MINNESOTA DEPARTMENT OF AGRICULTURE

Report to the Legislature

Annual Report on Biodiesel

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Executive Summary

In 2005, Minnesota became the first state to implement legislation mandating the use of biodiesel by blending biodiesel into its fuel supply at a level of 2 percent—commonly referred to as B2. According to subsequent legislation (Minnesota Statutes §239.77, subd. 2), **all diesel sold or offered for sale in Minnesota must contain 5 percent biodiesel (B5) as of May 2009, increasing to 10 percent (B10) in 2012 and 20 percent (B20) in 2015.**[1,2] The move to B10 was effectively delayed by a letter from the commissioners of Agriculture, Commerce and the Pollution Control Agency dated November 3, 2011. Notice has yet to be published implementing the change to B10.

The Biodiesel Task Force was formed in 2003—comprised of appointees from industry, academia, and various associations—**to advise the Commissioner of Agriculture on implementing the state's biodiesel blend requirement and building the state's biodiesel production capacity.** Since then, the Task Force has helped promote the industry and educate biodiesel developers, marketers, consumers and manufacturers about biodiesel and related issues in Minnesota.

Experience and testing demonstrate that biodiesel blends can perform well in cold weather. During the first winter following implementation of B5 in May 2009, some diesel fuel users in Minnesota reported problems potentially associated with the use of higher blends of biodiesel. In January 2010 the Minnesota Department of Commerce issued a temporary waiver for the B5 requirement in #1 diesel in response to concerns about the potential for clogged filters in extreme cold weather. In spite of sub-zero temperatures last winter and so far this winter, no issues with the state's B5 mandate have been reported.

Significant progress has been made in providing new industry specifications that establish and improve quality guidelines for biodiesel, biodiesel blends, and diesel fuel oil. The American Society for Testing and Materials (ASTM) introduced additions to existing standards that incorporated biodiesel blends up to B5 into the diesel fuel standard (D975), added a cold soak filtration test for B100 to the biodiesel specification (D6751), and established a new specification

[1] By law, the 10 and 20 percent minimum content levels would be effective from April 1st through October 31st only. According to MS §239.77, subd. 2a, "The minimum content for the remainder of the year is five percent. However, if the commissioners of agriculture, commerce, and pollution control determine, after consultation with the biodiesel task force and other technical experts, that an American Society for Testing and Materials (ASTM) specification or equivalent federal standard exists for the specified biodiesel blend level in those clauses that adequately addresses technical issues associated with Minnesota's cold weather and publish a notice in the State Register to that effect, the commissioners may allow the specified biodiesel blend level in those clauses to be effective year-round."

[2] According to MS §239.77, subd. 2b, the 10 and 20 percent minimum content levels "become effective on the date specified only if the commissioners of agriculture, commerce, and pollution control publish notice in the State Register and provide written notice to the chairs of the House of Representatives and Senate committees with jurisdiction over agriculture, commerce, and transportation policy and finance, at least 270 days prior to the date of each scheduled increase, that certain conditions have been met (e.g., ASTM specifications exist, adequate supply is available, etc.) and the state is prepared to move to the next scheduled minimum content level."

(D7467) for blends of biodiesel from B6 through B20. New specifications for B100 were added to the biodiesel standard (D6751) in 2012. These changes made within the biodiesel standard (D6751) to add a specification for a #1 biodiesel grade, making for biodiesel grades similar to the way #1 and #2 diesel fuel are used.

The price of biodiesel fuel has continued to grow faster than diesel fuel prices.[3] **The price difference to consumers for biodiesel blends, in some cases, has increased but not as dramatically as the price differential:** for example, a gallon of B5 towards the end of 2012 has averaged just less than 3 cents more than a gallon of diesel, while last year B5 averaged almost 11 cents more a gallon from April to September. The federal biodiesel blender's tax credit of $1.00 per gallon was in force the entire year of 2011 – this after the credit had been reinstated in December, 2010, retroactively for 2010 to the end of 2011. The credit at the end of 2011 the tax credit expired and did not return in 2012 until legislation was passed January 1, 2013, retroactive for 2012 through 2013.

The value of a Renewable Identification Number (RIN) for a gallon of biodiesel, a feature of the EPA's Renewable Fuels Standard program (RFS2), **was equal to or greater than the difference in the producer price for biodiesel (B100) and the rack price of #2 diesel for most of 2012.** As this mechanism settles into the marketplace, it is taking the place of the federal tax credit, depending on the point of sale and the price received for the RIN, can reduce the cost of biodiesel blends to the consumer.

The supply of biodiesel fuel to Minnesota terminals has generally been constant. Few if any B5 outages occurred at terminals because biodiesel fuel was not available; instead, common reasons for B5 outages include local diesel fuel outages and a lack of winter blending equipment at certain out-of-state terminals. A year-round blending facility was constructed and opened by Harms Oil in Sioux Falls, SD, across the street from a Magellan terminal. This is expected to blend much of the winter biodiesel supply for southwest Minnesota.

Minnesota's B2 and B5 mandates have provided an important incentive leading to the establishment of the state's biodiesel production capacity of 63 million gallons. **The state's existing capacity can provide more than the biodiesel necessary for B5, 84% of B10, and 50 percent required for future statewide B20 requirements.** A new biodiesel plant in Minnesota will likely provide additional capacity over the next few years.

Feedstocks for biodiesel production at Minnesota plants are generally determined by the price and availability of the oil or fat used in the process. Given the large soybean oil crushing capacity in Minnesota, **much of the soy oil used in Minnesota biodiesel plants is likely to be sourced from Minnesota oil producers. However, soybean oil prices have been at high levels since late 2010** (despite a small fall off this past year), **which has reduced** profitability. Given this, companies like Renewable Energy Group (REG), owner of the Glenville plant

[3] For 2006-2009, the end of 2010 and 2011 the price of biodiesel is the rack (wholesale) price after the $1.00 federal tax credit. For almost all of 2010 (where the credit was reinstated in December) and all of 2012 (where the credit was reinstated January 1, 2013), prices reflect wholesale prices without the credit.

(formerly Soymor), is investing $20 million in a retrofit designed to allow the plant to use lower cost feedstock such as corn oil from the corn ethanol process, waste vegetable oil, along with animal and poultry fats.

