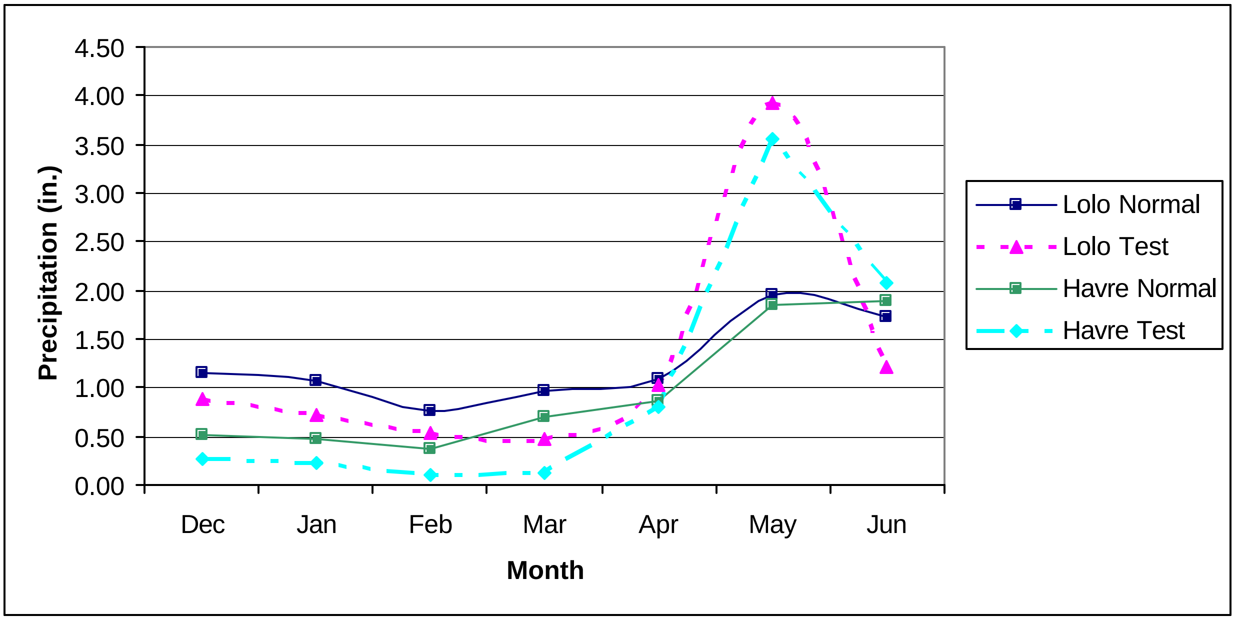
Lolo	
January 6	-23
January 5	-19
December 30	-6
January 4	-5
January 7	-1
February 13	3
January 8	4
January 3	7
January 1	8
4 days at	9

Havre	
January 4	-33
January 3	-28
February 3	-28
February 2	-24
January 5	-23
January 27	-22
January 28	-19
February 4	-19
January 6	-18
February 6	-15

(Source: 3)

It should be noted that MDT maintenance personnel were encouraged to use the same starting and indoor storage procedures with the B20 vehicles as they use for diesel vehicles. Consequently, the cold temperatures listed reflect the types of operating conditions for the vehicles after they left the maintenance facility, as opposed to the temperature conditions under which vehicles were started.

Monthly water-equivalent precipitation totals (during the field test and historical averages) for each location are shown in Figure 4-2. Precipitation totals were less than normal during the winter months, which suggests that roadway winter maintenance activities, especially plowing, may have been less frequent than in a typical winter. Precipitation levels were higher in May, which delayed spring maintenance activities (such as hauling gravel). By June, however, drier weather allowed maintenance crews to use the B20 vehicles on these activities as well.



(Source: 3)

Figure 4-2: Average and Observed Monthly Water-Equivalent Precipitation

4.1.2. Fuel Characteristics

Laboratory analyses were conducted on the base diesel and the blended B20 that were used at each site. At Lolo, samples were collected from the pump nozzle at Town Pump in Florence (diesel) and from the fuel vault (B20). At Havre, samples were collected from the pump nozzle at Cenex (diesel) and from the fuel vault (B20). Fuel testing was conducted in March and April (for both of Lolo's fuels and the Havre biodiesel blend) and June (for diesel No. 1 and a 50/50 blend of diesel Nos. 1 and 2 at Havre).

The results of the fuel tests are presented in Table 4-2. For both sites, the biodiesel had a lower specific heat value than the base diesel, which means there is less energy in the fuel. The biodiesel fuel was slightly heavier and had a higher viscosity. There was a reduction in carbon and hydrogen content, but an increase in oxygen content. Cold weather properties for B20 were poorer than for the base diesel. The values were closer in Lolo (except for pour point), where the base diesel is No. 2, which is not as good in extreme cold weather as diesel No. 1. It is interesting to note that lubricity using the high-frequency reciprocating rig (HFRR) test was markedly improved with B20. This has been a significant argument in using biodiesel in blends as low as 2 percent, especially with the advent of ultra-low sulfur diesel fuel in 2006 (see section 7.1.4).

Table 4-2: Results of Laboratory Fuel Tests

	Havre				Lolo	
	Base Diesel					
Description	**#1**	**50/50 #1/#2**	**#2**	**B20 w/ #1**	**Base Diesel**	**B20**
Specific Heat, BTU/gal	134,424	135,761	138,628	133,932	136,178	133,333
Kinematic Viscosity at 40 °C, cSt	1.488	1.921	2.770	2.173	2.420	2.752
Specific Gravity at 15 °C, g/mL	0.8194	0.8378	0.8576	0.8464	0.8504	0.8576
Density at 15°C, kg/L	0.8193	0.8377	0.8587	0.8466	0.8503	0.8586
Water and Sediment, % by vol.	0	0	0	0	0	0
Fuel Composition (% by mass)						
Carbon	85.49	86.40	86.02	84.60	86.16	86.02
Hydrogen	13.55	13.21	12.66	12.91	12.94	12.66
Nitrogen	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Oxygen	0.96	0.39	1.32	2.49	0.90	1.32
Sulfur Content (ppm)	35.0	135.0	229.1	105.5	145.0	136.3
Distillation	164 - 263	174 - 336	190 - 352	176 - 344	188 - 343	182 - 344
Flash Point (°C)	50	57	>190	177	>190	>190
Cloud Point (°C)	-54	-28	-18	-20	-22	-16
Pour Point (°C)	-58	-44	-30	-32	-36	-22
Cold Filter Plugging Point (°C)	-51	-30	-18	-26	-23	-19
Iodine Test	3.32	5.6	8.14	23.28	6.91	27.22
Microbial Test						
Bacteria Colonies per ML	0	0	0	0	0	0
Yeast Colonies per mL	0	0	0	0	0	0
Fungi	Absent	Absent	Absent	Absent	Absent	Absent
Lubricity						
Single-load BOCLE, friction coeff.	0.292	0.271	0.321	0.300	0.308	0.313
HFRR, microns	671	613	574	256	579	256
Cetane Number	40.5	42.5	39.1	45.4	41.3	40.9

MDT staff in Havre conducted tests on their used lube oil and provided results to WTI. These results were "negative" regarding the presence of water in the used lube oil; i.e. the water was determined not to be a materially significant amount.

4.2. Vehicle Maintenance

This section will review the maintenance histories of the B20 vehicles during the field test.

4.2.1. Lolo

In general, the vehicles at Lolo using B20 did not experience significant maintenance problems. Three of the four vehicles – the two Sterlings and the Dodge 1-ton pickup – exhibited no unusual problems during preventative maintenance activities, and had no unscheduled maintenance activities related to the engine or fuel systems.

The GMC Topkick, the oldest of the vehicles based at Lolo, experienced difficulties during the field test. The vehicle was reported to be operating poorly, and the filter was replaced showing a long, greasy, mucus-like substance in the fuel/water separator filter. After driving another 100 miles or so, the vehicle was still running poorly, so it was taken to Missoula for PM2. Even after the preventative maintenance, the vehicle has still been running poorly, with reports of poor idling and excessive smoke. After significant in-house diagnostic work, MDT took the vehicle to an outside repair facility, where the problem was diagnosed as fuel injectors needing to be replaced. The repair process left the vehicle out of service for over two months, during which time the single-axle truck was put into service, using conventional diesel. After the injectors were replaced, the vehicle was restored to service with biodiesel and no further problems were noted.

It is possible, but doubtful, that the injector problems were caused by the biodiesel. Biodiesel could possibly contribute to injector malfunction because of its higher water adsorption, and the detrimental effects water can have on fuel injectors. However, there are a variety of factors that counter this assumption. First, Lolo personnel indicated that this particular vehicle was not running well prior to the field test. Second, according to staff at the outside repair facility, the injector problem was probably a normal wear issue, given the mileage on the Topkick (4). Moreover, a review of maintenance records at the Missoula district showed eight other vehicles with the same engine model. Of these, two had injector problems at around 95,000 miles, and another had the engine replaced at 116,000 miles. Therefore, injector replacement was not entirely unexpected, and is likely not due to the biodiesel.

4.2.2. Havre

In Havre, two of the three test vehicles ran through the duration of the field test without any unusual difficulties. There were no unusual repairs needed on the 1985 Ford L9000. The 1996 Ford Tandem had a fuel filter replacement early in the field test. The filter was observed to contain grit and debris typically observed in dirty filters. Because of biodiesel's tendency to act as a solvent and clean out fuel system deposits left by conventional diesel, Havre personnel replaced the filters in the other two vehicles as a precaution at the same time.

The Sterling vehicle, the newest of the three vehicles being tested, experienced problems after this filter change. Investigation by maintenance staff concluded that the problem was likely due to the use of a 2-micron rating filter for the fuel/water separator. After two clogged filters (the second one clogged about 17 miles after the first) and consultation by Havre staff with their filter supplier, a 10-micron rating filter was installed. The first clogged filter was reported to contain a black jelly-like substance. The second clogged filter was reported to contain a white, semi-transparent, jelly-like substance. It was believed that it was a similar substance, with the black coloration resulting from the used oil in the Sentinel system (5). Because of the need to keep vehicles in use during inclement winter weather, maintenance staff made the decision to use conventional diesel in the vehicle to get it back in service, which worked successfully. Staff shortly switched the vehicle back to B20, and no further problems were experienced. Toward the end of the field test, Havre personnel experimented by reinstalling the 2-micron filter in the fuel/water separator, and no problems were observed.

It should be noted that while 2-micron filters may be increasingly recommended by engine manufacturers (see section 5.1), MDT personnel report that the specifications for this particular engine recommend a 12-micron filter. Moreover, according to the maintenance supervisor, no other vehicle – biodiesel or conventional diesel – at Havre has used a 2-micron filter.

After some investigation, it is not certain why the filter was clogging. As the Sterling was the newest of the three vehicles, vehicle age was discounted as a factor. Fuel quality was discounted as well, because the fuel supplier provided large volumes of fuel to the vault, and all of the vehicles were fueled out of the same batch. Several other theories were considered:

- Re-injection of lube oil. One theory is that the re-injection of the lube oil through the Sentinel system may have created problems with the biodiesel. The higher water content in used oil, plus the tendency for lube oil additives to polymerize upon contact with biodiesel, could potentially lead to filter clogging. However, routine lube oil tests ordered by Havre personnel showed that the water content was not unusually high. Moreover, the problem did not recur on this vehicle, or on the two Sterlings tested in Lolo.

- Microbial growth. According to maintenance staff from Havre, the fuel vaults had been sitting mostly empty for several years and were not cleaned out prior to being re-installed and filled with the B20. Over the course of several seasons with warm weather and condensation of water, conditions would be favorable for microbial growth. Moreover, when the Sterling was fueled just before the filter replacement, it was fueled with the last contents of the vault, where it was expected that microbial concentrations (and other fuel residue) would be strongest. However, as was indicated before, tests of the fuel pulled from the vaults showed no microbial activity of note. Moreover, the fuel intake normally draws fuel from near the bottom of the vault.

- Cold weather. Havre personnel noticed fuel separation within the fuel vaults, within the fuel tank of the Sterling, and also when a sample was pulled from the vault. The separation showed a white, cloudy substance separating from a clear substance, and rising to the top of the fuel. The second filter clog on the Sterling appeared to be filled with the same white, cloudy substance. Maintenance staff pulled a sample from the fuel at that time, when the outside air temperature was approximately -15° F, and found the fuel had separated. When manually mixed, the whitish substance would spread through the liquid in a marbling fashion, before slowing re-separating. However, the separation was not reproducible. The maintenance supervisor pulled a sample of the fuel and kept it in his office for the next few months, and no separation in the fuel was observed.

It is believed that cold weather, in combination with an overspecified 2-micron filter, was responsible for the unusual filter plugging that was observed. While cold weather properties of biodiesel are often cited as a concern, it should be noted that the base diesel used in the B20 was a 50/50 blend of diesels No. 1 and No. 2, whereas the conventional diesel used throughout this winter at Havre was generally 100 percent diesel No. 1. The cold weather properties of diesel No. 1 are superior to those of a blend of diesels No. 1 and No. 2. Therefore, the filter plugging may not have been observed, even with the 2-micron filter, had the base diesel been No. 1, as was being used for the other vehicles.

4.3. Fuel Economy

Fuel usage logs were used to determine the typical fuel economy for the vehicles using B20. Table 4-3 shows the fuel economy results for the vehicles in the study. Since fuel economy data is not routinely collected by staff at either location, there is limited data that can indicate comparability of results. A fuel log for another Sterling in Havre showed an approximate fuel economy of 6.48 miles per gallon, or about 1 percent better than the B20 vehicle. According to the maintenance supervisor at Lolo, the fuel economy of the Sterlings was slightly poorer with biodiesel – a drop from 6.2 or 6.3 miles per gallon to about 6.1 miles per gallon (2 to 3 percent). This change in fuel economy is well within limits that could be explained by factors other than the use of B20, including differences in vehicle usage (6).

Table 4-3: Fuel Economy for B20 Vehicles

Site	Vehicle		Fuel Economy (mpg)
Lolo	09-0268	2002 Dodge 1-ton	13.41
	29-4130	1991 GMC Topkick	7.04
	29-4297	2000 Sterling w/ Sentinel System	6.36
	29-4397	2000 Sterling w/ Sentinel System	6.35
Havre	29-4041	1985 Ford L9000	4.42
	29-4234	1996 Ford Tandem	7.43
	29-4316	2000 Sterling w/ Sentinel System	6.40

4.4. Maintenance Personnel Surveys

WTI interviewed maintenance personnel at Lolo and Havre at the conclusion of the field test to collect their observations regarding their experience with biodiesel during the test.

4.4.1. Lolo

Lolo personnel said that they used the vehicles with biodiesel on similar operational activities as when the vehicles ran on diesel, including normal patrolling and plowing operations, and hauling gravel in the spring months.

Regarding operational differences between biodiesel and conventional diesel, staff noted that the Sterling has a distinct smell since the conversion, although it still burns as cleanly as it had previously. The GMC Topkick runs smoother, although that could be attributed to the new fuel injectors. In general, there was no observed power loss. After the Topkick's injectors were replaced, a maintenance supervisor from Missoula test drove the vehicle up a significant grade and reported that the power seemed weak, and suggested that this could be due to the biodiesel. Other staff commented that the Topkick's engine has been less powerful than other vehicles, irrespective of the biodiesel. Personnel did not have to take any special precautions during cold weather because of the use of biodiesel. In general, personnel did not assess any difference between biodiesel and conventional diesel in vehicle operations.

Staff reported no maintenance differences between biodiesel and conventional diesel vehicles. They noticed nothing unusual during PM1 activities, and no differences during visual inspections of the vehicles. They mentioned the injector problems with the GMC Topkick, but believed that those were due to normal wear.

Overall, Lolo personnel said there were no big problems with using the fuel, and would have "no grief" with using it in the future apart from price considerations.

4.4.2. Havre

Havre personnel said that they used the vehicles with biodiesel on similar operational activities as when the vehicles ran on diesel, including plowing, patrolling and hauling. Vehicles were used by a few, not all, of the drivers at Havre.

Regarding operational differences between biodiesel and conventional diesel, Havre personnel had generally positive reports. They noted that the biodiesel vehicles run cleaner. The exhaust from the B20 vehicles smelled different and seemed to be less irritating to the eyes. Staff were particularly impressed with how the Ford L9000 seemed to smoke much less after B20, so much so that they were hoping to use the biodiesel in another vehicle that is running poorly. Reports on vehicle power were mixed. One person indicated that the B20 vehicles seemed to perform more strongly, while another cited less power. Personnel were asked specifically about issues of power loss on hills, and no degradation in performance was noted with biodiesel. On a couple of occasions, personnel applied fuel additives because of concerns about cold weather. Personnel indicated that these additives were used as a precautionary measure, not in response to vehicle operational problems, and that they would have used the additives in conventional diesel as well during those times.

Regarding vehicle maintenance, there were a couple of maintenance issues that were also discussed earlier. The Ford Tandem required a filter change when it started to run poorly, but the filter had no unusual grit. There were also the well-documented maintenance problems associated with the Sterling and its filter clogging issues. There were no other problems beside these, and nothing unusual turned up during preventative maintenance activities.

In general, Havre personnel appeared to be satisfied with biodiesel's performance, and were open to using it in the future. At the conclusion of the field test, they began using the remaining B20 in all of their other vehicles in order to exhaust the supply. Observations during this time included the following:

- In a transport truck that was used to haul equipment, the driver thought the B20 may have resulted in less power

- The last of the B20 was used in a Ford 1-ton truck with a 6.0-liter diesel engine, and it did not run well. The Ford was filled with conventional diesel and worked fine, and the B20 which was emptied out of the Ford was put in other equipment without any problems. It is speculated that the problems may have been the result of a high concentration of contaminants in the remaining B20.