Introduction

This report is submitted pursuant to Minnesota Statutes §239.77, subd. 5:

Beginning in 2009, the commissioner of agriculture must report by January 15 of each year to the chairs and ranking minority members of the legislative committees and divisions with jurisdiction over agriculture policy and finance regarding the implementation of the minimum content requirements in subdivision 2, including information about the price and supply of biodiesel fuel. The report shall include information about the impacts of the biodiesel mandate on the development of biodiesel production capacity in the state, and on the use of feedstock grown or raised in the state for biodiesel production. The report must include any written comments received from members of the biodiesel fuel task force by January 1 of that year designated by them for inclusion in the report.

Background

The Biodiesel Task Force was created by the Legislature in March 2003 to help the state carry out its biodiesel mandate. Since then, the Task Force has met on an ad-hoc basis to discuss issues related to biodiesel production and use. Sub-teams have been formed to address more specific issues such as cold weather operability.

The Biodiesel Task Force members are appointed by the Commissioner of Agriculture. Current membership includes:

- Douglas Peterson, Minnesota Farmers Union
- Kevin Paap, Minnesota Farm Bureau
- Dustin Haaland, CHS Inc.
- David Slade, REG Company
- Kevin Thoma, Minnesota Petroleum Marketers Association
- Kelly Marczak, American Lung Association of Minnesota
- Kristin Weeks-Duncanson, At large
- Dave Ladd, At large
- Ronald Marr, Minnesota Soybean Processors
- Darrick Zarling, University of Minnesota Center for Diesel Research
- Doug Root, AURI
- Brent Webb, Flint Hills Resources, LP
- Bruce Goodrich, R&E Enterprises/Minnesota Trucking Association
- Chris Hill, Minnesota Soybean Growers Association

- Bruce Heine, Magellan Midstream Partners, LP

Implementation of Minnesota's Biodiesel Requirements

B10 Implementation

The commissioners of agriculture, pollution control and commerce met November 26, 2012, to discuss the delay in implementing the move to B10. Their primary task for this meeting was to re-address where Minnesota stands with the move to B10, and specifically look at the shortcomings that required the delay from the May 1, 2012, implementation date set in MN Statute §239.77, subd. 2(a)(3). The reasons that had been cited in the original letter announcing the delay from the commissioners' letter of November 3, 2011, were:

- Regulatory protocol: The Minnesota Department of Commerce, Weights and Measures Division is the enforcement agent for the state's biodiesel content mandate. Weights and Measures audits and samples biodiesel stored at bulk delivery facilities or sold at retail outlets in the state to ensure adequate biodiesel blends are offered. The division's investigators inspect retail outlets on a regular schedule. The length of the interval between inspections might allow for an opportunity for undetected violations of the content mandate. Also, Weights and Measures does not have the authority to audit or inspect at farms or fleet facilities to determine if Minnesota bulk facilities are delivering mandate-compliant fuel.
- Amount of blending infrastructure: The majority of the state is equipped with adequate biodiesel blending infrastructure. The southwestern portion of the state historically has experienced some problems with access to mandate-compliant fuel, leading to supply issues.

The Weights and Measures Division of the Department of Commerce reported that they are making progress, but were still not satisfied with where they stand currently on mandate enforcement, and are asking for those changes in the upcoming legislative session.

Harms Oil of Sioux Falls, SD, opened an all-season biodiesel blending facility in Sioux Falls in November, 2012. Despite the opening of this facility, the commissioners decided to wait and see what affect the blending facility will have on the situation in southwest Minnesota, and readdress the issue again next summer.

It was then decided by the commissioners that the issue would be tabled until the summer of 2013. This, in effect, means that the earliest possible implementation of the B10 mandate would be in the spring of 2014.

Waiver of B5 Blending with #1 Diesel during Cold Weather Months

During the first winter following B5 implementation (B5 implemented in May, 2009), some diesel fuel users in Minnesota reported problems potentially associated with the use of higher biodiesel blends in extreme cold weather. In January 2010, the Minnesota Department of Commerce issued a temporary waiver for the B5 requirement in #1 diesel, requiring no blending of biodiesel with #1 diesel in the winter months of October, November, December, January, February and March. The waiver was continued and remained in effect through March 2012. During the legislative session of 2012, language was added to MN Statute §239.77, subd. 3(c) that extends exemption of blending biodiesel with #1 diesel in the winter months until May 1, 2015.

The Minnesota Biodiesel Task Force Cold Issues Team met on March 6, 2012. The Cold Issues Team was created in 2008 to provide essential guidance to the state on technical issues related to the production, handling and use of biodiesel in cold weather conditions.

The group's primary task was the report and review of the addition of a specification for a number 1 biodiesel grade to ASTM D6751. Number 1 biodiesel is a formulation with a lower cloud point and cold soak filtration value. During this meeting it was pointed out to the group that Cenex-Harvest States (CHS) and the Magellan pipeline already have a standard very close to the specifications for #1 biodiesel already in place.

Common practice is to field test a new ASTM specification for a couple years after its passage. This would mean the winters of 2012-13 and 2013-14 would be test seasons for a #1 biodiesel grade. The task force approved staying with the current winter blending practice of allowing #1 diesel to be exempt from biodiesel blending in the months October, 2012-March, 2013. The legislature revised statute to continue this practice until May 1, 2015.

Department of Commerce Pricing Report

A report regarding wholesale pricing of diesel fuel and blends from the Commissioner of Commerce, in collaboration with the Commissioner of Agriculture, was issued in February, 2012.[4] The report looked at prices at various terminals both in and out of the state to see what affect the biodiesel blends have on the overall price of diesel fuel. This information was reported to the governor who may, after consultation with the commissioners of commerce and agriculture, adjust the mandate should a price disparity appear to be causing economic hardship

[4] According to MS §239.77, subd. 2(e), "By February 1, 2012, and periodically thereafter, the commissioner of commerce shall determine the wholesale diesel price at various pipeline and refinery terminals in the region, and the biodiesel price determined after credits and incentives are subtracted at biodiesel plants in the region. The commissioner shall report wholesale price differences to the governor who, after consultation with the commissioners of commerce and agriculture, may by executive order adjust the biodiesel mandate if a price disparity reported by the commissioner will cause a hardship to retailers of diesel fuel in this state. Any adjustment must be for a specified period of time, after which the percentage of biodiesel fuel to be blended into diesel fuel retruns to the amount required in subdivision 2. The biodiesel mandate must not be adjusted to less than five percent."

to retailers of diesel in Minnesota. The report found it could not be determined whether economic hardship existed for diesel retailers in the state based upon the data available. Such a determination has no consequence, as the statute specifies that the blending requirement would not fall below 5% in any event. Should the mandate have been greater than 5%, any adjustment that would be made would be for a specified period only.