4.5. Summary

The six-month field test provided a brief opportunity to observe how biodiesel performed under normal MDT maintenance operations. The experiment used biodiesel blend fuel, the components of which met applicable fuel standards. The test was conducted primarily during the winter months to place a greater emphasis on cold weather properties.

In summary, the field test did not conclusively show any significant reasons against biodiesel implementation. Driver reports and routine maintenance activities did not show any significant issues with biodiesel. Reports on power gain or loss resulting from biodiesel were mixed. While the two major vehicle maintenance problems observed during the field test could be attributed to the fuel, there are a variety of reasons which suggest that biodiesel played a minor, if any, role in those problems. While users did not express an overwhelming desire to switch to biodiesel, there was a near consensus in willingness to use biodiesel in the future.

These findings require several qualifications.

- A six-month field test is a relatively short window in the life of a truck engine. There may be problems or benefits of biodiesel that would only be evident over a longer period of observation.

- The indoor storage of vehicles practiced by MDT may not be a typical storage pattern for other diesel vehicle operators in the state. Therefore, these results should not be automatically extrapolated to reflect other vehicle storage situations.

- MDT usage of their diesel vehicles differs from other users, such as motor carrier freight. The effects of typical vehicle operating speeds and typical vehicle cargo weights were not examined in this field test.

?? The field test used a 20 percent blend of biodiesel, a far richer concentration of biodiesel than has been considered by the Montana House of Representatives. It is likely that the benefits and drawbacks of B20 would both be dampened with the use of a lower blend of biodiesel.

5. OTHER CONSIDERATIONS

During the course of the field test, the research project's technical panel raised other questions regarding biodiesel that may affect considerations about biodiesel policy. These considerations are addressed in this chapter of the report.

5.1. Filter Trends

Biodiesel, like conventional diesel fuel, has a tendency to gel at lower temperatures and when this fuel is then pumped into engine through fuel filters, filters tend to clog with gelled biodiesel. Gelling can occur at higher temperatures in biodiesel blends than for conventional diesel, especially as a higher percentage of biodiesel is introduced into the fuel. With increasing demands on the efficiency and power of engines, engine manufacturers are moving toward using better and tighter fuel filter ratings to ensure that the proper quality of fuel is in the engine and to reduce fuel system wear. This has raised some concerns as to whether the tendency toward tighter filter specifications may pose any special disadvantage for adoption of biodiesel fuel.

Various diesel engine manufacturers have different fuel filters within their engines. The Filter Engineering Manager at Caterpillar stated that with "New International Standards Norms for calibration method used for particle counters coming in to place there is no one in the filter industry that can measure down to 2 microns with any accuracy." Caterpillar states that its engines are fitted with 4 micron filters and are 98.8 percent efficient at 4 microns with new calibration standards (7). John Deere claims that they have started using 2 micron filters in their new T2 electronically controlled engines (8). Cummins manufactures their own filters. Presently, Cummins has three categories of engines: non electronic-mechanical engines which use 25 micron fuel filters, CELECT-electronic engines which use 10-micron filters, and integrated system-electronic engines which use 2-micron filters. Cummins, however, is more concerned with water entering the engine. They have specifications for using a fuel-water separator before the fuel filter. The fuel-water separator filter must remove a minimum of 94 percent free water (SAE J1839) and 90 percent of emulsified water (SAE J1488) (9).

Most of the filter manufacturers have done some testing with biodiesel in order to see what effects biodiesel has on filters with tighter ratings.

Caterpillar states that it has done some testing with clean ASTM standard biodiesel and there were no instances of 4 micron filter plugging. They added, however, that there are different production methods and various raw components that can go into biodiesel, making it impossible to say that some products will not cause problems (7). John Deere has done some testing on its tractors in Europe with higher concentration of rapeseed methyl ester and compressed vegetable oil and has not found any problems of biodiesel plugging filters. They stated, however, that the properties of fuels used in Europe might be different than B20 used in the United States (8). Cummins does not have any results of biodiesel testing on its fuel filters; however, they indicated that the use of biodiesel fuel would not affect Cummins material and workmanship warranties (9).

In summary, the engine manufacturers have expressed no clear concern over the general use of biodiesel as filter specifications get tighter. There appear to be concerns primarily related to the quality of the biodiesel fuel that is used in the engine and the amount of water removed before the fuel passes into filters; however, there do not appear to be any concerns when the biodiesel complies with standards.

5.2. Microbial Growth

One potential problem with both diesel and biodiesel fuel is the phenomenon of microbial growth. This section describes the consequences of unchecked microbial growth in fuel, factors involved in microbial growth, how microbial growth may be addressed, and the severity of this problem with biodiesel in comparison with conventional diesel. Much material in this section is based on an ASTM publication that addresses fuel system microbiology (10).

5.2.1. Anatomy of Microbial Growth

Microbes include viruses, bacteria, archaea, fungi, and blue-green algae. Usually microbes grow in any controlled environment which includes rich sources of carbon and water. Diesel fuels are a rich source of carbon, which in a closed storage area can offer good conditions for microbial activity.

There are various factors on which microbial growth depends. Air can help certain types of microbes grow, while others are only active in oxygen-depleted environments. Microbes usually do not require free water; they do, however, require available water in small quantities. Up to certain critical temperatures, growth rate and metabolism of microbes increase with increasing temperature. This relationship is log-linear: As temperature increases linearly, metabolism activity increases logarithmically.

A group of microbes may come together to form a colony called a biofilm. These films develop at a system interface such as the fuel-water interface, or the fuel-tank wall surface. In fuel systems, communities are formed within biofilm.

Consortia are communities in which the individual members, working in concert, cause things to happen that wouldn't otherwise happen. Biofilms grow irregularly on the fuel-tank interface and don't completely coat the surface of metal. This leads to certain physiochemical conditions which are different at biofilm-free areas. Waste products from these biofilms, known as metabolites, create an electro-potential gradient which can etch the metal with which they come into contact.

Dormant microbes adsorbed on the body of dust particles may enter the fuel system even before the tanks are attached to the vehicle body. Continuous pumping of fuel introduces new dust particles and fuel containing absorbed bacteria.

Once they enter the system, the bacteria tend to settle and diffuse similarly to the way entrained water does. Many species of bacteria produce a sticky substance called extracellular polymeric substance (EPS). When a bacterium contacts a surface, the EPS enables the microbes to adhere. Once they have adhered, they begin multiplying. After attaching, the bacteria may mature in 0.5

to 6 hours. Biofilms are a dynamic environment, as the outer layer may die off and be separated as a suspended medium in the fuel to be washed away or settle to the bottom of the fuel.

5.2.2. Potential Consequences of Microbial Growth

If unchecked, microbial growth in fuel may present several problems.

Filter Clogging

Some of the biofilm layers might reach the fuel filters. Most diesel engine fuel filters have a 5-micron rating, whereas individual bacteria and fungi can range from 0.01 to 0.1 microns. Depending on the size of biomass that has been detached from the surface of biofilm and has reached the filter, some microbes can escape through the filter media. Once this happens, the microbes may block fuel injectors and, in severe cases, fuel lines. In this event, there could be potential engine failure and significant damage.

Hydrochloric Acid Deterioration of System Components

In addition to the effects related to filtration, metabolites produced by biofilms may be transported in the system and react with inorganic chlorates, which are present in the system and produce hydrochloric acid. This hydrochloric acid degrades rubber, some plastics and metal oxide films that may be in the system.

Fuel Deterioration

Carbon atoms which were present in the fuel for combustion get utilized by microbes and are oxidized before they can get burnt in combustion chamber. Due to this, the fuel loses its consistency and can lead to improper atomization, irregular combustion, loss of power and fuel efficiency.

Etching and Corrosion

Another possible effect of microbial activity is that it may etch or corrode surfaces within the fuel system. Due to the fact that fuel is continuously being pumped in and being burnt inside the combustion chamber, there may not be any effect to the cylinder walls. For microbes to etch or corrode any surface directly there has to be stagnation of fuel.

5.2.3. Methods of Removing Microbial Presence

Microbial growth is essentially inevitable in diesel and biodiesel fuel, and for most high-turnover fuel systems will not be a concern. In cases where microbial growth has become a significant concern, various processes may be used to return contaminated fuel and fuel systems to an acceptable level of cleanness.

Tank Cleaning

The fuel can be cleaned through filtration or centrifugation. Filtration involves emptying fuel from one tank into another through a small (0.2-micron) grating filter. Tank cleaning may also be used to ensure that a system has been decontaminated thoroughly. The actual protocol for tank cleaning depends on tank size and configuration, but the process requires the tank to be empty of fuel. More recommendations for this process are described in ASTM D4276 (11).

Application of Microbicides

Antimicrobial pesticides, also referred to as microbicides or biocides, are chemicals that are used to treat contaminated fuels and fuel systems. Microbicides are typically classified by their target organism. Broad spectrum anti-microbial pesticides called microbicides are used against both bacteria and fungi, and are generally effective against algae too. Moreover, antimicrobial pesticides may be classified on the basis of their fuel and water solubility. They are classified as fuel-soluble, water-soluble or dual-soluble. The chemistries are varied as is the performance of these materials. Engine manufacturers and trade groups may specify microbicides that are approved for use in fuels in their systems. Since microorganisms live in water and not in the fuel, a treatment strategy that will best fit both the physical characteristics of the system and the intended use of the system should be employed. Fuel-soluble microbicides may be used to control microbial contamination in water accumulated at the bottom of the fuel system. A dual-use microbicide might be useful for a fixed-roof, long-term storage facility, whereas water-soluble microbicides may be more advantageous in high throughput systems and in tanks which have irregular bottoms where water may be trapped and cannot be drained off.

Anti-microbials are generally not used as fuel additives and their usage is generally not continuous. Instead, they are typically applied as a "shock" treatment so that there is sufficient concentration of anti-microbials to respond to the microbial growth problems. Anti-microbials are rarely sufficient to correct a severe microbial contamination problem. Anti microbials are most effective when used as preventive treatments or in concert with system cleaning. Shock treatment might cause a mass of biomass to dislodge which might block fuel filters, pipes, etc. Microbicides are used to kill microbes and are not used to clean up or eliminate organic debris resulting from microbial growth.

The cost of anti-microbials varies significantly across manufacturers. For one additive manufacturer, a shock treatment would be about 10 cents per gallon and for maintenance (i.e. continuous) treatment would be between 3 and 4 cents per gallon (12). Another additive manufacturer's price is slightly over 1 cent per gallon (13).

5.2.4. Problem Severity

It was noted that microbial growth is a problem in biodiesel and conventional diesel. One oil company notes that the presence of water and warmer temperatures can foster microbial growth in conventional diesel fuel and recommends frequent checking of vehicle and storage tanks for water, and draining of tanks as necessary: "In extreme cases, biocides may be required to control microorganism growth." (14) Another oil company recommends that those who store diesel fuel for an extended period (i.e., in excess of one year) should take several precautions, including keeping free water out of the fuel, and adding a stabilizer that includes a biocide (15). The Filter Manufacturers Council emphasizes the need to remove water from the diesel fuel system, but notes that the only way to ensure removal of microbes is through a biocide (16). The Steel Tank Institute, which represents manufacturers of atmospheric steel storage tanks (including those used in fuel storage), noted that changes in the petroleum distribution infrastructure and chemical changes in fuel composition have made microbial growth more common than originally thought (17). In summary, microbial growth is a documented problem with conventional diesel fuel.

Water contamination, and hence microbial growth, is believed to be a more significant issue for biodiesel than conventional diesel. One study noted that biodiesel can contain up to 40 times more dissolved water than diesel. The report noted if biodiesel comes into contact with free water during storage, which is almost inevitable, it would absorb two to three times as much water as is allowed by current diesel fuel specifications. The report also noted, however, that the water is chemically bound to the fuel and is therefore not available to support microbial growth. The same report, in a different experiment, measured greater growth in microbial populations with biodiesel than diesel. The report recommended, "In applications where the fuel is expected to come into contact with sufficient quantities of free water to support the growth of microorganisms, the fuel should be treated with a biocide to prevent their growth. … As water is more prevalent in biodiesel then conventional diesel there may be increased microbial activity in biodiesel." (18) The Engine Manufacturers Association (EMA) stated, "Biodiesel fuel is an excellent medium for microbial growth. Inasmuch as water accelerates microbial growth and is naturally more prevalent in biodiesel fuels than in petroleum-based diesel fuels, care must be taken to remove water from fuel tanks." Nevertheless, EMA stated that blends up to a maximum of B5 would not cause engine or fuel system problems, provided that the base biodiesel meets ASTM standards (19), and several manufacturers support B20 usage (20, 21, 22).

5.2.5. Conclusion

Both diesel and biodiesel are susceptible to microbial activity, which may lead to filter clogging (with attendant loss of power), fuel deterioration, and metal etching inside the tanks. Some inherent characteristics in biodiesel provide a better environment for microbial growth than conventional diesel. The use of proper controls, such as ensuring microbe-free fuel supply, low water content in fuel system, and keeping tanks filled, will reduce the chances of microbial activity inside the fuel system. Except in cases of fuel stagnation or significant water contamination, there should be no need for additional treatment to deal with microbial growth in biodiesel as compared to conventional diesel, especially for low blends of biodiesel (B20 or less).

5.3. Evasion

One concern that has been expressed over Montana adopting a biodiesel mandate is that long-haul truck drivers will avoid re-fueling in Montana to avoid using biodiesel fuel. This may occur because of the additional cost of the fuel, perceived concerns about the effects of biodiesel performance, or both. This could have implications for state fuel tax receipts as well as for revenues of fueling stations in Montana.

5.3.1. Example of Evasion

A similar issue of fueling evasion was raised when Maricopa County in Arizona considered adopting California's more stringent diesel fuel standard in order to reduce mobile source emissions. CARB (California Air Resources Board) diesel was estimated to cost 6.5 cents more per gallon than conventional diesel, and there was concern that diesel-fueled vehicles traveling through the county would fuel elsewhere. This evasion would reduce the volume of fuel sold by fueling stations based in the county, and would also reduce the potential emissions reduction benefits.

To determine the amount of CARB fuel used by diesel vehicles traveling in the county, they assumed that 10 percent of all non-local diesel miles (i.e. long-haul truck drivers) would be fueled using local fuel. Based on estimates of the percentage of diesel vehicle-miles of travel (VMT) driven by local vehicles, it was estimated that approximately 40 percent of diesel VMT in the county would be driven using CARB diesel (23).

The evasion question was never conclusively answered in Arizona, as the CARB mandate has not been imposed. There are a couple of factors to consider in this regard. First, when California adopted CARB standards a few years ago, there was also a concern of vehicles refueling outside the state to escape the mandate. U.S. Department of Energy (DOE) statistics indicated, however, that diesel fuel sales were minimally, if at all, affected by this type of fuel evasion[2] (24). Second, travel patterns in Maricopa County, a highly urbanized county of over 3 million people, will significantly differ from those in a rural state like Montana which has much less concentrated urban development. Third, Maricopa County, at just over 9,200 square miles, includes a significantly smaller area than Montana. Therefore, it would take more accommodation for a long-haul trucker to avoid fueling in Montana than it would to avoid fueling in Maricopa County.

5.3.2. Evasion due to Price

Recent volatility in fuel prices in 2004 has caused long-haul drivers to be more aggressive in seeking out lower priced fuel (25). If a biodiesel mandate were to further increase the cost of the fuel, this could be an additional factor encouraging long-haul drivers to fuel in other states. There are a couple of factors which should be considered to balance this. First, as the price of diesel increases, the price of biodiesel could become more cost competitive, so that there may be no real difference in the fuel price. Second, the level of price difference compared to the price differential attributable to other factors (including taxation) needs to be considered. Table 5-1 shows how Montana diesel fuel prices compare with neighboring states, Washington and Minnesota. It is clear that there are differences in diesel prices between states, partially but not entirely due to differences in tax rates. If a biodiesel policy were to increase the cost of diesel fuel by an amount less than the difference in fuel prices between Montana and a more expensive state, it is doubtful that evasion would occur due to price alone.

[2] It could be argued, because California is more urban, that a higher percentage of truck traffic in California is intrastate than in Montana. This could result in greater consequences from potential fuel evasion in Montana.

Table 5-1: Diesel Fuel Prices and Tax Rates, Selected States

	Tax		Pump Price					
			May 2004			November 2004		
State	State	Federal	with tax	w/o tax	difference	with tax	w/o tax	difference
Idaho	$0.250	$0.244	$2.094	$1.600	$0.172	$2.435	$1.941	$0.215
Minnesota	$0.200	$0.244	$1.722	$1.278	($0.150)	$2.176	$1.732	$0.006
Montana	$0.278	$0.244	$1.949	$1.428	$0.000	$2.247	$1.726	$0.000
North Dakota	$0.210	$0.244	$1.754	$1.300	($0.128)	$2.122	$1.668	($0.058)
South Dakota	$0.220	$0.244	$1.759	$1.295	($0.133)	$2.183	$1.719	($0.007)
Washington	$0.280	$0.244	$2.194	$1.670	$0.242	$2.395	$1.871	$0.145
Wyoming	$0.140	$0.244	$1.860	$1.476	$0.048	$2.202	$1.818	$0.092

(Source: 26, 27)

5.3.3. Evasion due to User Concerns

Another potential contributor to evasion could be a perception that biodiesel will negatively impact vehicle performance. ASG Renaissance conducted a survey in 2003 which examined user acceptance of biodiesel among major fleet managers, representing Federal and state agencies, fleets affected by the Energy Policy Act (see section 7.1.1), fuel providers, power companies, as well as municipal and commercial fleets (28). The original impetus of the study was from Ford Motor Company, which was interested in the level of interest that their major fleet operators had in biodiesel. Ford provided ASG Renaissance with a list of key diesel operators from commercial and government accounts in their fleet database, and ASG Renaissance focused on contacting large customers (100+ vehicles). ASG Renaissance augmented this database with fleet contacts from the National Biodiesel Board. In addition, ASG Renaissance surveyed fleet managers at a couple of conferences. Most of the respondents were identified through Ford’s initial database, and most respondents used multiple brands of vehicles in their fleets.