ASTM Specifications

ASTM is the premier international industry association that designates quality specifications for a wide variety of industrial products including fuels and lubricants. Updates in 2008 to the existing ASTM "Standard Specification for Diesel Fuel Oils D975" incorporated biodiesel blends up to 5 percent. The specification D975-09 was not adapted into Minnesota Statutes because of objections from some members of the petroleum industry who believed that adding 5 percent biodiesel into #1 diesel fuel would not allow that fuel to meet required distillation properties. An ASTM committee is currently working to resolve this issue; however, the state waiver for biodiesel blending in #1 fuel addresses this concern in Minnesota into 2015. Changes and additions were made to D975 in 2011 and 2012. The current version is D975-12.

In 2012, the latest version of the biodiesel specification, D6751, was accepted. This standard now specifies four grades of biodiesel, which includes the #1 specifications for cold temperature blending:

- Grade 1-B S15-A: special purpose biodiesel blendstock intended for middle distillate fuel applications requiring good low temperature operability and requiring a fuel blend component with 15 parts per million (ppm) sulfur maximum.
- Grade 1-B S500-A: special purpose biodiesel blendstock intended for middle distillate fuel applications requiring good low temperature operability and requiring a fuel blend component with 500 ppm sulfur maximum.
- Grade 2-B S15-A: general purpose biodiesel blendstock for middle distillate fuel applications that require a fuel blend component of 15 ppm maximum.
- Grade 2-B S500-A: general purpose biodiesel blendstock for middle distillate fuel applications that require a fuel blend component of 500 ppm maximum.

The use of the new #1 grade biodiesel is entirely voluntary. Various refiners and terminals have their own standards for delivery of biodiesel and other products into their systems and these may actually be more stringent than the voluntary number 1 grade biodiesel ASTM specifications. In fact, biodiesel requirements among some Minnesota terminals and refiners have been more stringent than ASTM D6751 before 2012, but not all have adopted these strict requirements.

The existing ASTM "Standard Specification for Biodiesel Fuel Blend Stocks for Middle Distillate Fuels D6751" was first amended in 2008 to include the cold flow filtration test into the recommended test parameters to address cold flow issues. In addition, the federal government

established a penalty for trading biodiesel not passing the cold flow filtration test that would be sold, transported or used after September 1, 2009.

The ASTM "Standard Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20)" was approved in 2008 as D7467. The standard establishes specifications for biodiesel blends including B10 and B20, which are proposed for general usage in Minnesota in the years 2012 and 2015, respectively. The standard has not been updated since 2010.

Biodiesel Prices

Diesel prices statewide and across Minnesota's border—to the south (Omaha, Nebraska) and west (Denver, Colorado)—have shown remarkably close pricing historically. Figure 1 compares average yearly prices for ultralow sulfur diesel over the past four year period. Ranges include $1.7268 – $1.7660 (low at Omaha, NE – high at Fargo, ND), difference of $0.0391 for 2009; $2.2513 – $2.3087 (low at Omaha, NE – high at Superior, WI, difference of $0.0574 for 2010; $3.0991 - $3.1755 (low at Omaha, NE – high at Superior, WI), difference of $0.0764 for 2011; and $3.1711-$3.2095 (low at Omaha, NE – high at Superior, WI), difference of $0.0405 for 2012.

Prices for B100 vary more than diesel prices, with average monthly prices for regularly reporting regions varying as much as 21 cents in 2009 (Rochester's low to Mankato's high), 50 cents in 2010 (Marshall's low to Denver's high), 25 cents in 2011 (Marshall's low to Grand Fork's high) and 35 cents in 2012 (Marshall's low to Denver's high). The cities of Omaha, Sioux Falls, South Dakota, and Superior, Wisconsin, do not provide pricing for B100. Figures 2 and 3 compare average yearly prices for B100 for the reporting regions.

Figure 1. Diesel pricing by city (average of terminals reporting), 2009-2012 (table).

City/Region, State	2009	2010	2011	2012
Alexandria, MN	1.7600	2.2860	3.1357	3.1954
Denver, CO	1.7377	2.2975	3.1170	3.1985
Duluth, MN	1.7532	2.3006	3.1639	3.2095
Fargo, ND	1.7660	2.2941	3.1459	3.2117
Grand Forks, ND	1.7628	2.2899	3.1424	3.2086
Mankato, MN	1.7515	2.2740	3.1190	3.1843
Marshall, MN	1.7538	2.2811	3.1223	3.1874
Omaha, NE	1.7268	2.2513	3.0991	3.1711
Rochester, MN	1.7437	2.2714	3.1198	3.1795
Sioux Falls, SD	1.7375	2.2617	3.1084	3.1776
Superior, WI	1.7616	2.3087	3.1755	3.2040
Minneapolis-St. Paul, MN	1.7456	2.2741	3.1236	3.1832

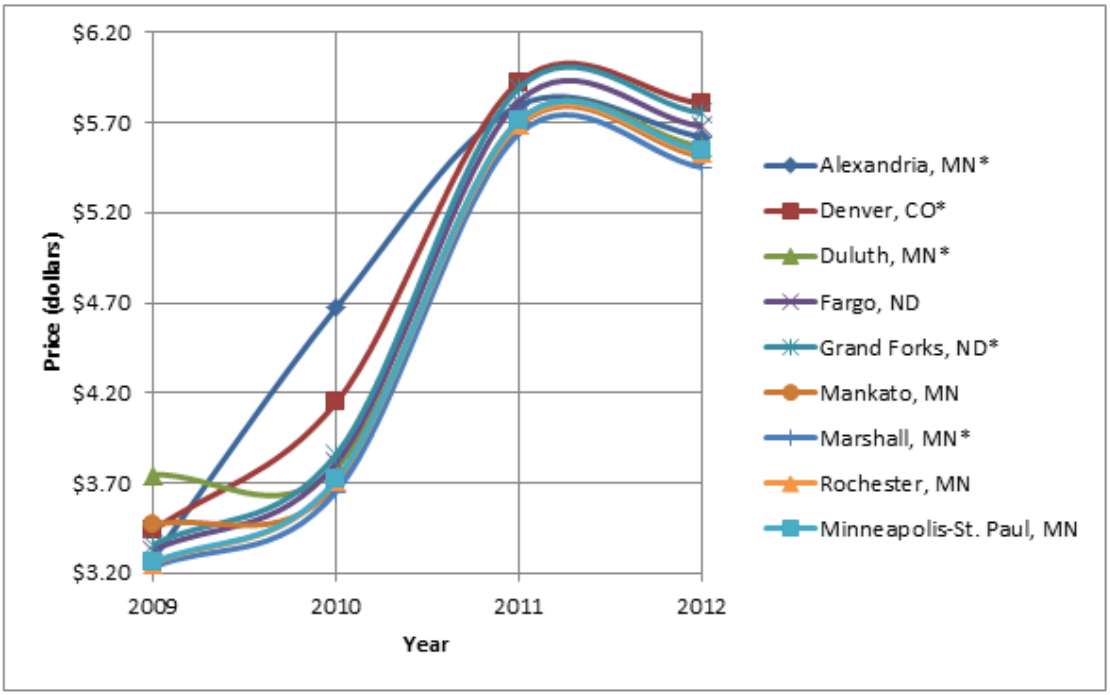
Figure 2. B100 pricing by city (average of terminals reporting), 2009-2012 (table).

City/Region, State	2009	2010	2011	2012
Alexandria, MN*	3.2834*	4.6725*	5.7960	5.6217
Denver, CO*	3.4409*	4.1464	5.9249*	5.8060
Duluth, MN*	3.7471*	3.7842	5.7123	5.5683
Fargo, ND	3.3285	3.8114	5.8174	5.6789
Grand Forks, ND*	3.3600*	3.8587	5.8907	5.7536
Mankato, MN	3.4683	3.6852	5.6818	5.5131
Marshall, MN*	3.2352*	3.6536	5.6378	5.4524
Omaha, NE	No B100 data available			
Rochester, MN	3.2544	3.7133	5.6940	5.5321
Sioux Falls, SD	No B100 data available			
Superior, WI	No B100 data available			
Minneapolis-St. Paul, MN	3.2592	3.7193	5.7100	5.5442

*-missing prices (shaded cells) for:

Alexandria: December 11, 2009 – December 8, 2010
Denver: June 26, 2009 – July 22, 2009; March 3, 2011 – September 29, 2011
Duluth: April 28, 2009 – July 22, 2009
Grand Forks and Marshall: June 5, 2009 – June 19, 2009; July 14, 2009 – July 22, 2009

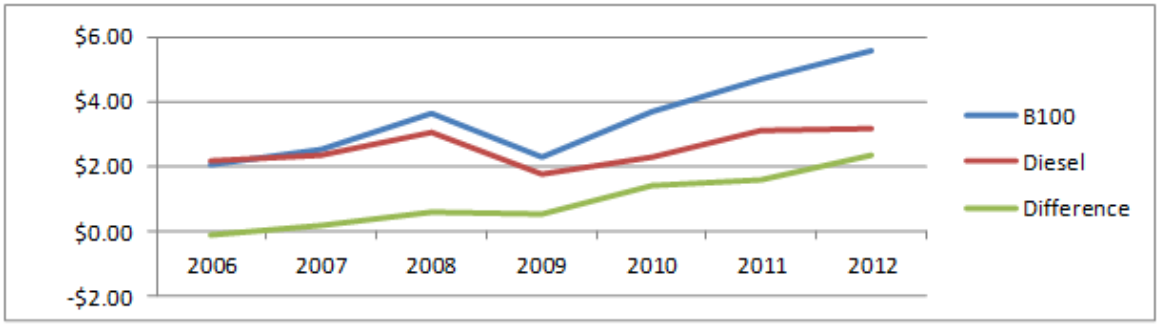
Figure 3. B100 pricing by city (average of terminals reporting), 2009-2012 (graph).



*-incomplete pricing data, see figure 2.

A graph of the net average wholesale prices (at the rack)—adjusted to illustrate after-tax costs of B100 compared to the wholesale cost of diesel at major Minneapolis/St. Paul terminal locations—can be seen in Figure 4. The retroactive $1 tax credit for 2010 and 2012 have not been subtracted from the B100 price to the blender.

Figure 4. Minneapolis-St. Paul Diesel[5] and Biodiesel[6] Price Trends, 2006-2012[7].



Source: Minnesota Department of Agriculture analyses of Axxis pricing data through December 31, 2012.

From 2006 to 2007, the net after-tax cost of B100 to the blender was lower, but since then has been higher than the commensurate cost of diesel fuel. For example, in 2006 the net price of B100 was about 14 cents lower per gallon than the price of one gallon of diesel fuel, rising to 51 cents higher in 2009, rising to $2.36 this past year. When factoring in the retroactively reinstated tax credit for 2012, the difference would be $1.36 per gallon, which is lower than the $1.59 difference in 2011.