Managers of more than 50 fleets representing over 50,000 vehicles, with an average fleet size of 550 diesel vehicles, responded to the survey. Significant findings include the following:

- Ninety-one (91) percent of fleet managers have a positive attitude toward biodiesel.
- The 9 percent of respondents who had a negative impression of the fuel indicated that cost was the major roadblock to further consideration of the fuel.
- Forty-five (45) percent of fleets are using biodiesel (B20 or higher blends are used by 88 percent current end users), and all present users report favorable experience with the fuel.
- Ninety-six (96) percent of users would recommend biodiesel to other fleets (the other respondent was concerned about price).

- ?? Fifty-three (53) percent of respondents said support of biodiesel by original equipment manufacturers (OEMs) will definitely or most likely be a factor in the decision to buy products from those manufacturers.

While not statistically significant, these findings suggest general support among major fleet managers for usage of biodiesel. The positive experience of users – 96 percent of respondents willing to recommend the fuel to others – would suggest that as people are made aware of the fuel and use it, they are satisfied. As the biodiesel industry progresses toward increased commercialization of the fuel, it would be expected that this should continue.

5.3.4. Conclusion

Long-haul trucks, with their ability to bypass fueling over entire states, make potential evasion of fueling in Montana an issue to be examined. This evasion could occur because of increased prices that may result from a biodiesel mandate, in addition to concerns among potential users about the impacts of biodiesel on their trucks' fuel economy and power.

Experience from other areas suggests that fueling evasion due to the price of B2 should not be a significant concern. Current fuel prices show that the issue of fuel price differential is already present in Montana, and anecdotal evidence indicates that many long-haul truckers know this and fuel in neighboring states like North Dakota and Wyoming. The differential price for B2 would likely have minimal additional effect on fuel evasion. Evasion due to negative perceptions of biodiesel might be an issue, but it appears that increased usage of the fuel has helped to enhance its reputation.

6. THE MONTANA BIODIESEL MARKET

One major motivation behind the Montana House's proposed B2 mandate was to provide an additional market for Montana's farmers. The purpose of this chapter is to document potential sources of feedstock for biodiesel within Montana, and their suitability for usage in larger scale biodiesel production.

6.1. Biodiesel Production

Most commercial biodiesel is made by a chemical process called transesterification. This involves mixing the feedstock oil with an alcohol – typically methanol or ethanol – in the presence of a catalyst, such as sodium hydroxide or potassium hydroxide. The reaction produces methyl esters (if methanol is used) or ethyl esters (if ethanol is used) – which comprises the biodiesel fuel – and glycerin (29).

This section describes the different stages in biodiesel production and distribution, to highlight the factors that may affect the success of developing a biodiesel industry in Montana, and the extent to which legislation (and what type of legislation) can be a tool for developing that industry.

6.1.1. Feedstock

Biodiesel may be made from a variety of feedstocks, as shown in Table 6-1. The predominant biodiesel used in the U.S. is soy methyl ester, although rapeseed methyl ester is predominant in Europe. It is estimated, on average, that feedstock comprises 80 to 85 percent of the cost of biodiesel fuel (30, cited in 31).

Table 6-1: Feedstocks Used for Biodiesel Manufacture

Vegetable Oils	Animal Fats	Other Sources
✍ Soybeans ✍ Rapeseed ✍ Canola Oil (a modified version of rapeseed) ✍ Safflower Oil ✍ Sunflower Seeds ✍ Yellow Mustard Seed	✍ Lard ✍ Tallow ✍ Poultry Fat	✍ Recycled Restaurant Cooking Oil (a.k.a. Yellow Grease)

The properties of biodiesel are not affected by the catalyst used; however, the type of feedstock can impact performance. For example, there is some difference in cloud point based on feedstock used, with vegetable source biodiesel having the lowest cloud points, animal sources having the highest cloud point, and yellow grease falling in between the two (32).

Montana produces several feedstocks that may be used in biodiesel. It should be emphasized that the production figures presented do not reflect surplus production.

Vegetable Sources

Oilseeds are the primary vegetable source used as biodiesel feedstock. In order to convert oilseeds into oil suitable for biodiesel production, the oilseeds must be de-gummed and crushed. Crushing will produce feedstock oil and a meal byproduct that may be sold to other markets.

Soybeans are the primary crop used for biodiesel in the United States. This is largely due both to the volume of soybean production in the United States – 164 billion pounds in 2002, of which nearly 63 billion pounds were exported – and the significant volume of soybean oil stocks available: an estimated 2.359 billion pounds in 2002 (33). A 1998 University of Missouri-Columbia study indicated that between soybeans, sunflower, canola and animal fats, canola would be the lowest cost feedstock for production. However, because of the value of its meal, soybeans would result in a lower cost of production for biodiesel than canola (34). This may be another reason why soybean oil continues to dominate the U.S. market as feedstock for biodiesel. To date, soybeans are not grown in Montana on any significant scale.

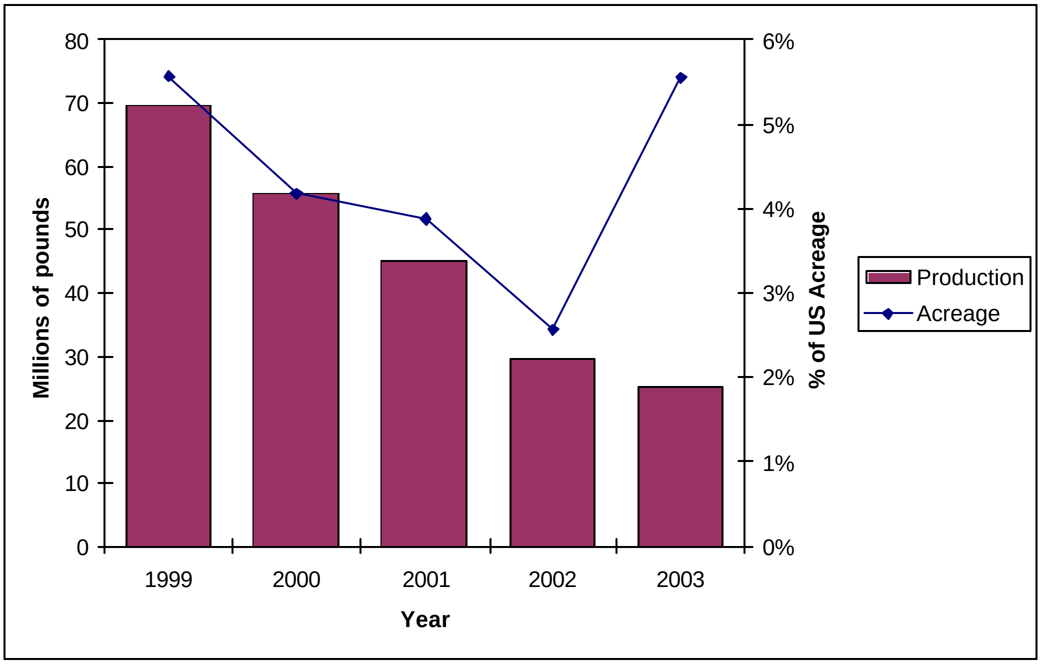
Canola or rapeseed has been the dominant feedstock for European biodiesel[3], and is grown in Montana. Over 90 percent of the canola produced in the U.S. is from North Dakota, whereas less than 5 percent is from Montana (36). Montana produced nearly 70 million pounds of canola in 1999, but that number has dropped in recent years as shown in Figure 6-1 (on page 29), primarily due to drought. Assuming 40 percent oil content (37) and 7.35 pounds of oil to make one gallon of biodiesel (38), the 70 million pounds produced in 1999 would be enough to make 3.8 million gallons of biodiesel. However, the reduced production level in 2003 would have yielded only 1.38 million gallons.

Yellow mustard seed is another oilseed grown in Montana. Production levels in Montana are less than safflower, and have also been affected by drought as shown in Figure 6-2 (on page 29). Assuming 27 percent oil content (39), the 12.3 million pounds produced in 2003 would be enough to make a little more than 450,000 gallons of biodiesel.

Safflower is also grown in Montana. Unlike canola, safflower production levels in Montana have been consistent over the last several years, as shown in Figure 6-3 (on page 30). This may be due to safflower's drought tolerance (40). Oil content ranges from 30 to 45 percent. Assuming a median oil content, the 32 million pounds of safflower produced in 2002 could have been used to make 1.65 millions gallons of biodiesel.

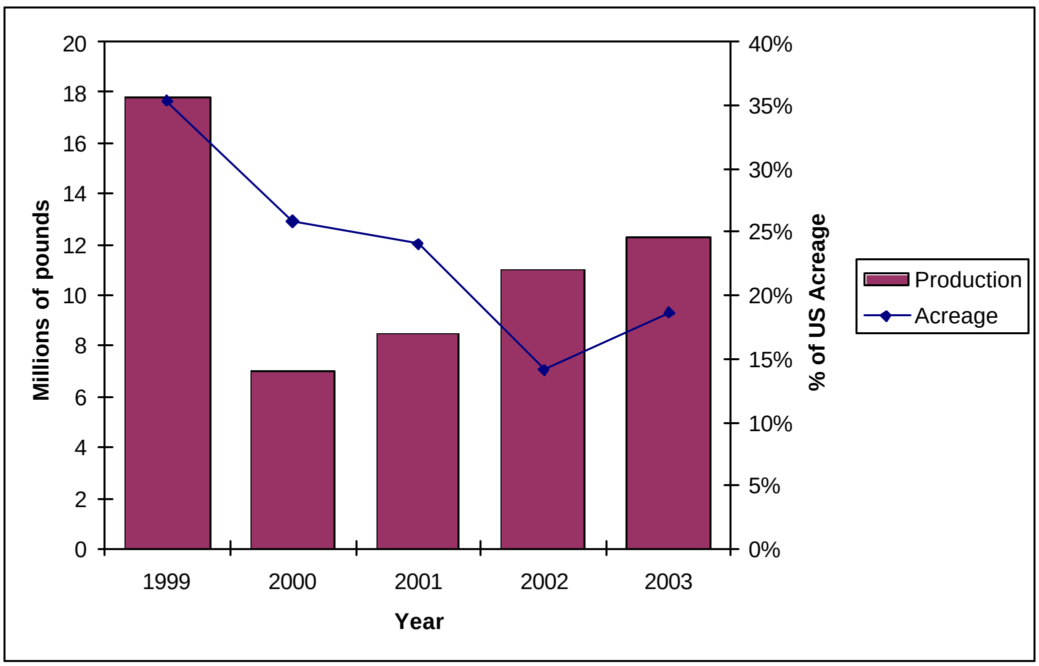
Price is an important consideration as to which feedstocks would be used in biodiesel production. Recent prices for canola, mustard and safflower oil have been at 28.4, 16 and 79 cents per pound, respectively (41, 42). This results in per-gallon prices of feedstock of $1.82, $1.18 and $5.81 respectively. At the most recent price of 13.5 cents per pound for soybean oil (43), the current price for soybean-based feedstock would be $0.99 per gallon. As canola prices are currently higher than historical levels, it is believed that canola and mustard may be suitable for use in biodiesel, but safflower will be too expensive.

[3] Canola is an edible variety of rapeseed. According to the Northern Canola Growers Association, the two terms are not interchangeable (35).



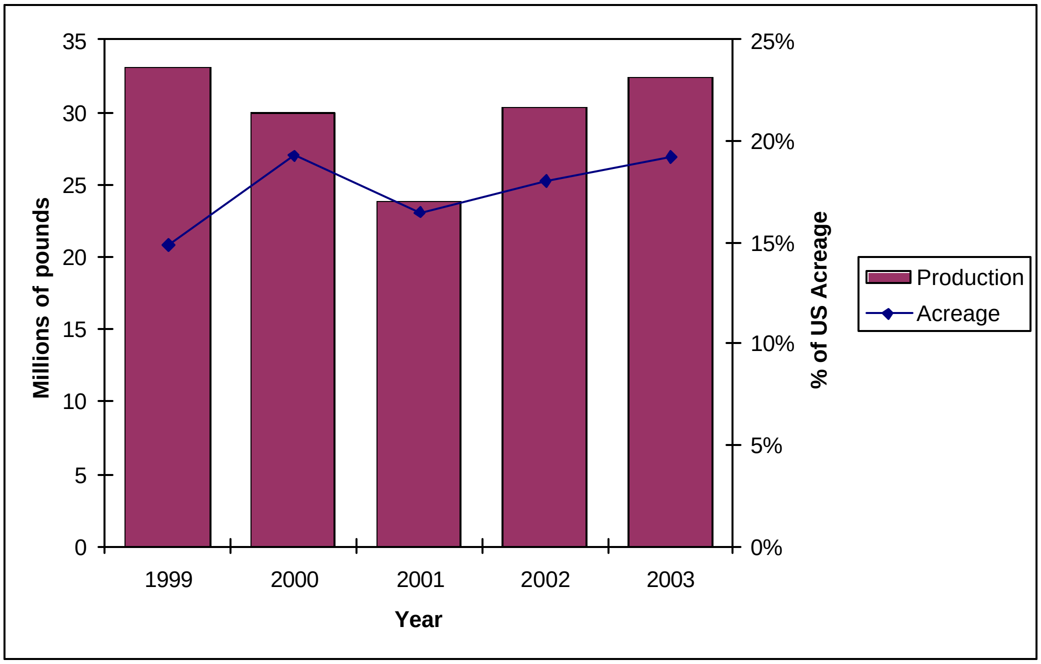
(Source: 44, 45)

Figure 6-1: Annual Production and Acreage of Canola in Montana



(Source: 44, 45)

Figure 6-2: Annual Production and Acreage of Yellow Mustard Seed in Montana



(Source: 44, 45)

Figure 6-3: Annual Production and Acreage of Safflower in Montana

Animal Fats

Another potential source for feedstock is animal fats, including beef tallow and lard. Less than 0.01 percent of commercial cattle slaughtered in the U.S. is slaughtered within Montana, with operations in Nebraska, Texas, Kansas and Colorado slaughtering 67 percent of the nation's total (46). A 1998 report estimated 2.56 million tons of beef tallow were produced in the United States (47). With a 3 percent increase in slaughtered cattle over that time frame, it may be estimated that there were 2.64 million tons produced in 2004. If Montana produces beef tallow in a proportion similar to its share of the cattle slaughter market, there would be enough beef tallow to produce about 350,000 gallons of biodiesel, assuming that 7.7 pounds of feedstock are required to produce one gallon of biodiesel. A similar analysis for hog slaughter reveals that Montana produces enough lard to produce 18,000 gallons of biodiesel.

While animal fats may be cheaper than other feedstocks, they have higher cloud and pour points (32), which could prove to be a challenge for cold weather operations.

Yellow and Brown Grease

Two types of grease may be used in biodiesel: yellow and brown grease. Yellow grease is derived from used cooking oil and waste greases that are separated and collected at the point of use by the food preparation facility. Brown, or trap, grease is collected in traps that prevent grease from entering through drain lines at restaurants into the sewage system. Both are significantly cheaper than vegetable oil feedstock; however, yellow grease has inferior cold weather properties, and brown grease is both smelly and cannot be processed using newer transesterification processes (32, 48).

No estimates of used restaurant grease are available for the state of Montana. A study of several metropolitan areas estimated grease availability of 9 pounds per capita of yellow grease and 16 pounds per capita of brown grease (49). With an estimated population of 910,000, this grease could be converted to 8.2 million pounds and 14.6 million pounds of yellow and brown grease, respectively. This could result in 1.06 million and 1.9 million gallons of biodiesel fuel, respectively.

Summary

Table 6-2 shows estimates of biodiesel that could be produced using feedstocks produced in the state. Feedstocks that are better in cold weather – canola and mustard – are designated as winter feedstocks, while animal-based or grease-based feedstocks, which have inferior cold weather properties, are classified as summer. Safflower prices are too high for it to be feasible as a feedstock.