To consumers buying biodiesel blends, however, these differences are not as dramatic as it might appear—Figure 5 demonstrates computed prices for biodiesel blends based on actual B100 and diesel prices at the rack, as follows:

Where:
Pb = Net price of one gallon of biodiesel to blender (after tax credit)
Pd = Price of one gallon of diesel at the rack
%b = Percent of biodiesel in blended fuel
%d = Percent of diesel in blended fuel
*(Pb * %b) + (Pd * %d) = Computed price of biodiesel blend*

[5] Price of diesel at the rack (wholesale-Minneapolis/St. Paul average).
[6] For 2006 to 2009, the price of biodiesel is the rack price after the $1.00 federal tax credit. For 2010, prices reflect the rack price without the tax credit until December 20, although the tax credit was reinstated in December retroactive for 2011. 2012 reflects the rack price without the tax credit, although the credit was reinstated retroactive for all of 2012 on January 1, 2013.
[7] Generally, prices were recorded by Axxis daily (on business days). However, in 2006 prices were only recorded weekly and did not start until February for biodiesel and May for diesel. In 2007, diesel prices were consistently recorded on a daily basis throughout the year, while biodiesel prices were only recorded weekly from January through June and then daily for the remainder of the year. As such, average prices for 2006-2007 represented in the chart may be less consistent than those in subsequent years. In addition, from March 24, 2008 to May 2, 2008, data on the price of biodiesel was not available through the Axxis pricing service. After a review of data in May, Axxis determined that the increase in price was not an error, but actually reflected market conditions. Axxis reestablished B100 prices effective May 2, 2008. To avoid the appearance of understating the price of biodiesel during that period, the average price of the last day of available data (March 28) and the first day (May 2) was inserted for the month of April. Prices since then have continued uninterrupted for both diesel and B100.

Figure 5. Diesel and Biodiesel Blend Prices (per gallon), 2006-2012.

Year (Blend Mandate)	Net Cost of B100 to Blender [6]	Average Rack Diesel Price	Computed Price of B2	Computed Price of B5	Net Impact Price of Biodiesel
2006 [1,2]	$2.0584	$2.1944	$2.1917		-$0.0027
2007 [3]	$2.4983	$2.3388	$2.3420		$0.0032
2008 [4,5]	$3.6607	$3.0538	$3.0659		$0.0121
2009	$2.2592	$1.7456			$0.0176
2009 (1-4 to 4-30) (B2)	$2.2064	$1.4120	$1.4278		$0.0159
2009 (5-1 to 12-31) (B5)	$2.2864	$1.9176		$1.9361	$0.0184
2010 [7,8]	$3.6826	$2.2741		$2.3446	$0.0704
2010 (w/o tax credit, 1-4 to 12-17) (B5)	$3.6826	$2.2614		$2.3324	$0.0711
2010 (w/tax credit, 12-20 to 12-31) (B5)	$3.6822	$2.6087		$2.6624	$0.0537
2010 (with $1 tax credit all year)	$2.7193	$2.2741		$2.2964	$0.0223
2011 (1-3 to 12-30) (B5) [9]	$4.7100	$3.1236		$3.2029	$0.0793
2012 [9,10]	$5.5442	$3.1832		$3.3013	$0.1180
2012 (with $1 tax credit all year)	$4.5442	$3.1832		$3.2513	$0.0680

1	2006 includes B100 and B2 prices for Feb 23 through June 20 and July 24 through Dec 29, and diesel prices for May 4 through Dec 29.
2	Beginning in October 2006, the federal government limited sulfur in diesel to 15 ppm.
3	2007 includes B100 and B2 prices for Jan 5 through Dec 31, and diesel prices from Jan 2 through Dec 31; however, biodiesel prices were very spotty (about weekly) from Jan-June whereas diesel prices were recorded daily
4	2008 includes B100 prices for Jan 2 through March 24 and May 2 through Dec 31 (B2 prices consistent), and diesel prices from Jan 2 through Dec 31.
5	From March 24, 2008 to May 2, 2008, data on the price of biodiesel was not available through the Axxis pricing service. The rapid increase in the price of biodiesel apparently caused a loss of data. After a review of data in May, Axxis determined that the increase in price was not an error, but actually reflected market conditions. Axxiss reestablished B100 prices effective May 2, 2008. To avoid the appearance of understating the price of biodiesel during that period, the average price of the last day of available data (March 28) and the first day of data (May 2) was inserted for the month of April.
6	Net cost of biodiesel is the net cost to the blender after federal tax credit is applied.
7	B5 blend all year in #2 diesel; no B100 in #1 diesel 1-15 to 3-31 and 10-1 to 12-31
8	The tax credit was reinstated (retroactive for 2010 and thru 2011) on December 20
9	No B100 blended with #1 diesel January-March and October-December
10	No $1 tax credit for 2012; reinstated retroactively for 2012 on 1-1-2013 through 2013

The computed price of biodiesel blends was generally around 1 to 2 cents higher per gallon than diesel fuel from 2008 to 2009, when the blender's tax credit appeared to expire. The tax credit was reinstated retroactively in December, 2010, but it is questionable as to whether or not blenders were able to take full advantage of the retroactive credit. Since that time, prices have been higher. The average was about 7 cents over for 2010 (without the tax credit), 7.9 cents in 2011 (with the tax credit all year) and 11.9 cents in 2012, which went without the credit the entire year before being retroactively reinstated on New Year's Day. When calculating in the retroactive $1 blender's tax credit for 2010 and 2012, these impacts are lowered to 2 cents and 6.8 cents, respectively.

Computed prices for B2 and B5 have tracked closely with actual prices for these fuels at the rack, which generally ranged from about 6 cents more to 15 cents less per gallon than the blend at the rack (see Figure 6). The average difference in the calculated blend price and the actual blend price over the seven year period is 2 cents less for the calculated price. These differences in price have been attributed to a variety of factors including the additional impact of the timing and length of marketing contracts; the marketing strategies of biodiesel producers, petroleum refiners, pipeline operators and position holders (marketers); the temporary losses of the federal tax credit; and the amortization of the cost of blending equipment installed at refiners and terminals.

Figure 6. Comparison of Projected B2/B5 Pricing and Rack Pricing, 2006-2012.