Table 6-2: Current Estimated Feedstock Production in Montana

Feedstock	Production		Winter	Summer
	Pounds	Gallons		
Canola	25,380,000	1,381,000	1,381,000	-
Yellow Mustard	12,322,000	453,000	453,000	-
Safflower	32,340,000	1,650,000	-	-
Beef Tallow	2,730,000	371,000	-	371,000
Lard	138,000	19,000	-	19,000
Yellow Grease	8,200,000	1,116,000	-	1,116,000
Brown Grease	14,600,000	1,986,000	-	1,986,000
Total		**6,976,000**	**1,834,000**	**3,492,000**

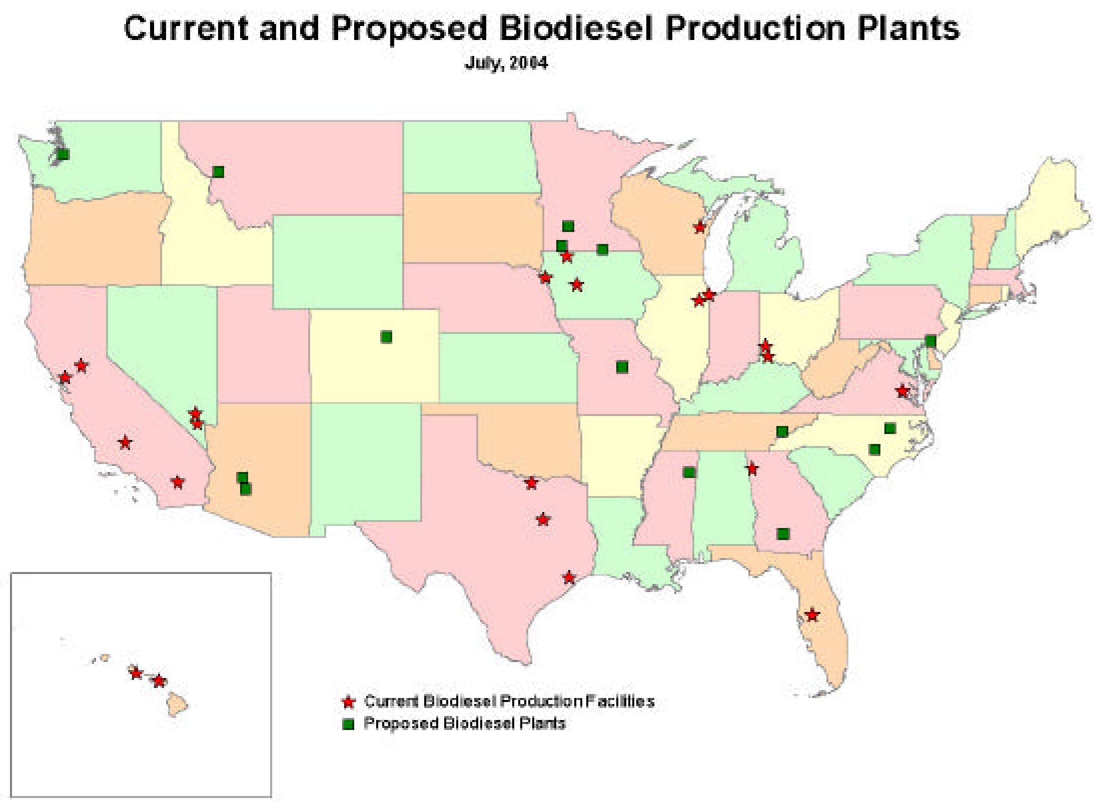
The use of alternative feedstocks during warm weather months could significantly decrease the cost of biodiesel. For example, current prices are lower for inedible tallow (14 cents per pound), yellow grease (9 cents), and brown grease (5 cents or cheaper) (48, 50). These alternatives would not be suitable for year-round usage, however, because of concerns over cold-weather properties and a higher free fatty acid content which may make processing more expensive (51).

6.1.2. Production

The production process for biodiesel traditionally involves transesterification employed in a batch production process. Feedstock oil is mixed with alcohol (either methyl or ethyl alcohol) and a catalyst to produce biodiesel, glycerol and some recyclable alcohol. The process is chemically and mechanically simple.

While feedstock costs comprise the majority of biodiesel costs, the costs of production are also important. The average range of production costs have been cited as $0.15 to $0.50 per gallon; however, this could be higher as plant size decreases. A University of Georgia report concluded that economies of scale were realized at a production level of 15 million gallons per year, where production costs were estimated at $0.37 per gallon (52). A North Dakota State University study estimated that production of biodiesel in a hypothetical 5-million plant would cost about $0.73 per gallon (53). As biodiesel demand increases worldwide, it would be expected that resources would continue to be devoted toward reducing biodiesel processing costs.

As Figure 6-4 indicates, there is only one biodiesel production plant currently planned for Montana: a 10-million gallon facility to be operated by Sustainable Systems, LLC in Missoula.



(Source: 54)

Figure 6-4: Current and Proposed Biodiesel Production Plants, July 2004

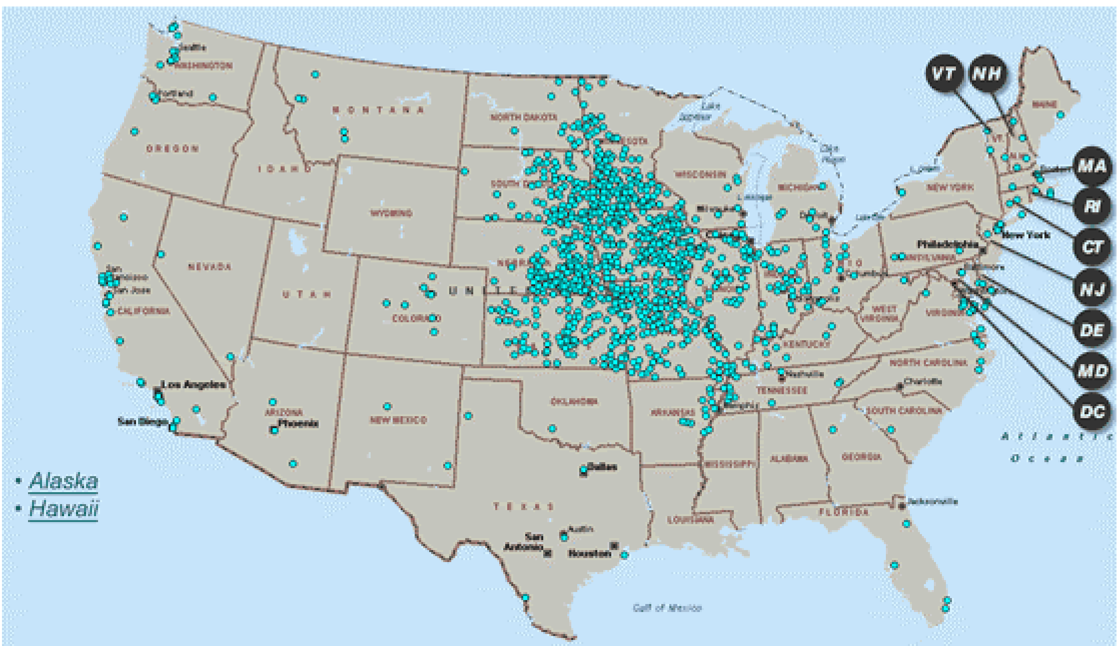
6.1.3. Transportation

As shown in Figure 6-4, active biodiesel production facilities are currently located a significant distance away from Montana. Therefore, another consideration beyond the cost of production is the cost of transportation.

The price point for shipping is dependent on sales volume, so larger volumes of biodiesel freight are less expensive to ship. Rates for shipping were recently estimated at $0.34/gallon for shipment by truck and $0.12-0.17/gallon for shipment by tank cars (55). Shipping costs would decrease as a biodiesel industry develops in Montana to meet local demand. Transportation costs will also be a function according to distance, so locally produced biodiesel could be transported to Montana consumers at a cheaper rate – all things being equal – than biodiesel produced outside of the state.

6.1.4. Distribution Infrastructure

Figure 6-5 shows where biodiesel distributors are located throughout the country. There are several biodiesel distributors currently serving Montana.



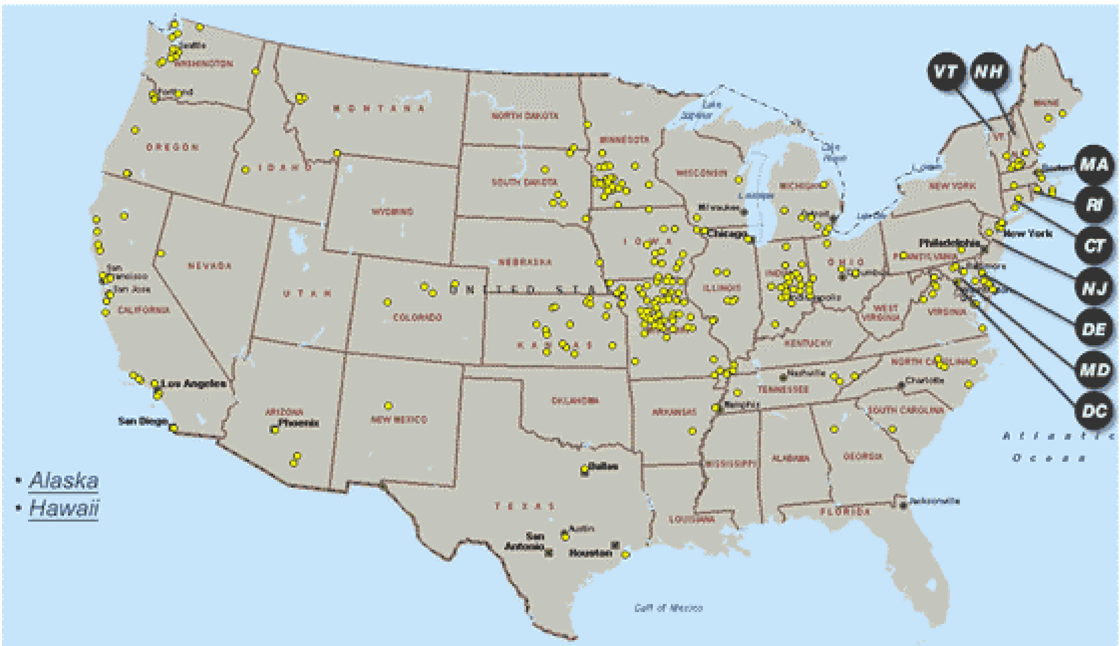
(Source: 56)

Figure 6-5: Distributors Map, September 2004

While scale economies favor centralized production, Van Dyne and Blase demonstrated that transaction costs, such as marketing, processing and transportation, can be a significant component in biodiesel costs. They show that the average cost per gallon of soy-based biodiesel for transaction costs is $2.19 to $2.33 per gallon. Using a new generation cooperative as a model, where there is greater vertical integration of the biodiesel production chain, they estimate the final cost of the fuel to be $1.36 per gallon (30). This approach suggests that more localized, smaller-scale production and distribution facilities could make biodiesel more affordable.

6.1.5. Retail Infrastructure

Figure 6-6 shows the location of biodiesel retailers throughout the country. There are currently multiple retail outlets in Missoula where biodiesel blend fuel can be purchased, along with a station in West Yellowstone.



(Source: 57)

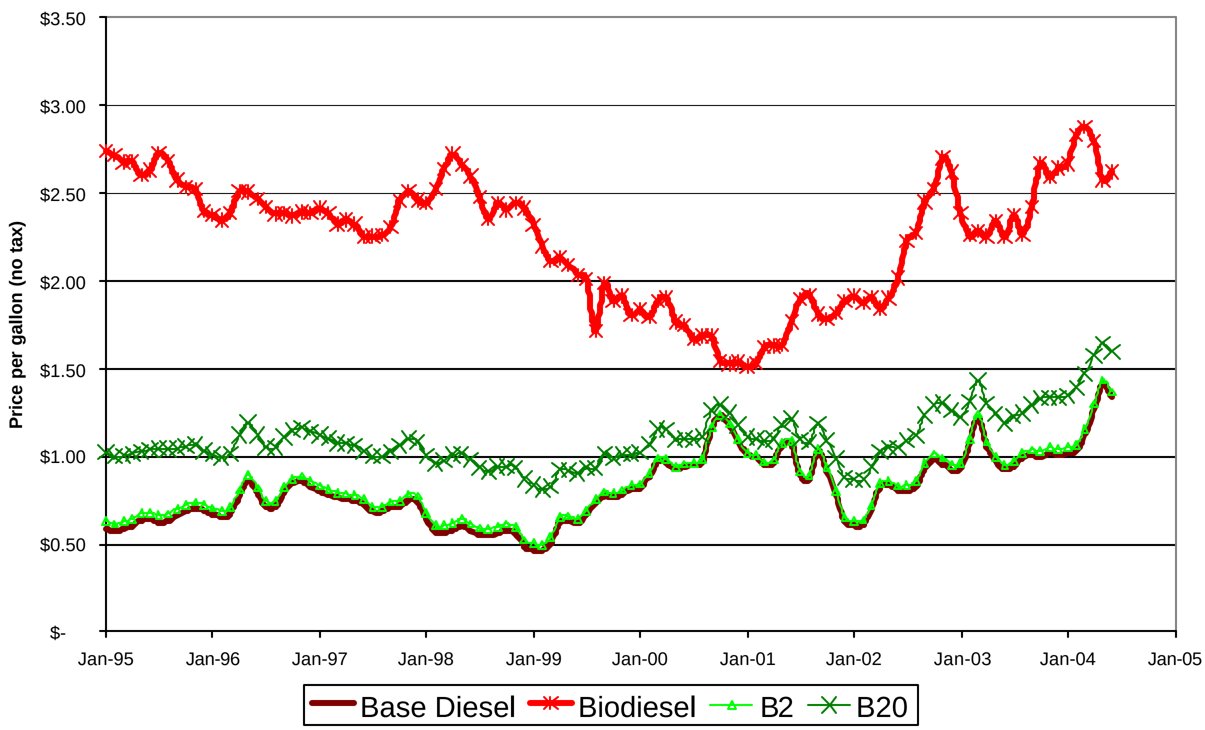
Figure 6-6: Map of Biodiesel Retailers, September 2004

6.1.6. Fuel Price

There is considerable difficulty in developing reliable estimates for biodiesel prices, due to the complicating factors of feedstock choice, level of integration in production and marketing, and cost of various methods of transport. Nevertheless, it is an important consideration in relation to formulating biodiesel policy.

Figure 6-7 compares estimated prices of canola-based biodiesel versus diesel from January 1995 to June 2003. The cost estimate for canola-based biodiesel assumes that 7.7 pounds of canola oil are required to make 1 gallon of biodiesel, with processing and transportation costs of $0.35 and $0.15 per gallon, respectively[4]. As can be seen, the cost of pure biodiesel is generally much higher than diesel. Biodiesel blends, however, may be relatively competitive. Over the time period shown in the graph, B2 would cost 2.7 cents more per gallon than conventional diesel, while B20 would have a premium of 27.0 cents per gallon compared to conventional diesel.

[4] It is expected that there would be favorable economies of scale in both production and transportation as production levels increase.



(Sources: Canola Prices from 41, 58; Diesel Prices from 59, adjusted for 52.15 cents per gallon combined Federal and State tax)

Figure 6-7: Price Comparison of Diesel Fuel vs. Canola Biodiesel Blends

The high cost of biodiesel relative to conventional diesel is perhaps the most significant reason that biodiesel has not gained wider acceptance in the U.S. Favorable taxation in Europe has allowed biodiesel to achieve approximate cost parity with conventional diesel. It is important to emphasize, however, that fuel taxes make fuel in European substantially more expensive than fuel in the United States.

Does the higher price of biodiesel provide benefits in increasing vehicle longevity? Few studies have examined life cycle costs associated with biodiesel as compared with conventional diesel. A 1994 study from the University of Georgia compared the costs of operating an urban bus for conventional diesel versus biodiesel and other alternative fuels. The report determined that while biodiesel was the lowest cost alternative fuel option for an urban bus, it was still more expensive than diesel. The authors concluded that the economics of biodiesel (and other alternative fuels) require "compelling environmental or socioeconomic benefits … to warrant incentives for promoting alternative fuels." (60)

A more recent study has indicated that biodiesel could be cheaper over the long run than conventional diesel. St. John's public school district in Michigan converted to B20 in 2002, and they report that B20 has saved the district $4,000. Cost savings are attributable to B20's higher lubricity, which has prolonged the lives of the fleet's fuel pumps while extending the intervals between oil changes by up to 30 percent. Fuel economy has also improved by nearly 1 mile per gallon (61).

Table 6-3 shows production cost forecasts produced by the U.S. Department of Energy's Energy Information Administration (EIA). It compares the cost of producing pure biodiesel from soybean oil and yellow grease versus production costs for diesel No. 2. It can be seen that biodiesel is projected to remain more expensive in the near term, because of the higher feedstock and production costs associated with biodiesel. It should be emphasized that EIA's methodology excluded capital costs from biodiesel and included them for diesel, so the true cost of biodiesel will be higher.

Table 6-3: Projected Production Costs for Diesel Fuel by Feedstock, 2004-2013.

	Soybean Oil	Yellow Grease	Petroleum
2004-05	$2.54	$1.41	$0.67
2005-06	$2.49	$1.39	$0.78
2006-07	$2.47	$1.38	$0.77
2007-08	$2.44	$1.37	$0.78
2008-09	$2.52	$1.40	$0.78
2009-10	$2.57	$1.42	$0.75
2010-11	$2.67	$1.47	$0.76
2011-12	$2.73	$1.51	$0.76
2012-13	$2.80	$1.55	$0.75

Note: All cost estimates are in 2002 dollars

(Source: 62)

The cost differences for B2 and B20 compared to conventional diesel are shown in Table 6-4. Excluding the effect of capital costs on biodiesel, the surcharge for B2 is forecast to be, on average, 1.4 to 3.7 cents more per gallon than diesel, while the price premium for B20 could be between 13.6 and 36.5 cents per gallon.

Table 6-4: Marginal Fuel Costs for B2 and B20, 2004-2013

	Soybean Oil				Yellow Grease			
	B2		B20		B2		B20	
	Price	Premium	Price	Premium	Price	Premium	Price	Premium
2004-05	$0.71	$0.037	$1.04	$0.374	$0.68	$0.015	$0.82	$0.148
2005-06	$0.81	$0.034	$1.12	$0.342	$0.79	$0.012	$0.90	$0.122
2006-07	$0.80	$0.034	$1.11	$0.340	$0.78	$0.012	$0.89	$0.122
2007-08	$0.81	$0.033	$1.11	$0.332	$0.79	$0.012	$0.90	$0.118
2008-09	$0.81	$0.035	$1.13	$0.348	$0.79	$0.012	$0.90	$0.124
2009-10	$0.79	$0.036	$1.11	$0.364	$0.76	$0.013	$0.88	$0.134
2010-11	$0.80	$0.038	$1.14	$0.382	$0.77	$0.014	$0.90	$0.142
2011-12	$0.80	$0.039	$1.15	$0.394	$0.78	$0.015	$0.91	$0.150
2012-13	$0.79	$0.041	$1.16	$0.410	$0.77	$0.016	$0.91	$0.160
Average		$0.037		$0.365		$0.014		$0.136

6.2. Diesel Consumption

The Federal Highway Administration reports that approximately 200 million gallons of diesel fuel were sold in Montana for motor vehicles in 2002, out of a national market of 35.5 billion gallons of fuel (63). On-highway usage may include a wide-range of uses, including personal diesel vehicles, commercial vehicles and motor carriers, public transit, school buses, and government owned fleets. Fuel consumption statistics by vehicle use are difficult to obtain, but it is likely that the biggest on-highway users are commercial vehicles and motor carriers. For reference, the three urban transit districts in Montana consume 395,800 gallons of diesel fuel per year (64).