Year (Blend Mandate)	Computed Price		Rack Price		Computed/Rack Difference (Computed minus Rack)	
	B2	B5	B2	B5	B2	B5
2006 (B2)	$2.1917		$2.1678		$0.0239	
2007 (B2)	$2.3420		$2.4901		-$0.1481	
2008 (B2)	$3.0659		$3.0903		-$0.0243	
2009 (1-4 to 4-30) (B2)	$1.4278		$1.4421		-$0.0143	
2009 (5-1 to 12-31) (B5)		$1.9361		$1.9679		-$0.0319
2010 (w/o tax credit, 1-2 to 12-17) (B5)		$2.3324		$2.3238		$0.0086
2010 (w/tax credit, 12-20 to 12-31) (B5)		$2.6624		$2.6898		-$0.0274
2010 (with tax credit all year) (B5)		$2.2964		$2.3372		-$0.0409
2011 (B5)		$3.2029		$3.2266		-$0.0237
2012 (B5)		$3.3013		$3.2488		$0.0524
2012 (with tax credit all year) (B5)		$3.2513		$3.2488		$0.0024

Looking to projected prices for B10 blending, the projections for the past four years appear as in Figure 7. These projections use average prices of diesel fuel and B100 for each year and apply the same formula listed above. Different scenarios are presented, all based on Minneapolis-St. Paul average prices at the rack, disregarding any effect for the trading of RIN values (see Impact of RIN's in the following pages). The increase in price reflects the divergent relationship of

costs in B100 and diesel fuel over the past four years (see figure 8, where 2010 and 2012 are prices shown as the year occurred without tax credits, which were reinstated retroactively, and with the years shown as if the tax credit had been in place the whole time).

Figure 7. Projected cost of B10 over the past four years with its associated cost difference with straight diesel fuel[8].

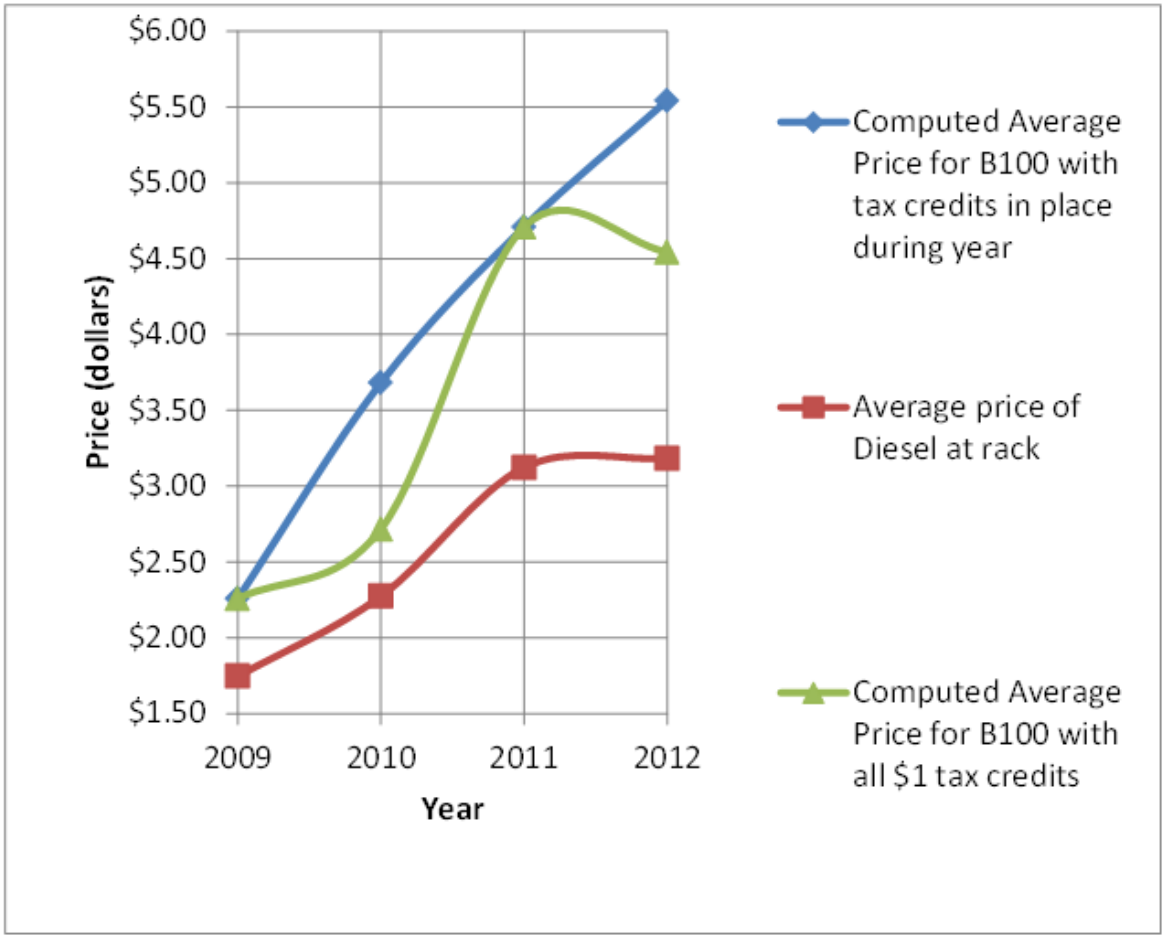
Year (Blend Mandate)	Computed Average Price for B100	Average price of Diesel at rack	Computed Average Price for blended fuel (B5 winter/B10 summer)	Net Price Impact of B5/B10 Blend
2009	2.2592	1.7456	1.7823	0.0367
2010 [1]	3.6826	2.2741	2.4251	0.1510
2010 - with all year tax credit	2.7170	2.2741	2.3056	0.0315
2011	4.7100	3.1236	3.2468	0.1232
2012 [2]	5.5442	3.1832	3.3622	0.1790
2012 - with all year tax credit	4.5442	3.1832	3.2873	0.1041

[1] - Total for year as it occurred with no tax credit 1-4 through 12-17

[2] - Total for year as it occurred with no tax credit during entire year

[8] Data from Minneapolis-St. Paul rack averages as reported by Axxis. This data assumes that the tax credit was not deducted from the B100 price (which is not always true), and does not take other factors, such as the trading of RINs by non-obligated parties under RFS2, into account.

Figure 8: B100 and diesel fuel price trends, 2009-2012.



* - the blender tax credit for biodiesel was not in effect during most of 2010 and all of 2012, but eventually reinstated retroactively for both years.

Impact of Federal Tax Credit

Production of biodiesel for 2011 set a new record at approximately 967 million gallons. This broke the 2008 mark of 690 million gallons set in 2008, and more than tripled the 315 million gallon output of 2010. That increase in production was directly tied to the reinstatement of the Federal Tax Credit in December, 2010.

The tax credit continued through 2011 and expired on December 31, 2011. During 2012, the lack of the tax credit exemplified how the value of the RIN through RFS2 renewable fuel use requirements could be used as the only government intervention helping bring down the value of biodiesel fuel from its straight market value. In the end, the tax credit was reinstated, retroactive for 2012, through December 31, 2013, in the Federal Fiscal Cliff legislation passed January 1, 2013.

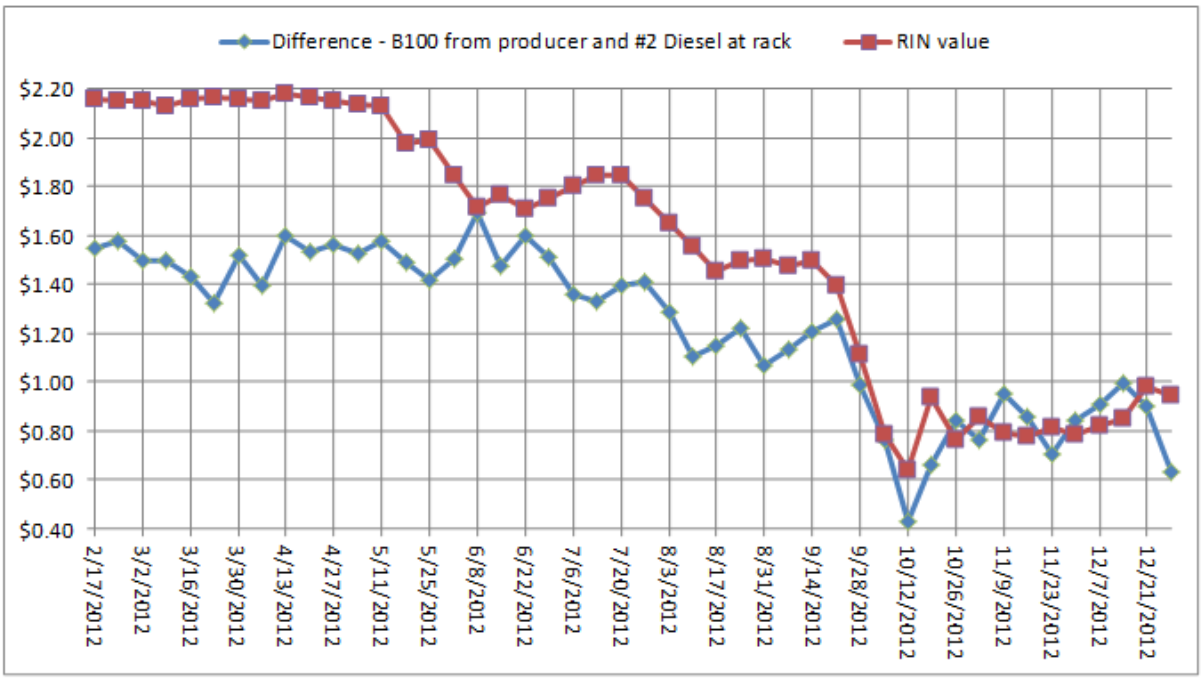
Impact of RIN's

The federal Renewable Fuel Standard (RFS2) program allocates Renewable Identification Numbers (RINs) to each gallon of biodiesel produced or imported. Each qualified gallon of biodiesel earns 1.5 RINs, which can be used by the blender to offset the cost of biodiesel. In early December 2011 the value of a biodiesel RIN was between 135 cents and 140 cents—therefore each qualifying gallon of biodiesel had a RIN equivalent value between $1.95 and $2.18. Values earlier in the year (before production took off later in the year) reached as high as $1.90/biodiesel RIN which is equivalent to $2.80/gallon of biodiesel. This value was over and above the federal biodiesel tax credit ($1.00). RIN's are bought in the market by energy companies (also known as "obligated parties" who do not blend renewable fuel (or don't blend enough) and need to retire RINs to demonstrate compliance with RFS2.

In a letter sent to petroleum distributers from Commissioner of Agriculture Dave Fredrickson dated March 18, 2011, the nature of RINs was addressed. There had become concern that little, if any of the RIN value was being passed along to dealers or consumers, leading to distorted fuel prices. It was recommended that dealers inquire with the fuel suppliers or with biodiesel producers to determine if the value of the RIN could be made available to them.

For the year 2012, the RIN value was the only government intervention that could reduce the cost of B100. While obligated parties under RFS2 – refiners and petroleum importers, are mandated to blend certain percentages of their production with biofuels, other petroleum marketers and distributers are not. RINs can be separated from gallons of biodiesel purchased from the producer, and the RINs can be sold in the RIN market for whatever price they can command at the time. When this value is greater than the difference between the price of biodiesel purchased from the producer, and the price paid for #2 diesel, a potential for profit from blending exists. A look at the RIN values (for a gallon of biodiesel: biodiesel RIN X 1.5) and the weekly difference for averages of B100 and biodiesel fuel for 2012 is shown in Figure 9.

Figure 9: Comparison of Difference in B100[9] and #2 Diesel Price[10] with Biodiesel RIN Value[11], 2012.