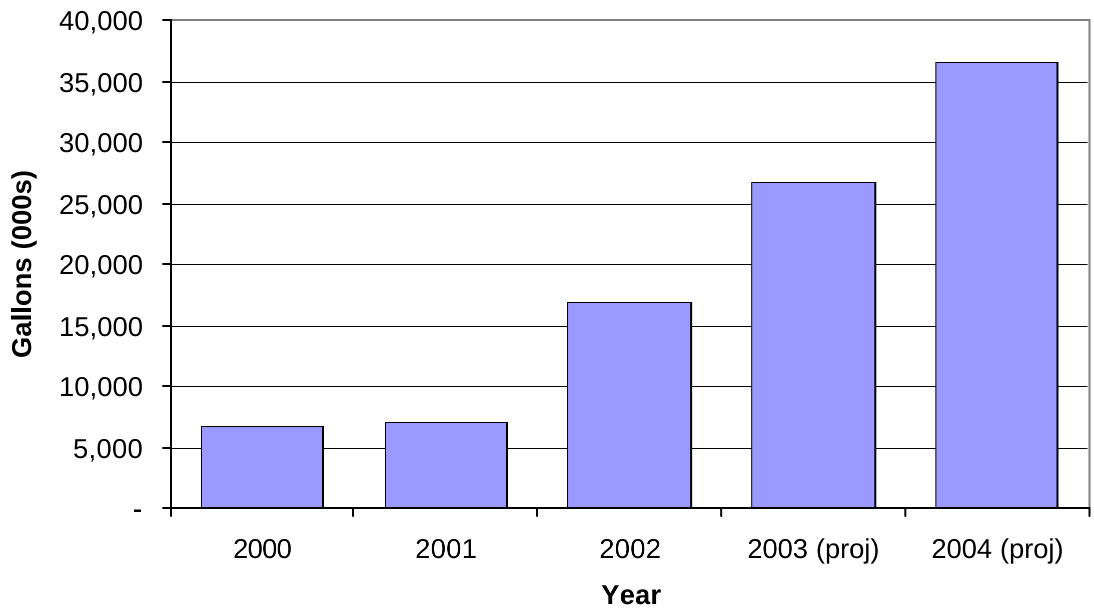
Total state diesel usage, which would include off-road uses such as construction, mining, farming, railroads and marine, is estimated at 300 million gallons (65).

6.3. National Biodiesel Market

Figure 6-4, Figure 6-5 and Figure 6-6 showed the geographic distribution of biodiesel production, distribution and retailing enterprises, respectively. Biodiesel activities seem to be most concentrated in states in the Great Plains and Mississippi River valley, where soybean production is also strongest.

Because widespread biodiesel consumption is relatively new, it is not tracked in a centralized fashion. Therefore, a variety of sources were used to assemble a picture of current diesel consumption.

As shown in Figure 6-8, biodiesel consumption has grown significantly in recent years. It still remains a small percentage of total diesel consumption: estimates for 2004 indicate that biodiesel consumption is 0.09 percent of annual diesel consumption (66).



(Source: 66)

Figure 6-8: National Consumption of Biodiesel

The U.S. Department of Agriculture's Farm Service Agency administers a Bioenergy Program, which pays ethanol and biodiesel producers for production of biodiesel. The program pays credits for the increase in production between fiscal year, along with credits for 50 percent of the baseline production level. The credits are 1 feedstock unit for every 2.5 units used in production for production less than 65 million gallons, and 1 feedstock unit for every 3.5 units used when production exceeds 65 million gallons. The program is funded at $150 million through FY06, and payments are prorated to keep subsidies within the program's appropriation. Payments are made through USDA's Commodity Credit Corporation. To be eligible, production must use vegetable feedstocks (67). Payments were made on 11.5 million gallons of biodiesel in FY 2003, and on 12.9 million gallons of biodiesel through the first three quarters of FY 2004 (68). EIA estimated that after the Bioenergy Program expires, biodiesel production will grow by 1.8 percent per year (69).

Based on potential fleet demand for biodiesel to comply with the Energy Policy Act (see section 7.1.1), EIA estimates that nationwide demand for biodiesel will be at least 6.5 million gallons in 2010 and 7.3 million gallons in 2020 (62). These estimates are less than current usage levels shown in Figure 6-8, which suggests there is some voluntary usage of biodiesel beyond what is mandated.

EIA estimates that, with biodiesel's potential as a lubricity additive, demand could grow to 470 million gallons in 2010 and 630 million gallons in 2020 (62). Its role in lubricity could become critical as the ultra-low sulfur fuel rule takes effect (see section 7.1.4).

7. POLICY CONTEXT

The motivation for this research effort was consideration of proposed legislation by the Montana House of Representatives to mandate biodiesel use in the state. Adoption of this, or other legislation, should be considered in the context of other policies, at both Federal and state levels. This chapter provides a brief review of some of these policies.

7.1. Federal Policy

The Federal government has a number of policies and rules that bear on the question of usage of biodiesel; these are discussed in this section. Also, two lingering pieces of Federal legislation – re-authorization of the Federal transportation bill and passage of an energy policy bill – could change the context for Federal biodiesel policy. These will be discussed as well.

7.1.1. Energy Policy Act of 1992 (EPAct)

Congress passed the Energy Policy Act (EPAct) in 1992. The primary objective of EPAct was to reduce U.S. reliance on foreign oil by the promotion of alternative fuels. The long-range goal of EPAct is a 30 percent reduction in imported petroleum by the year 2010 (51). Sections 501 and 507 of EPAct were designed to promote the use of non-petroleum fuels, such as ethanol, methanol, natural gas, propane, hydrogen, electricity and biodiesel (70). Subsequently, in October 1997, the definition of alternative fuels was expanded from biodiesel (B100) to any gradient between B100 and B20 (71). This is important from a policy perspective because it provides additional incentive for fleets to invest in biodiesel.

EPAct includes three alternative fuel vehicle (AFV) credit programs: (1) State and Alternative Fuel Provider Program, (2) Federal Fleet Program, and (3) Private and Local Government Fleet Program. Due to community population requirements, however, all but a few Montana fleets are exempt from EPAct compliance and enforcement.

State and Alternative Fuel Provider Program

The State and Alternative Fuel Provider Program requires certain fleets to acquire a given percentage (75 percent for state fleets and 90 percent for alternative fuel providers) of alternative fuel vehicles (AFVs) (51). Compliance is required by state government and alternative fuel provider fleets that operate, lease, or control 50 or more light-duty vehicles (LDVs) within the United States, 20 of which need to be in a Metropolitan Statistical Area [MSA] and/or Consolidated Metropolitan Statistical Area [CMSA]. Fleets may comply with these requirements by acquiring AFVs, purchasing credits from other covered fleets, or using credits they have earned (72). For every 450 gallons of B100 (2,250 gallons B20) purchased and consumed, a full vehicle credit is awarded (73).

Federal Fleet Program

The EPAct Federal Fleet Program is a legislative requirement for AFVs by Federal agencies. Starting in fiscal year 2000, this program required that alternative fuel vehicles "represent 75 percent of all affected vehicle purchases for government fleets." (51) Further, 2005 Federal fleets are required to reduce their petroleum consumption by 20 percent. EPAct set forth the statutory requirements for the acquisition of AFVs by Federal agencies (74). All EPAct Federal Fleets must be in the MSA and/or the CMSA areas, none of which are located in Montana.

Private and Local Government Program

Under this program, the Department of Energy (DOE) has authority to develop a vehicle acquisition program for private and local government fleets. DOE is continuing to evaluate whether to implement a rule in this area (75). The following criteria must be met:

?? the company or local government owns, operates, leases or otherwise controls 50 or more LDVs within the United States;

?? at least 20 of those LDVs are used primarily within a MSA/CMSA;

?? those same 20 LDVs are centrally fueled or capable of being centrally fueled; and

?? vehicles in the Private & Local Government Fleet Program cannot also be in the other two AFV programs.

It should be noted that one of EPAct's intents is to diversify the fuels used in transportation in the U.S. Therefore, an additional stipulation is that fleets may only substitute their biodiesel fuel consumption for up to one half of their total annual alternative fueled vehicle fuel purchase requirements (73).

7.1.2. Biodiesel Mixture Excise Tax Credit

On October 22, 2004, President Bush signed the American JOBS Creation Act of 2004. The act contains a variety of provisions related to tax reform and tax relief. One provision included in the bill was the Biodiesel Mixture Excise Tax Credit. This provision provides an excise tax credit based on the amount of biodiesel used biodiesel mixtures, at the amount of $1.00 per gallon of biodiesel for biodiesel from vegetable feedstocks, and $0.50 per gallon for biodiesel from other feedstocks. This translates to a penny per percentage point of vegetable feedstock biodiesel blended with conventional diesel, and 0.5 cents per percentage point of non-vegetable feedstock biodiesel. This credit applies to fuel sold between October 1, 2004 and December 31, 2006. No credit is provided for "casual off-farm production" of a qualified biodiesel mixture (76, 77).

The National Biodiesel Board estimated that the incentive would increase production from 2004 production levels of 30 to 35 million gallons per year to 124 million gallons per year (78).

7.1.3. Energy Policy Act of 2003

In November 2003, the U.S. House of Representatives passed the Energy Policy Act of 2003 (H.R. 6). The bill stalled in the Senate and was not passed prior to adjournment. President Bush has expressed interest in energy policy, and support for biodiesel in particular (79), so it is likely that energy legislation will re-emerge in the next Congress. It is uncertain, however, whether the provisions approved by the U.S. House in 2003 will be included in the final legislation.

The proposed Energy Policy Act of 2003 included elements favorable to biodiesel[5], including the following (80, 81).

- It would have allowed fleets to use credits from biodiesel usage to meet 100 percent of EPAct's alternative fuel requirements, as opposed to 50 percent.
- It contained provisions increasing consumption of renewable fuels, including biodiesel, from 2.3 billion gallons in 2004 to 5.0 billion gallons in 2012. These provisions are known as the renewable fuel standard (RFS).
- It would have required federal agency fleet managers to use B2 agency-wide within five years, and B20 within ten years of passage, where the fuel is available at a competitive price.

The EIA modeled impacts of this legislation and determined, "Biodiesel supply is not expected to be affected significantly by the RFS nor by the short-term tax incentives for biodiesel." (82)

7.1.4. Diesel Policy

In recent years, especially with passage of the Energy Policy Act in 1992, there has been increased Federal emphasis on the promotion and use of alternative fuels. Nevertheless, there is recognition that the vehicle and fueling infrastructure currently in place for gasoline and diesel represents a significant investment that should continued to be used. Recognizing that diesel continues to be the preferred engine technology for many applications, the Federal government is seeking to improve on diesel technology so that it better meets specific environmental and policy goals.

In December 2000, the U.S. Environmental Protection Agency (EPA) enacted regulations for highway heavy-duty vehicles that treat the vehicles and fuel as a single system. Under this program, EPA established new emission standards to reduce particulate matter (PM) and NO_x emissions to levels that are 90 and 95 percent (respectively) below 2004 standards. The standards will be phased in for heavy-duty highway engines and vehicles starting in model year 2007 (full compliance for NO_x is not required until 2010). According to EPA, these standards assume the use of high-efficiency catalytic exhaust emission control devices or comparably effective technologies (83).

In addition, EPA passed a rule reducing the sulfur content of diesel fuel to 15 parts per million (ppm) by June 2006, or a 97 percent reduction from current diesel standards (84). The reduced-sulfur content is necessary for the emissions control devices described above to be effective (83).

[5] The legislation would have added a biodiesel mixture credit on biodiesel up to B20; however, these provisions were incorporated in the American JOBS Creation Act (see section 7.1.2), so would likely be removed from an energy policy act.

When EPA announced the regulation, they estimated the cost of compliance, when fully implemented, would increase the cost of producing and distributing diesel fuel by about 4 ½ to 5 cents per gallon (85). This is in addition to an increased cost of diesel engines with the new emissions control technologies. After engine manufacturers' re-tooling and research and development costs are recovered, it is estimated that engines will cost between $1,200 and $1,900 more in 1999 dollars (86).

EPA has expressed confidence in industry's progress toward complying with the regulation (83). However, there is concern about an apparent relationship between lower sulfur content in diesel fuel and reduced lubricity. Lubricity is an indication of the amount of wear or scarring that occurs between two metal parts as they come in contact with each other (87). The EPA declined to mandate any lubricity standard in the low-sulfur fuel, instead adopting a voluntary approach. In doing so, they deferred to the ASTM standards development process for revising ASTM D975, the standard for diesel fuel. The EPA report noted that there are several alternatives for enhancing lubricity, including the use of fuel additives and metallurgical improvements in injection equipment systems (86).

One solution to improving lubricity is to add biodiesel. Even a small amount of biodiesel can significantly enhance lubricity. According to a National Biodiesel Board review of tests conducted by Stanadyne Automotive Corporation, "most of the lubricity benefits of the biodiesel were achieved by adding only 2% biodiesel to either number 1 or number 2 diesel." (87). In the EPA report, the National Biodiesel Board commented that the use of biodiesel "would eliminate the inherent variability associated with the use of other additives, and would also eliminate the question of whether sufficient additive was used." Since biodiesel is a fuel, it would also prevent any adverse consequences of adding too much biodiesel. The EPA report noted, however, that the amount of biodiesel required to enhance lubricity in a low-sulfur base diesel fuel has not been determined (86).

7.1.5. Motor Fuel Tax

The Federal government currently taxes diesel fuel at 24.4 cents per gallon. This taxation rate applies to diesel, biodiesel and biodiesel blend fuels equally. Some alternative fuels – liquefied propane gas, for example – have different tax structures, but these have not been applied to biodiesel yet.

7.1.6. Transportation Re-authorization

At the time of writing, re-authorization of the Federal transportation bill was not complete. The current version under discussion is called the Transportation Equity Act: A Legacy for Users (TEA-LU). As reflected in HR 3550, the legislation did not have any unusual provisions for biodiesel (88).

7.2. Review of Other States' Policies

Several states have been considering biodiesel legislation in recent years, primarily out of a motivation to provide additional markets for local agriculture producers, but often with an additional interest in promoting usage of renewable fuels and reducing vehicle emissions on targeted vehicles. Table 7-1 provides a summary of legislation that has been enacted in each state. Key pieces of legislation are summarized in this section, along with estimated economic impacts where they have been provided.

Table 7-1: States with Biodiesel Legislation

	Consumer				Producer		Retailer	
State	General	Limited	Tax Credit	Other	Equipment	Production	Equipment	Sales
Arkansas					✍	✍		
Delaware				✍				
Hawaii			✍					
Idaho			✍	✍				
Illinois	*		✍	✍				
Indiana						✍		✍
Iowa				✍				
Kansas		✍						
Kentucky				✍				
Maine						✍		
Michigan	*				✍	*		
Minnesota	✍	✍						
Mississippi						✍		
Missouri		✍		✍		✍		
Nebraska						✍		
Nevada				✍				
New Hampshire				*				
New Jersey			*					
New York	*							
North Carolina					✍		✍	
North Dakota			✍		✍			
Ohio	*	*						
Oklahoma		✍						
Pennsylvania				*	*			
Rhode Island			✍					
South Dakota			✍					
Texas			✍			✍		
Washington			✍	✍	✍		✍	

Legend
✍ Enacted
* Proposed

7.2.1. Broad Usage Mandates

The legislation proposed in Montana in 2003 would have mandated a minimum of 2 percent biodiesel content for on-highway usage across the state. At the time of this report, such a broad usage mandate has precedent in only one state – Minnesota – while other states have considered it. Table 7-2 lists states which have enacted or are actively considering legislation that would

Table 7-2: States with Enacted and Proposed Biodiesel General Mandate Legislation

State	Laws/Bills	Date Effective	References
Enacted			
Minnesota	2% general mandate	June 30, 2005	Minn. Code 239-77
Proposed			
Illinois	2% general mandate	June 30, 2006	SB 0134
Michigan	20% general mandate	January 1, 2007	HB 5942
New York	2% general mandate	June 30, 2006	A11517A, S07528
Ohio	5% general mandate	June 1, 2006	HB 293

impose a general biodiesel mandate.

Minnesota passed major biodiesel legislation in 2002, which requires 2 percent by volume biodiesel in diesel fuel sold in the state. (The text is included in Appendix B.) The legislation exempts diesel fuels used in motors located at nuclear power plants, railroad locomotives, and off-road taconite and copper mining equipment. The mandate will be in force only when two requirements have been satisfied. First, the state's agriculture commissioner must certify that the state has the capacity to produce eight million gallons of biodiesel per year. Second, the mandate will not take effect until eighteen months after there is a two cent reduction in Federal taxes on biodiesel blend fuels, or June 30, 2005, whichever comes first (89). If the mandate is repealed within eight years of its effective date, the legislature made provisions for distributors to be partially reimbursed for capital costs required to comply with the mandate (90).

The state legislature did not conduct any fiscal analysis of this legislation, as there were no foreseen direct impacts on state taxes or revenues. However, analyses were developed for (91) and against (92) the legislation. Douglas Tiffany of the University of Minnesota argued that the 2 percent mandate would have a net positive economic effect on the state. Using historical fuel price trends, he estimated that the marginal cost of B2 would be 1.7 cents per gallon higher than conventional diesel[6]. The additional costs of fuel borne by consumers would be offset by benefits to soybean farmers, in terms of both increased demand and higher prices, based on an economic analysis conducted by the Food and Policy Research Institute (91). Paul Runge, also of the University of Minnesota, argued in a separate paper that the benefits of the 2 percent mandate would not outweigh the costs. His analysis relied on U.S. Department of Agriculture data to show that the average price increase would be 1.7 cents per bushel of soybeans, far less than the estimate used by Tiffany. Runge estimates benefits to farmers at $11 million, with additional costs to diesel consumers of over $21 million. The net revenue impacts of these alternatives are summarized in Table 7-3. Neither analysis explicitly stated possible effects of shifting in crop production away from other crops to soybeans. Runge noted the possibility of other feedstocks or

[6] Tiffany also presented a scenario assuming that Congress enacts a National Renewable Standard, which would reduce the price of B2 by 3 cents per gallon. With this in place, Tiffany suggested that B2 would be cheaper than diesel based on historical trends by 1.3 cents per gallon (91).

production facilities in other states being used to meet Minnesota's B2 demand, but did not quantify the potential impacts.

Table 7-3: Estimated Net Revenue Impacts of B2 in Minnesota

	Net Revenue Impact ($ millions)	
	Tiffany	Runge
State Government	$ -	$ -
Consumers (on-road)	$ (9.35)	$ (16.30)
Consumers (off-road)	$ (4.25)	$ (5.30)
Farmers (oilseed crops)	$ 15.00	$ 11.00
Total	**$ 1.40**	**$ (10.60)**

(Source: 91)

The actual impacts of the Minnesota mandate will be watched closely, to see whether its benefits outweigh its costs.

Purdue University conducted an economic analysis on the effects of proposed (but not enacted) B2 legislation in Indiana. The study examined three policy alternatives, all with a B2 mandate. The scenarios included: a B2 mandate alone, a B2 mandate with a tax credit that made the cost of B2 equivalent to diesel, and a B2 mandate accompanied by production tax credits. The results of this analysis are shown in Table 7-4. The analysis indicated that the positive net benefits to the agricultural industry were offset by the increased cost of fuel paid by customers and taxpayers.

Table 7-4: Net Revenue Impacts of Indiana B2 Legislation

		Revenue Impact ($ million)		
Sector	**Explanation**	B2	B2 + Fuel Tax Credit	B2 + Producer Incentives
Biodiesel	Growth in biodiesel sales	$ 14.43	$ 14.51	$ 14.44
Soybean Processing	Includes crushing facilities	$ 5.51	$ 5.55	$ 5.51
Soybean Production	Increased prices for oil, decreased prices for meal	$ 21.20	$ 21.32	$ 21.21
Corn Production	Corn acreage shifts to soy	$ (20.66)	$ (20.78)	$ (20.68)
Agricultural Inputs	Lost revenue from inputs to corn production	$ (11.97)	$ (12.03)	$ (11.98)
Refining	Diesel refining industry	$ (2.86)	$ (2.23)	$ (2.77)
Distribution	Less fuel sold because of increased cost of fuel	$ (0.65)	$ -	$ (0.56)
Consumers	Assumes 3 cents per gallon increase	$ (21.35)	$ -	$ (18.37)
Taxpayers	Change in tax revenues and expenditures	$ (0.87)	$ (21.49)	$ (3.75)
Total		**$ (17.22)**	**$ (15.16)**	**$ (16.95)**

(Source: 93)

While there is no consensus that a B2 mandate, if enacted by a single state, would provide net benefits to farmers, states continue to explore this policy mechanism as a method of guaranteeing a level of demand that could justify large-scale biodiesel production.

7.2.2. Targeted Mandates

Instead of a general mandate, several states have adopted a targeted mandate to encourage usage of biodiesel. The targeted mandate has sometimes, but not always, been developed in response to EPAct requirements. States which have targeted mandates for biodiesel are listed in Table 7-5.

Table 7-5: States with Enacted and Proposed Biodiesel Targeted Mandate Legislation

State	Laws/Bills	Date Effective	References
Enacted			
Kansas	2% for state vehicles	July 1, 2004	Ks. St. 75-3744a
Minnesota	20% for state vehicles	April 4, 2002	Minn. St. 16C.135
Missouri	20% for state vehicles	July 1, 2004 (50%) July 1, 2005 (75%)	RSMo 414-365
Oklahoma	State and school vehicles must use biodiesel when available and does not cost more	November 1, 2003	Okla. Statutes 74-130.3
Proposed			
Ohio	20% for state vehicles	June 1, 2005	HB 293

In general, these targeted mandates have allowances based on the availability and relative cost of biodiesel. Kansas requires B2 in state-owned diesel powered vehicles and equipment, provided that the price is no greater than $0.10 more per gallon than the price of diesel fuel (94). Minnesota requires individuals fueling state vehicles to use cleaner fuels, including B20, if the fuels are reasonably available at similar costs to other fuels and are compatible with the use to which the motor vehicle is put (95).

Oklahoma requires all school and government vehicles which have been converted to use alternative fuels to do so whenever the price of the alternative fuel is equal to or less than that of the original fuel, and when the alternative fuel is available within five miles of where the vehicle is based. Re-fueling with the alternative fuel outside of this radius is not required when the vehicle is more than five miles from its base, and there is no reasonably available location for the vehicle to re-fuel with the alternative fuel. While the text of the statute does not refer to biodiesel, biodiesel was referred to in the introduced version of the bill. It is not clear whether the legislation requires use of B100 or whether a lesser blend, such as B20, would be acceptable (96).

Missouri's legislation is unique in that it is explicitly linked to EPAct. Their legislation requires the state to use B20 in 50 percent of state-owned diesel-powered vehicles as of July 1, 2004, and in 75 percent of vehicles as of July 1, 2005. The statutes assume that the cost of B20 is no more than 25 cents per gallon higher than comparable diesel fuel. A clause in the statute states, "Nothing in this section is intended to create a state requirement for biodiesel fuel use in excess of the requirements of [EPAct]." The additional cost for B20 was to be paid for out of a biodiesel revolving fund, described in section 7.2.4 (97).

7.2.3. Fuel Tax Incentives

Another legislative approach to encourage biodiesel usage has been to reduce sales and fuel tax rates. States that have enacted or are currently considering these approaches are shown in Table 7-6.

Table 7-6: States with Enacted and Proposed Biodiesel Fuel Tax Incentives

State	Laws/Bills	Date Effective	References
Enacted			
Hawaii	Reduced excise tax by 70%	July 1, 2004	HRS 243-4
Idaho	Reduced excise tax by 10%	July 1, 2002	Idaho Stat. 63-2407
Illinois	Reduced sales tax between B1-B10 No sales tax on B10-B20	June 11, 2003	35 ILCS 105/3-10, 110/3-10, 115/3-10, 120/3-10
North Dakota	Reduced excise tax by 5%	NA	ND Cent. Code 57-43.2
Rhode Island	Fuel tax exemption	July 7, 2004	General Laws 31-36-1
South Dakota	No excise tax on B100	February 9, 2004	SD Codified Laws 10-47B
Texas	No fuel tax on B100 or on biodiesel portion of biodiesel blend	January 1, 2004	Tx. St. Tax Code 162.204
Washington	Exemption from use tax	July 1, 2003	RCW 82.12.955
Proposed			
New Jersey	Fuel tax exemption		R.S.54:39-2, 54:39-27

Several states have adopted aggressive approaches with reducing taxes on biodiesel. Rhode Island has completely exempted biodiesel from the state's motor fuel tax (98). South Dakota exempts B100 from the state's 22 cents per gallon excise tax on B100 (99), and Texas exempts the biodiesel portion of a biodiesel blend fuel from the state's 20 cents per gallon diesel fuel tax rate (100).

Illinois adopted legislation in 2003 which exempted biodiesel blends exceeding B10 from state sales taxes and reduced taxes by 20 percent on biodiesel blends between B1 and B10 (101). These provisions are to be in effect for ten years (102). Hawaii enacted legislation in 2004 reducing motor fuel taxes on alternative fuels as a proportion of diesel fuel taxes. The fuel tax for biodiesel was set at a rate of 0.25 times the rate of diesel, with an additional 0.25 cents per gallon added (103). As a consequence, the normal diesel tax rate of 16 cents per gallon is reduced to 4.75 cents per gallon for biodiesel. Although biodiesel blends as low as B20 are considered alternative fuels in Hawaii, the tax reduction appears to apply to B100 only.

Some states have adopted more conservative approaches. Idaho has reduced the excise tax for biodiesel by 10 percent. With a normal excise tax of 25 cents per gallon, this reduces the price of biodiesel by 2.5 cents per gallon (104). Through June 30, 2005, North Dakota has reduced the motor fuel tax and special fuels excise tax rates on diesel fuel with a minimum of two percent biodiesel content by 5 percent, to 19.95 cents per gallon and 1.9 percent respectively (105).

One important consideration with fuel tax reductions is the potential revenue impact. A loss of fuel tax revenue would be expected, but this could be offset by increases in tax revenue by increased biodiesel production in the state. Most states have not examined these issues. In Illinois, the legislation slightly reduced incentives for gasohol, which the Department of Revenue believed would cover the cost of new incentives for biodiesel, making the legislation revenue neutral (106). The Illinois Soybean Association, a strong advocate in favor of the legislation, estimated that the exemptions would boost production of soybeans to 30 million bushels per year, adding $22.5 million to the Illinois economy. This was predicated on an assumption that the price of soybeans would increase by $0.05 per bushel (107). Secondary effects of the legislation, such as reduced revenues from other crops (e.g. corn), were not explicitly considered. In Texas, where another fiscal analysis was conducted, the biodiesel exemption was included in legislation that revamped the state's fuel tax collection system, so the impacts of biodiesel were not separately assessed (108).

7.2.4. Other Consumer Incentives

States have instituted a variety of other incentives to encourage greater consumption of biodiesel, as shown in Table 7-7.

Table 7-7: States with Other Enacted and Proposed Biodiesel Consumer Incentives

State	Laws/Bills	Date Effective	References
Enacted			
Delaware	Biodiesel to power all the State vehicles	April 11, 2004	Title. 30
Idaho	Grant program to buy down cost of fuel		
Illinois	Rebate for biodiesel use		
Iowa	Created revolving fund for Iowa DOT	April 19, 2001	Ia. Code 307.20
Kentucky	Voluntary encouragement to use B2	July 15, 2002	Ky. Rev. St. 363-9055
Missouri	Revolving fund for B20 purchase	July 12, 2001	RSMo 414-407
Nevada	School bonds for biodiesel vehicles	June 9, 2003	NRS 387.335
Washington	Encourages state usage of B20		RCW 43.19.642
	Encourages use of B2 for lubricity	June 1, 2006	RCW 43.19.642
Proposed			
New Hampshire	Exemption of biodiesel vehicles from paying tolls		
Pennsylvania	Creates fund to provide 5 (10) cents/gallon biodiesel credit		SB 255 (SB 1114)

Rebate Programs

As discussed earlier, the Energy Policy Act of 1992 was amended in 1997 to classify B20 as an alternative fuel. This allowed fleets under EPAct mandates to meet alternative fuel vehicle requirements using biodiesel. Many states also have various incentives to promote usage of alternative fuel vehicles, some of which have made specific accommodations for biodiesel.

Illinois has an Alternate Fuels Rebate Program to encourage greater use of alternative fuels, including biodiesel. To be eligible, a vehicle must be registered and operated in Illinois, and must use a minimum blend of B80 for over 50 percent of the miles driven annually. The rebate amount is determined by a formula which reflects the difference between the fuel economy of diesel and biodiesel, the price difference between the fuels, and the number of miles driven per year. Rebates are limited to a three-year period, and a total of $4,000 per vehicle (109, 110, 111).

The Maryland Soybean Board is offering Maryland residents a short-term rebate on half the cost of the first biodiesel purchased by residents. The program, funded by soybean checkoff dollars, applies only to virgin soybean-based biodiesel (112). The Delaware Soybean Board has a similar program (113).

Fuel Price Buy-Down Programs

Because biodiesel is historically more expensive than diesel, the price of fuel may be an obstacle to greater implementation. The Idaho Energy Division, part of the Idaho Department of Water Resources, has developed a B20 program that uses grant funding from the U.S. Department of Energy and the Community Planning Association of Southwest Idaho to buy down the price of B20 to make it comparable to diesel. The goal of the program is to encourage diesel users, especially fleets, to try B20 with the hope they will permanently switch over (114, 115).

Revolving Funds

In a variation on the previous concept, some states have established revolving funds from which the incremental costs of biodiesel can be paid. Iowa established a biodiesel purchase fund that can only be used to buy soy-based biodiesel for the Iowa Department of Transportation (IDOT) diesel vehicles. The biodiesel fuel consists of revenues received from the sale of EPAct credits banked by the department on April 19, 2001, funding appropriated by the general assembly, and any other monies obtained or accepted by the department for deposit in the fund (116). Missouri established a similar fund, accessible by all state agencies, to pay for the incremental cost of B20 (117). In July, 2003, New Jersey's Office of Clean Energy introduced a Biodiesel Fuel Rebate Program. This program, funded by the state's Petroleum Overcharge Reimbursement Fund, provides rebates to state and local governments to offset the incremental cost of buying biodiesel fuel (118).

Subsidies

In a couple of cases, states have provided special financing to help encourage biodiesel. Missouri provides for increased funding for transportation costs for school districts which use B20, to offset the additional cost of the fuel (119). Nevada allows schools to issue bonds to raise funds for purchase of transit vehicles that will use biodiesel, which the state has defined as B5 to B20 (120).

Other Approaches

Some states have used executive orders and other resolutions to encourage, but not mandate, greater usage of biodiesel. For example, the governor of Delaware has encouraged all state fleets, including the Delaware Department of Transportation, to use the fuel to power all their diesel trucks and equipment (121). In Illinois, the governor issued an executive order in 2004 directing the state's procurement department to "immediately take all actions necessary" to facilitate procurement of B2 for the state's diesel vehicles, and to investigate ways to increase the availability of B2 to state vehicles, including establishing state-operated B2 refueling stations (122).

Kentucky applied less direct pressure still when, in July 2002, their general assembly passed a resolution wherein they "strongly [encouraged]" voluntary compliance with a minimum of B2 for all diesel fuel sold in the state as of January 1, 2006 (123). Washington encourages the use of B20 in state vehicles, and of B2 in cases where a lubricity additive is needed to comply with low-sulfur diesel fuel requirements (124).

7.2.5. Producer Equipment Incentives

The previous four groups of policies have dealt with increasing or creating demand for biodiesel. Increased demand will create a market that producers will seek to fill. Another policy approach many states have adopted is to more directly increase the production of biodiesel through producer-based incentives. Increasing production could help to drive the price of biodiesel down, to make its purchase more attractive.

The first type of production incentive deals with encouraging the development and installation of equipment for dedicated biodiesel production. Table 7-8 lists state policies which relate to encouraging biodiesel production facilities.

Table 7-8: States with Enacted and Proposed Biodiesel Producer Incentives

State	Laws/Bills	Date Effective	References
Enacted			
Arkansas	Tax credit of 5% of cost of facilities and instruments for producing and supplying Biodiesel	January 1, 2003	Ch.15-4-2801
Michigan	Property tax abatement for location of biodiesel plants in certain areas	April 24, 2003	MCS 207.552
North Carolina	Tax credit of 25% on equipment	January 1, 2005	NC GS 105-129.16D
North Dakota	Tax credit of 10%	January 7, 2003	Ch 57-38
Washington	Property and leasehold tax exemption for equipment used in biodiesel manufacture	July 1, 2003	RCW 82.29A.135 RCW 84.36.635
	Deferral of sales and use taxes for seven years	July 1, 2003	HB 1240
Proposed			
Pennsylvania	Tax credit of 30% on cost of equipment		HB 121

Tax credits on equipment are a fairly common policy method. Recently enacted legislation in North Carolina provides tax credits toward the costs of constructing and equipping renewable fuel processing facilities. The tax credits are 25 percent of the cost (125). Legislation in North Dakota provides a 10 percent tax credit for up to five years for a maximum of $250,000 for costs incurred to retrofit a facility to produce or blend diesel fuel containing biodiesel (105). Arkansas' Biodiesel Incentive Act, passed in 2003, established an income tax credit to biofuels suppliers equal to 5 percent of the costs of facilities and equipment used directly in the wholesale or retail distribution of biodiesel fuels (126).

Exemptions from certain taxes have also been used. Washington State exempts equipment and land used in biodiesel production from property and leasehold taxes for six years (127), and defers sales and use taxes for seven years after construction of a biodiesel plant in a relatively rural county (128). In Michigan, the legislature extended property tax abatement privileges established for certain areas to including location of biodiesel production facilities. The duration of this abatement is twelve years (129).

7.2.6. Producer Production Incentives

Some states have adopted policies that reward biodiesel producers based on the amount of biodiesel produced. States which have enacted this type of legislation are listed in Table 7-9.

Table 7-9: States with Enacted and Proposed Biodiesel Production Incentives

State	Laws/Bills	Date Effective	References
Enacted			
Arkansas	Tax credit of $0.10/g	January 1, 2003	Ch.15-4-2801
Indiana	Tax credit of $1.00/gallon for biodiesel Tax credit of $0.02/gallon for blended biodiesel	January 1, 2004	Ch 27, IC 6-3.1-27
Maine	Tax credit of $0.05/g	May 10, 2004	MRSA §5219-W
Mississippi (1)	Cash payments to state's biodiesel producers	July 1, 2003	Miss. Code 69-51-5
Missouri (2)	Tax credit of $0.30/gallon for biodiesel	June 24, 2002	RSMo 142-031
Nebraska	Tax credit of $0.105/gallon	January 1, 2005	Neb. St. 66-489
Texas	Tax credit of $0.20/gallon	September 1, 2003	Tx. St. Ag. Code Chp. 16
Proposed			
Michigan	Tax credit of 10 % for > B20		SB 1012, HB 5624

(1) No specific amount stated
(2) Not funded

The most ambitious attempt at a biodiesel producer incentive was in Missouri. In 2002, Missouri passed a law creating a biodiesel producer incentive fund with a $0.30 per gallon incentive on 15 million gallons per year for the first five years after the law takes effect (130). The funding for this incentive was to be provided by Proposition B, which would have increased fuel taxes in the state to generate nearly $500 million per year, primarily for transportation projects (131). More than 72 percent of Missouri voters rejected the measure (132), preventing implementation of the fund.

Other states have been successful in funding production incentives. Arkansas' Biodiesel Incentive Act also included grants up to 10 cents per gallon of biodiesel on the first five million gallons of biodiesel fuel produced annually by a producer qualified by the state's Alternative Fuels Commission, for a period not to exceed five years. There is a restriction for available funding under this act, and the commission has discretion to not authorize grants when the fund for incentives is exhausted (126). This type of restriction is pretty common across biodiesel production incentives. In Texas, registered biodiesel producers in the state are eligible to receive a grant of 20 cents per gallon of biodiesel produced until the tenth anniversary of the date when production begins. This is paid for by a 3.2 cent per gallon fee assessed on biodiesel producing facilities, with the balance paid for by general revenues (133). Nebraska has legislation which exempts pure biodiesel located within the state from taxation until it leaves the storage area (134).

Maine allows tax credits of 5 cents per gallon of biofuel produced within the state. In cases of blended fuels, the credit allowed is only on the portion of that blend that the biofuel constitutes (135). In Indiana, effective January 1, 2004, there is a $1 tax credit per gallon of biodiesel and $0.02 tax credit per gallon of blended biodiesel (B2 to B99) produced at an Indiana facility. The total amount of credits available is $1 million in any tax year. The tax credit would be offset by any Federal credits given for biodiesel production (136).

Mississippi enacted a statute which authorizes the Commissioner of Agriculture and Commerce to make cash payments to producers of biodiesel; however, the state has not yet enacted legislation which states the amount of the cash payment. The same section of the Mississippi Code authorizes payments of 20 cents per gallon of ethanol produced in the state (137).

7.2.7. Retailer-based Incentives

In order for increased biodiesel production to reach the general public, a few states have taken measures to encourage retailers to dispense biodiesel. These states are identified in Table 7-10.

Table 7-10: States with Enacted and Proposed Biodiesel Retailer Incentives

State	Laws/Bills	Date Effective	References
Enacted			
Indiana	Tax credit of $0.01 per gallon	February 24, 2003	Ch 27, IC 6-3.1-27
North Carolina	Tax credit of 15% on equipment	January 1, 2005	NC GS 105-129.16D
Washington	Property and business & occupation tax exemption for equipment used in biodiesel retailing	July 1, 2003	RCW 82.04.4334 RCW 82.08.955

Indiana provides an incentive to biodiesel dealers through a $0.01 per gallon tax credit for all blended biodiesel sold. The total amount of credits available is $1 million in any tax year. The tax credit would be offset by any Federal credits given for biodiesel production (138). North Carolina and Washington State have incentives related to the costs of equipment dedicated to dispensing biodiesel. North Carolina provides tax credits of 15 percent toward the costs of constructing and installing equipment dedicated to dispensing renewable fuels (125). Washington state exempts machinery, equipment, vehicles, and services related to the sale of a biodiesel blend (B20 or higher) from the state's retail sales tax (139), business and occupation tax (140), and use tax (141).

7.3. Current Montana policy

Montana Code Annotated (MCA) 15-70-301 essentially defines biodiesel as a B20 blend (142). Currently, according to MCA 15-70-370, the fuel tax is reduced by 15 percent for all biodiesel or ethanol fuel sold in the state (143, 144), an incentive which is in effect four years after an ethanol plant begins operation in Montana (145). It should be noted that the B2 blend, which was being proposed in the legislation considered by the Montana House, would not be included in this tax reduction. Montana currently taxes diesel fuel at 27.75 cents per gallon (146). In addition to the temporary tax reduction on biodiesel and ethanol fuels, motor fuel tax revenues are currently reduced by production incentives to encourage the use of Montana agricultural products to produce alcohol that could be mixed into motor fuels (147).

8. POLICY ALTERNATIVES

The purpose of this research project has been to provide information to help the Montana State Legislature make decisions regarding biodiesel policy in the future. This chapter seeks to combine the information gleaned from the literature review, the results of the field test, and the current policy environment to assess several alternative policy approaches to biodiesel. Several alternative approaches are presented and assessed according to their responsiveness to technical, economic and other concerns.

There are a couple of primary caveats before presenting the alternatives.

- These alternatives are all approached from a legislative standpoint. Diesel users, whether government, fleet, corporate or individual, may make decisions regarding their biodiesel usage independent of any legislative framework.

- Because of the complex and dynamic political and economic framework within which the state of Montana operates, the true impacts of any policy or combination of policies may differ significantly from those described, and the impacts may also change significantly over time based on changes in external factors.

8.1. Discussion of Metrics

In analyzing the effects of any proposed policy, it is necessary to have some tools by which to evaluate potential policies. Evaluating potential biodiesel policy alternatives is difficult because of the range of parties which may be impacted, and the sensitivity of various alternatives to external factors. This section highlights the metrics which will be used in analyzing the alternatives presented later in this section.

8.1.1. Economic Metrics

The price and usage of diesel fuel has significant impacts throughout the economy. Therefore, the introduction of biodiesel fuel may have far-reaching impacts as well. Some metrics are included in this section.

Consumer

Diesel fuel is used extensively by trucking and rail freight that provides goods to Montana consumers and assists Montana producers in delivering goods to market. Increases in fuel prices may result in broader impacts on consumer prices in general, resulting in an increased cost of living. Conversely, decreasing fuel prices may increase the average Montanan's standard of living, and may increase markets for Montana producers. This metric refers to both the price that consumers pay at the pump, and the prices that trucking and rail firms will pay for fuel (which will likely be ultimately passed onto the final consumer of the shipped good). In addition to price paid at the pump, the consumer may face additional costs with the usage of biodiesel, such as initial filter replacement (at B20 or higher) and, for very high percentages of biodiesel, additives or fuel storage improvements to accommodate operations in extreme cold weather.

For the purposes of this analysis, it is assumed that B2 will cost 2.7 cents per gallon more than diesel, based on the assumptions from chapter 6. The sensitivity metrics (section 8.1.3) will loosen the assumption of current prices.

Retailer

Diesel fuel retailers compete on the quality and price of fuel. Depending on their location, a retailer's competitors may be primarily in the same town, or may possibly include retailers in adjacent states (in the case of retailers located on Interstate highways). Additional costs to the retailer – either in the base fuel price or in additional equipment necessary to provide biodiesel fuel – may decrease the competitiveness of retailers whose competition is in other states. Reduced fuel costs through biodiesel usage may alternatively enhance their competitiveness.

Distributor / Refinery

Distributors and refineries play a significant role in providing fuel to consumers through retailers. They are responsible for providing the appropriate quality and quantity of fuel to retailers that matches their markets and their facility storage requirements. Accommodating biodiesel could result in significant expenses to distributors and refineries, depending on the type of policy that is enacted.

Feedstock Producer

Legislation promoting biodiesel would provide an additional market for producers of feedstocks, ranging from oil seeds to brown grease. The extent to which legislation promotes increased biodiesel usage should also result in increased economic growth for feedstock producers.

However, the benefits of state-based biodiesel legislation to feedstock producers may not necessarily be limited to Montana farmers. First, because biodiesel can be produced from feedstocks beside oil seeds, oil seed farmers would need to compete with producers of other feedstocks for market share. Canola or rapeseed oil has better operating properties than yellow grease, for example, but it also costs more. The pricing of competing feedstocks, along with the results of research in improving the biodiesel production process and oil content of seeds, could have significant impacts on the market share for Montana farmers who grow rapeseed, safflower, or other oil seeds.

Second, producers of feedstocks in Montana would need to compete with producers from other states, or even countries (such as Canada). Producers in other regions may have competitive advantages based on location relative to biodiesel production facilities, economies of scale in production, and more favorable transportation.

Biodiesel Producer

It is not necessary for biodiesel feedstocks and biodiesel production to occur in the same location. Legislation may be set up to encourage production of biodiesel feedstocks, to encourage creation of biodiesel manufacturing plants, or both. As was noted before, there are economies of scale which currently affect biodiesel production. Legislation that seeks to promote biodiesel fuel in Montana may not, by itself, provide enough of a market to make an economic case for large-scale biodiesel production within Montana, allowing producers in other states (e.g. Minnesota) to provide fuel for the Montana market.

Government

The government may receive direct fiscal impact from legislation. Government impacts could include reduced tax revenues (for example, through a fuel tax exemption) and/or increased expenditures (for example, through a production subsidy program). As a biodiesel industry develops, this may increase the government's tax base, increasing government revenues. There may also be indirect impacts of fuel prices on the overall economy; these are beyond the scope of this analysis.

8.1.2. Non-Economic Metrics

There are other metrics which may be difficult to quantify in economic terms, but could be important from a policy perspective.

Environmental Impacts[7]

As was documented in the Phase 1 technical report, biodiesel fuel can reduce emissions from vehicles. While not currently a critical issue in Montana at this time, this could become more important over time.

Leadership in Alternative Fuels

There may be value in being perceived as a leader in developing an alternative fuels industry within Montana. This perception could provide economic benefits to the extent it attracts residents and businesses who are especially concerned about environmental issues, but these benefits would be difficult to quantify economically.

Environmental Leadership

There may also be value in being perceived as a leader in introducing alternative fuels to provide better stewardship of the environment. This, too, may have economic benefits, but these would be difficult to attribute to biodiesel legislation with any certainty.

Favorable Business Climate

A biodiesel policy may be set up in a way that it could be perceived as adding to the cost of doing business in Montana, thereby potentially discouraging residents and businesses from moving to the state. Any specific effects will also be difficult to attribute to biodiesel legislation.

[7] Other environmental impacts of biodiesel fuel, such as impacts resulting from the need to construct additional fuel storage and distribution facilities or the energy balance from using biodiesel compared to diesel, are not considered.

8.1.3. Sensitivity Metrics

A final group of metrics relates to the sensitivity of alternatives to various external factors. In some ways, these factors may be most critical of all, because they may negate the desired benefit of any legislation that may be enacted. Some of these factors are listed below.

Ratio of Biodiesel to Diesel Prices

As biodiesel and diesel prices fluctuate, some alternatives may become more appealing and others less so. For example, a B20 mandate could look very appealing if the price of conventional diesel rose to $4.00 per gallon, but less so if the pre-tax price fell to $0.75 per gallon. This ratio could change depending upon the price of feedstock, advances in biodiesel production technology, and development of new sources for petroleum.

Policy in Other States[8]

Other states' policies may encourage biodiesel development in those states to the extent that those states would provide more formidable competition for a Montana biodiesel industry, possibly eliminating any potential gains to Montana farmers. Conversely, if other states stop considering biodiesel legislation, Montana (if it enacted legislation) could be relatively unique, which could have positive or negative economic impacts, as described earlier.

Federal Policy[9]

Some have suggested that biodiesel policy is better addressed at a Federal level (92), and some legislation has been proposed at a Federal level which would impact biodiesel markets (80). This metric refers to the extent to which the Montana biodiesel legislation might be strengthened or weakened by Federal legislation.

8.2. No Action / Baseline Alternative

Under this alternative, the state legislature takes no new action to directly encourage biodiesel use in the state[10]. Instead, the state legislature would rely on other factors, including Federal biodiesel policy, Federal rules regarding diesel fuel and engine requirements, market prices for diesel and biodiesel, etc. to drive the usage of biodiesel in the state.

This "no action" alternative is defined as the baseline against which the other alternatives will be compared. As the baseline, this alternative will have no economic or non-economic impacts. This

[8] Based on the increasing introduction of legislation regarding biodiesel in recent years, it is assumed that the trend will be for states to adopt legislation that encourages biodiesel usage and production.

[9] It is assumed that the Federal policy will be to tend to encourage greater utilization of alternative fuels.

[10] The state could pass a resolution encouraging the usage of biodiesel, similar to what Kentucky has done, but it is assumed that the impacts of this type of legislation would be negligible.

alternative will, however, be sensitive to the impacts of policies passed at the Federal and state levels. It may be assumed that state policies favorable to biodiesel will spur development of additional feedstock and biodiesel production in those states. As other states develop a biodiesel infrastructure, it may be more difficult for Montana feedstock growers to get sufficient economies of scale to overcome transportation costs and tap into these markets. However, the policies that other states implement may come at a cost to those states, including reduced tax revenues or increased fuel prices. The timing of Federal policy initiatives in this area, if any, will play a major role in the potential benefits of a "no action" alternative.

8.3. Consumer-based Policies

Montana may introduce legislation to help strengthen demand for biodiesel fuel. This can be done using a variety of alternatives, which are discussed in this section.

8.3.1. Low-blend mandate (B2)

This alternative would essentially replicate the legislation considered by the Montana House of Representatives in 2003, and also the legislation adopted by Minnesota.

The economic impact of the legislation could be considerable. The additional price at the pump would be relatively minimal – about 2.7 cents per gallon. However, there are important considerations about blending and distribution of fuel. Refiners might need additional equipment at terminals to store pure biodiesel received by tank car from production facilities, as well as facilities to mix the fuel. Use of the existing pipeline system for distributing the B2 could be problematic depending on the policies adopted by adjacent states or provinces. From a retail perspective, the percentage of biodiesel is small enough that it would not require any additional infrastructure for retailers (for example, replacement of hoses, heating of storage tanks, etc.). There is the possibility of some fuel evasion for long-haul truck drivers; however, this could be minimized in the long-term depending on how refiners and engine manufacturers adapt toward the ultra-low sulfur fuel regulations.

A low-blend biodiesel should have no measurable impacts on vehicle performance, even in cold weather conditions. By enhancing lubricity, B2 could save truck companies from buying lubricity additives that may be necessary for ultra-low sulfur fuel.

In terms of non-economic impacts, Montana would be recognized as a leader in biodiesel policy, since only one state to date (Minnesota) has adopted such a broad mandate. The additional costs of the fuel, especially when rising diesel prices have eaten into profit margins of companies dependent on freight, could be perceived as adding to the cost of doing business in the state. However, if the marginal cost of B2 is a couple of cents per gallon, this impact will likely be slight.

This mandate is somewhat sensitive to the relative prices of biodiesel and diesel. This approach would also be somewhat sensitive to policies in other states and at the Federal level. If other states were to implement similar policies, it would be better for Montana to be first in terms of developing a biodiesel industry. A B2 mandate could also help toward meeting national renewable fuels consumption goals as outlined in the House version of the Energy Policy Act of 2003.

8.3.2. Higher-blend mandate (B20)

Similar to the alternative discussed in the previous section, this alternative would mandate a higher level of usage of biodiesel. This is clearly a bolder initiative than the previous alternative. B20 is a strategic level for a higher-blend of biodiesel for a couple of reasons. First, 20 percent is a threshold of biodiesel above which cold weather properties will significantly deteriorate. Second, B20 is classified as an alternative fuel in the Energy Policy Act.

The benefits of this policy would be similar to the benefits of a B2 mandate, but greater in magnitude. There would be a substantial benefit for feedstock growers and biodiesel producers. At current pricing levels, there would be a significant negative economic impact on consumers. There are also significant arguments related to the distribution infrastructure, and how and where biodiesel would be mixed with the diesel fuel. While in the long run it is expected that the B20 would help vehicles run cleaner, there would be an initial period where old engines and fueling systems are cleaned out. Additional filter changes and tank cleanings may be required. This would be especially pronounced in the distribution infrastructure, resulting in significant initial costs.

At a 20 percent usage level, a more cogent argument can be made about biodiesel usage affecting energy security and emissions. Given that a market of this size could better capitalize on the economics of scale inherent in current production models, it would also be more likely to create a biodiesel industry in Montana. It should be noted, however, that the demand for biodiesel would far outstrip current supply of feedstock in the state. This means that there would need to be a significant redistribution of how Montana farmers use their land, an increase of land in active agricultural production, and/or fulfillment of that demand with feedstock produced outside the state.

At a 20 percent level, biodiesel would have a greater impact on fuel properties than B2. This would mean decreases in CO, CO_2, particulate matter and hydrocarbons emissions, which would help air quality. This would also mean that the operational problems that have been occasionally observed in previous studies – e.g. filter clogging, microbial growth, gelling in cold weather – would be more likely to occur under this approach than a B2 mandate. B20 has been used in literally millions of miles of on-road testing, and the problems foreseen at B20, as indicated in the field test, would likely be minimal and manageable. However, there would be an increased need for user education about proper fuel management with B20. There may also be a much higher likelihood of fuel evasion, if there is a perception within the long-haul freight community that B20 would harm truck engines and/or void warranties, and if biodiesel costs significantly more than diesel.

One possible approach to the cold weather difficulties is for biodiesel producers to develop winter-blend and summer-blend biodiesel, as was suggested in section 6.1.1. The winter-blend would utilize feedstocks such as rapeseed and soy, which have better cold-weather properties, while the summer-blend could use yellow grease or similar products, which are less expensive.

This will require a biodiesel production infrastructure that can work well with a variety of feedstocks.

This approach would be highly sensitive to the price of biodiesel and diesel fuels. This policy would be fairly insensitive to other states' policies, with the exception of states adopting production tax credits. This could result in a situation where fuel prices are higher in Montana with a B20 mandate, and the beneficiaries are biodiesel producers in, for example, North Dakota. This type of approach may present some unique opportunities in impending Federal energy legislation, especially in providing access to many provisions and credit programs that might be offered.

Given that biodiesel fuel prices are higher than diesel, this would likely be perceived by the business community, especially freight-based companies, as unfavorable to business. Without doubt, however, this would gain positive national recognition to the state as a leader in alternative fuels adoption. It would remain to be seen how these factors would offset each other.

8.3.3. Targeted Mandate of Higher-Blend (B20)

Under this alternative, the state would adopt a policy where they would use a B20 blend in select vehicles (for example, vehicles in state fleets, transit, school buses, contractors doing work for the state, etc.). Such legislation can help to expand the market for biodiesel here, resulting in improved competition and economies of scale that could reduce prices for other potential consumers of biodiesel. By doing this, the state could demonstrate a leadership role in biodiesel usage, and provide an even greater amount of evidence that biodiesel would not adversely affect vehicle operations.

The demand level of targeted fleets would determine the extent to which this could develop a sustainable industry for biodiesel. One significant disadvantage with this approach is that, in many cases, these vehicles are fueled using commercial vendors. A B20 mandate as described would require significant coordination with existing commercial vendors to supply an acceptable grade of B20, or the development of special fueling facilities where vehicles may fuel with B20. There is also the issue of the incremental cost of the biodiesel fuel that must be paid for by targeted fleets. Without the economies of scale in purchasing and distribution, there may be a higher price premium for B20 under this scenario.

The benefits of this approach in developing an industry or improving the environment would likely be relatively small, especially if implementation is constrained by application to only a few vehicle fleets and the availability of fueling stations. However, it would be relatively immune to policies adopted by other states, and could take advantage of credits and incentives in the new Federal energy bill.

8.3.4. Fuel Tax Reduction or Exemption

Instead of mandates, Montana could employ an incentive-based approach to encourage greater usage of biodiesel. One such approach would be to reduce or remove the state fuel tax on biodiesel fuel. This can be done on a sliding scale approach based on the percentage blend (as done in Illinois), or it can be done as a full or partial exemption from the fuel tax when the blend is over a certain percentage.

In terms of encouraging biodiesel usage, this approach is very favorable for consumers. Depending on the fuel tax rate and the minimum blend required, consumers could acquire biodiesel blend fuel at no additional price compared to diesel, while simultaneously gaining lubricity and using a renewable resource. Retailers would be free to decide whether to pass on the reduced fuel tax to consumers. From a production and distribution perspective, this would not encourage broad use of biodiesel immediately, so there would likely be higher transportation costs for participating retailers.

Fuel tax revenues would clearly suffer under this alternative. If these reduced revenues are offset by increased revenues from taxes on biodiesel production in the state, then this could be revenue-neutral for the state, although the state may consider how to shift funds so that transportation funding is not adversely affected.

8.3.5. Non-Renewable Fuel Tax Increase

The same tax rate differential outlined under the previous alternative may be obtained by increasing the tax rate on non-renewable fuels. This would have the benefit of increasing tax revenues while providing an incentive for greater use of biodiesel. The tax revenues could be directed to general revenues or programs that will help encourage alternative fuel production and usage (for example, producer tax credits).

Until biodiesel (and ethanol) industries develop in a larger scale, this would result in increased fuel prices for consumers. This will result in negative impacts on retailers near state borders, and will have rippling effects throughout the economy. This approach might also be perceived as unfavorable to business.

8.4. Producer-based Alternatives

The previous five alternatives have dealt with increasing demand for biodiesel. Another approach is to look at ways of increasing the supply of biodiesel. Increasing the supply could help to drive the price of biodiesel down, to make its purchase more attractive. From the perspective of the Montana House of Representatives, the ideal supply-based approaches would create an additional market for Montana farmers and thereby help Montana's economy. Therefore, these alternatives focus on what would spur supply of biodiesel made in Montana from Montana-grown feedstocks.

8.4.1. Tax incentives for creation of production facilities

One approach is for the state to adopt tax incentives that could spur investment in facilities to produce or blend biodiesel within Montana. These facilities could serve demand for biodiesel within Montana, or could also be used to supply demand for other states.

Producers will likely invest in significant biodiesel production facilities to the extent they perceive a viable market. Without a clear market, development of a biodiesel production infrastructure may lag. Therefore, there might not be as much demand for biodiesel feedstock. While this is true, it should be noted that there has been a significant increase in biodiesel production facilities in recent years, and few of these have come about because of a general mandate. Increased interest in using renewable fuels, due to concerns about dependence on foreign oil, may help to create a suitable sustainable market.

As this is a producer-based approach, producers would become responsible for "creating" a market for biodiesel. They would need to make biodiesel costs reasonable, and distribution practical, so that it can be effectively sold at retail. They would need to educate customers about the benefits of biodiesel. Any tax incentives would likely be enough only to nudge an entrepreneur to invest in biodiesel production equipment, not to provide a long-term subsidy.

This approach could be costly to the state government in a couple of areas. First, there would be direct costs associated with lost tax revenue from biodiesel production facilities. Second, other industries could seek to gain similar favorable tax provisions for the sake of equity, resulting in greater tax revenue losses. If this were to succeed in developing a biodiesel production industry, especially one that exports fuel to other states, these costs may be compensated by the benefits of a growing industry (e.g.. job creation).

This type of approach would be perceived as favorable to business development and to alternative fuels development. The environmental benefits from the biodiesel produced would be diffused over a greater geographic area than a state mandate, so the air quality benefits would be lesser.

This approach will benefit significantly from other state or Federal initiatives that create a biodiesel market. However, it should be noted that production incentives offered by other states may offset the comparative advantage that could be enjoyed by Montana producers, were such an incentive introduced in Montana.

8.4.2. Tax incentives for producers

Another approach is for the state to adopt tax incentives that reward biodiesel producers based on the volume of biodiesel actually produced. These incentives could be capped to a certain volume of biodiesel per year, a maximum amount of credits per producer, or a limited time frame when credits can be claimed.

The merits and weaknesses of this approach are similar to those described in section 8.4.1. One benefit of this approach is that a tax credit based on production equipment could be used as a tax write-off and not actually help to develop an industry that quickly. However, production volume incentives assume the existence of a biodiesel production infrastructure. Therefore, this approach would be more favorable to companies with existing production facilities that could be adapted to biodiesel production, rather than in the creation of a new industry.

This type of approach also raises questions relative to government fiscal impact. The production incentives will likely help to create jobs and produce net economic benefit for the state. Whether this benefit would offset the costs of the production incentives is not determinable.

8.5. Retailer-based Alternatives

Finally, Montana may adopt approaches which benefit retailers of biodiesel, by offsetting the costs of equipment modifications needed to support alternative fuels, or by providing a tax credit on biodiesel fuel that is sold. Equipment modifications are not necessary for dispensing biodiesel; however, some retailers may find it more economical to blend their biodiesel on-site, which could require installing additional tanks or equipment.

The states that have adopted retailer-based incentives – Indiana, North Carolina and Washington – are all more urbanized than Montana. In these states, it is more likely that there will be significant competition between retailers in the same city or town. Montana's retailers will generally not have the same incentives to differentiate their product through providing biodiesel. Therefore, the level of incentive would have to be sufficient to offset the increased costs of the fuel.

This approach would have a negative impact on government tax revenues, especially since there is no incentive here for the biodiesel to be produced within the state. This could result in a scenario in which biodiesel produced out of state (providing profits to out-of-state firms) is sold to Montana consumers at prices subsidized by Montana taxpayers. On the other hand, since retailers are a first-hand way for tourists to experience Montana's culture, retailers could help to promote Montana as a leader in renewable fuels.

8.6. Contingencies

One method that may be used to mitigate some potential negative impacts of legislation is to introduce contingencies under which the policy will or will not be in effect. Some potential contingencies that may be considered are listed below. The policy alternatives described earlier are matched with the contingencies which might be applied to each alternative.

?? Limitation to certain fuel uses. For example, Minnesota's legislation exempts motors located at nuclear power plants, railroad locomotives, and off-road taconite and copper mining equipment (89).

?? Requirement for minimum in-state production levels. In order to ensure that a mandate does not benefit biodiesel producers outside the state, the state could require a certain minimum level of production capacity from within the state. Minnesota's B2 legislation, has a minimum production level of 8 million gallons per year specified (89). With annual on-road consumption of diesel at over 650 million gallons (63), this volume represents approximately 1.2 percent of their diesel consumption; therefore, the in-state production of biodiesel would not be adequate to meet the 13 million gallons per year required by the mandate.

?? Delayed effective date. Delaying when the legislation becomes effective allows time for a market to develop, and may make biodiesel prices more stable over the long-term.

?? Maximum price differential. For limited mandates, the state may consider not requiring purchase of B20 when the price difference between B20 and the base diesel exceeds a certain threshold. This will make state fuel expenditures more predictable (although it could provide less predictable demand for producers).

?? Maximum duration of credits. This could ensure that producers and retailers decide to produce and sell biodiesel largely on its own merits, as opposed to the existence of a government subsidy.

?? Phase-out of provisions with Federal incentives. If the Federal government enacts mandates or incentives which replicate the state's provisions, the state may find it appropriate to rescind its provisions.

?? Equipment refund. If the biodiesel legislation is revoked within a certain time period, producers and retailers could receive partial reimbursement from the state for expenses incurred in complying with the legislation.

8.7. Comparison of Alternatives

The advantages and disadvantages of the alternatives presented in this chapter are summarized in Table 8-1. The best policy approach may be a combination of one or more of these alternatives, or it may reflect an altogether different approach. Clearly, the relative success of the alternatives in developing a biodiesel industry is dependent on many factors, especially the future price of fuel, which are uncertain.

Table 8-1: Impacts of Biodiesel Policy Alternatives

	Economic						Non-Economic				Sensitivity		
Alternative	Consumer	Retailer	Distirbutor / Refiner	Feedstock Producer	Biodiesel Producer	Government	Environmental Impacts	Leadership in Alternative Fuels	Environmental Leadership	Favorable Business Climate	Ratio of biodiesel to diesel price	Policy in other states	Federal policy
No action	·	·	·	·	·	·	·	-	-	·	S	S	S
Low-blend mandate (B2)	-	·	- -	+	+	·	+	+	+	-	SS	SS	SS
Higher-blend mandate (B20)	- - -	-	- - -	+++	+++	-	+++	+++	+++	- - -	SSS	SSS	SSS
Government use of B20	·	·	·	+	+	-	+	·	++	·	SS	S	SS
Fuel tax reduction or exemption	+	·	-	+	+	- -	+	·	+	·	S	S	SS
Increased non-renewable fuel tax	- -	-	-	·	·	++	+	+	++	- -	SS	SS	SS
Tax incentives for creation of production facilities	·	·	+	+++	+++	-	+	++	++	++	S	SSS	SSS
Tax incentives for production	·	·	·	+++	+++	-	+	++	++	+	SS	SSS	SSS
Tax incentives for retailers	·	+	·	+	+	-	·	·	·	·	SS	S	S

Legend:

+++	- Very Positive
++	- Positive
+	- Slightly Positive
·	- Indeterminate
-	- Slightly Negative
- -	- Negative
- - -	- Very Negative
SSS	- Very Sensitive
SS	- Moderately Sensitive
S	- Slightly Sensitive

9. SUMMARY AND NEXT STEPS

This report concludes Phase 2 of a research project, requested by the Montana House of Representatives, examining the technical feasibility of using biodiesel on a broad-scale for on-highway use in Montana.

9.1. Summary of Research Findings

Phase 1 of the research project, as summarized in (2), reviewed a variety of literature related to previous experience – laboratory and on-road – with biodiesel. The report observed the following:

?? Engine performance did not appreciably degrade through using biodiesel. Most studies which have shown a difference in fuel economy show biodiesel to have poorer fuel economy than diesel, although some studies have shown improved fuel economy. Recent studies have shown little if any reported power loss.

?? In higher blends of biodiesel (B20 or higher), biodiesel may adversely affect the cold-temperature properties of the fuel; however, this is typically not an issue in formulations less than 20 percent, and is essentially not an issue in a B2 formulation[11].

?? Biodiesel produces lower emissions (HC, CO, CO_2 and PM) than conventional diesel. It has been observed to produce higher emissions of NO_x; some studies have indicated that these increases in emissions could be mitigated.

?? Engine damage may be a concern when high grades of biodiesel (over B20) are used in older engines which contain rubber components. It also may be an issue as biodiesel cleans out fuel tanks and lines and creates the need for more frequent filter changes on initial switchover to biodiesel blend. However, there is no documented literature which suggests engine performance is degraded through long-term use of biodiesel, and engine manufacturers are generally agreeable to its use in their engines.

Phase 2 of this project focused on a small-scale field test with MDT maintenance vehicles based in the Department's Havre and Lolo South maintenance shops. As was discussed in Chapter 4, there were no problems in the field test that could be conclusively linked to the use of biodiesel. The response from personnel who used the vehicles indicated no significant negative reactions to continued use of the fuel.

With the promising results of the field test, this report examined broader issues related to implementation of policies that would affect biodiesel usage and production in the state. First, issues related to microbial growth, engine technology change, and evasion of Montana fuel by long-distance truck drivers were discussed. The first two issues do not seem to cause significant

[11] Kelly Strebig of the University of Minnesota's Center for Diesel Research said that cold weather properties may be improved with B2 because of its enhanced lubricity (148).

concern for biodiesel. Evasion would likely be a concern only if the price differential between B2 and diesel is comparable to the difference in fuel tax rates between Montana and adjacent states. This is especially true since the trend among biodiesel users seems to indicate that increased usage leads to increased user acceptance.

This report reviewed characteristics related to the biodiesel market, as it is and might be in Montana. There are a variety of feedstocks that may be used, but it is unclear to what extent Montana feedstocks would be used in producing Montana biodiesel. The economics of biodiesel production were demonstrated to be fairly complicated. Demand for diesel fuel was also discussed, to highlight the potential nuances in defining which diesel uses could fall under a state mandate.

A review of policies at the Federal and state levels were used to develop a variety of policy alternatives for consideration; these were summarized in Table 8-1. These alternatives are all more or less sensitive to a variety of economic and non-economic factors.

9.2. Next Steps and Future Research

An extensive amount of research has been done on biodiesel over the last 20 years. As was demonstrated in Phase 1 of this report, the research has focused primarily on technical questions related to fuel properties, usage and demonstration. As the biodiesel industry has gained a significant part of the alternative fuels market, the focus on research has been shifted toward questions related to marketability.

Through the course of this project, several areas of promising research related to biodiesel have been identified. Some of these questions may be important for the Montana State Legislature to consider as they convene in 2005 to decide what biodiesel policy, if any, should be adopted.

?? What is the public perception of biodiesel in Montana? How many people have heard of the fuel? Are their perceptions generally positive or negative? What willingness would the public have to use biodiesel, and at what additional cost?

?? How would Montana farmers respond to a biodiesel mandate? Would they shift toward growing oilseeds like canola and rapeseed? Would this put more land into active production, or would there be a decrease in acreage of other crops?

?? How would Montana fuel refiners respond to a biodiesel mandate? What would be the additional cost resulting from a mandate? How easy would it be for refiners to accommodate biodiesel in their terminal operations? How are Montana fuel refiners responding to the ultra-low sulfur diesel fuel rule?

?? What is the availability of non-vegetable feedstocks (such as animal fats and yellow grease) for biodiesel production in Montana? How easy would it be, especially from the perspective of transportation costs, for these feedstocks to be incorporated into the biodiesel production process?

?? How would the life-cycle costs of a vehicle fueled on B20 compare with those of a vehicle fueled using conventional diesel? Does B20 have any beneficial effects on vehicle longevity?

?? What are the economic effects of the B2 mandate on Minnesota? Have farmers benefited? Have fuel costs increased more than in other states? Has it stimulated a biodiesel industry in the state? This could offer significant lessons to other states and the Federal government about the impact of state mandates on expansion of the alternative fuel industry.

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APPENDIX A: FUEL USAGE LOG FORMS

<u>Fuel Usage Log</u>

MDT Biodiesel Research Project

Vehicle Name/ID: ___________________________________

Date	Driver	Odometer	Gallons	Comments

Fuel Usage Log: Lolo

Fuel Usage Log

MDT Biodiesel Research Project

Vehicle Name/ID: ______________________________

Date (Month/Day)	Driver Initials	Odometer	Fuel			Temp (°F)	Comments
			Gallons	Fuel Blend (% D1, % D2)	Additives Used (Name & Amount)		

Fuel Usage Log: Havre

APPENDIX B: MINNESOTA'S B2 MANDATE

Minnesota Statutes 239.77 Biodiesel content mandate.

Subdivision 1. Biodiesel fuel. "Biodiesel fuel" means a renewable, biodegradable, mono alkyl ester combustible liquid fuel derived from agricultural plant oils or animal fats and that meets American Society for Testing and Materials Specification D6751-02 for Biodiesel Fuel (B100) Blend Stock for Distillate Fuels.

Subdivision 2. Minimum content; effective date. (a) Except as otherwise provided in this section, all diesel fuel sold or offered for sale in Minnesota for use in internal combustion engines must contain at least 2.0 percent biodiesel fuel oil by volume.

(b) The mandate in paragraph (a) is effective on and after the date that the conditions in clauses (1) and (2), or in clauses (1) and (3), have been met:

(1) thirty or more days have passed since the commissioner of agriculture publishes notice in the State Register that annual capacity in Minnesota for the production of biodiesel fuel oil exceeds 8,000,000 gallons;

(2) eighteen months have passed since the commissioner of agriculture publishes notice in the State Register that a federal action on taxes imposed, tax credits, or otherwise, creates a reduction in the price of two cents or more per gallon on taxable fuel that contains at least two percent biodiesel fuel oil and is sold in this state;

(3) the date June 30, 2005, has passed.

Subdivision 3. Exceptions. (a) The minimum content requirement of subdivision 2 does not apply to fuel used in the following equipment:

(1) motors located at an electric generating plant regulated by the Nuclear Regulatory Commission;

(2) railroad locomotives; and

(3) off-road taconite and copper mining equipment and machinery.

(b) The exemption in paragraph (a), clause (1), expires 30 days after the Nuclear Regulatory Commission has approved the use of biodiesel fuel in motors at electric generating plants under its regulation.

(Source: 89)