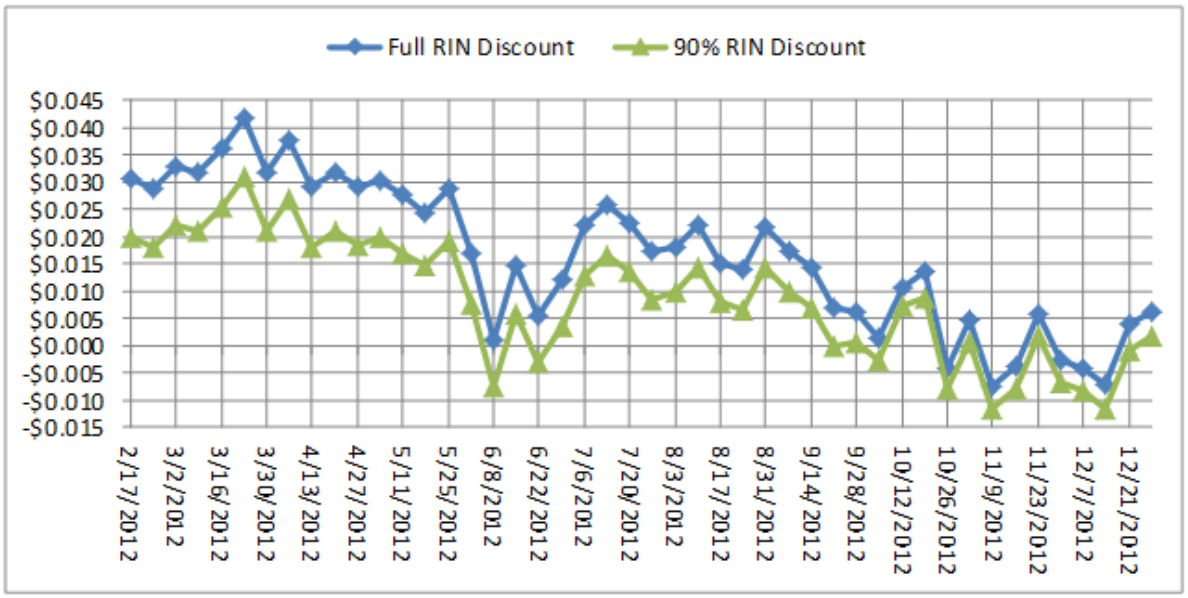


Keeping biodiesel RIN data week by week starting mid-February, an average of 82% of the value of a biodiesel RIN gallon (and a median value of 77.4%) would make up for the difference in the two fuels being blended. The extra percentage of the RIN gallon price could be used for transport, processing, profit and price break to the customer of the outside-the-rack blender.

When the net price for B100 is less than the price paid for #2 diesel, a higher the percent of biodiesel blended in the fuel makes for lower cost the resulting blended fuel. Figure 10 shows the 2012 trend by week showing what profit (or loss) could be attained depending on what percent of the RIN value can be recovered (in this case 90% or 100%), by comparing the projected B5 with the rack #2 diesel price for each week. The reading of $0.00 on the vertical axis would be the breakeven point before other expenses.

Figure 10: Week-by-week Profit or Loss Obtained Dependent of RIN Value: Difference of B100 minus the RIN gallon value (or percentage of that value) and the Rack Price of #2 Diesel

[9] National Weekly Ag Energy Round-Up, USDA Livestock and Grain Market News, Des Moines, IA.
[10] Weekly average rack
[11] PFL Markets Daily, Progressive Fuels Limited, Naples, FL.



The ability to take advantage of RIN trading does require knowledge of the market, or services of an agency that specifically works with trading in that market. In the very least, this data does show that there is potential profit for blenders who are not obligated parties. There is also potential for Minnesota's obligated parties due to the fact that the blending required by Minnesota's biodiesel mandate is higher than blending volumes required nationally by RFS2. This leaves extra RINs for those companies to either use for out-of-state RFS2 compliance, or to trade in the market. The effect of the reinstatement of the $1 blender credit for 2013 will depress the biodiesel RIN value. Like 2011, the RIN will still have value nationally through RFS2 and will be a factor in determining final price.

Summary

The cost of biodiesel depends on a number of factors; even with reinstatement of the tax credit, RIN prices will be an important element to watch. RINs and other mitigating factors can also contribute to fluctuations in profitability, the loss of jobs and the price of B100 becoming uncompetitive with diesel, but there should be less industry instability with the tax credit in place, and production will not be capped by RFS2. Establishing RINs as the de-facto replacement for the tax credit now has another year remaining before it may be tried again.

The net cost of biodiesel to the blender (which could ultimately be passed onto the consumer) is dependent on a number of variables including unpublished wholesale customer discounts, term contract prices versus spot market differentials, the value of RINs, profit margins and marketing strategies, not to mention the $1 tax credit for the coming year. The ability to manage these variables can add to the profitability of blending; thus, the "actual cost" of biodiesel to blenders is not reflected by rack or retail prices alone.

Biodiesel Supply

The supply of biodiesel fuel to Minnesota terminals has generally been constant. Few, if any, B5 outages occurred because B100 was not available. More common reasons for blend outages were the lack of diesel fuel at terminals or the lack of winter blending equipment at some out-of-state terminals.

On November 28, 2012, Harms Oil Company of Sioux Falls, South Dakota, held their grand opening for a new biodiesel blending facility across the street from the Magellan terminal. Two 20,000 gallon underground storage tanks were installed; one is heated and can keep the B100 at 75°F throughout the winter months. When the warm biodiesel is injected into the tanker of #2 diesel, the warmth helps with the overall blending of the fuels. The availability of biodiesel at this site should provide petroleum marketers in the southwest portion of the state an additional option to comply with the statutory requirements of biodiesel sales in Minnesota.

Impact of Minnesota's Biodiesel Requirements

Production Capacity

Assuming approximately 1 billion gallons of annual state diesel fuel use[12], it is estimated that the B5 mandate requires 50 million gallons of biodiesel; the B10 mandate would require 80 million gallons and the B20 mandate would require 140 million gallons of biodiesel to meet state blending requirements.[13] The state's existing 63 million gallons of production capacity therefore provides more than the biodiesel necessary for B5, 80% for B10, and 45 percent of that required for B20. Differences in the actual rate of state diesel fuel usage and gallons of state production will increase or decrease the percentage of biodiesel available from state producers.

Minnesota's biodiesel mandate was an important incentive leading to the establishment of the state's existing biodiesel production capacity of 63 million gallons. Plans to further increase the minimum biodiesel content to B10 and B20 could therefore be an important driver of additional state biodiesel production capacity. The extension of the federal tax credit may cause producers to establish new production facilities or increase production to higher levels, but it remains to be seen how the loss of the tax credit would affect the spectrum of small to large producers. As the RIN value for biodiesel is used to reduce the cost of biodiesel to the consumer, this could bring profitability back to the biodiesel producer and restore investor confidence.

The prospect for new and increased biodiesel production capacity will also depend on developing markets and the relative price of organic fats and oils compared to diesel fuel. The EverCat Fuels biodiesel plant in Isanti, currently with 3 million gallons of production capacity, plans to expand capacity to 30 million gallons in the future. If that expansion occurs, the state

[12] Minnesota Department of Revenue, Petroleum Collections, 1/1/2012 through 12/31/2012; estimate from reports.
[13] B10 and B20 would be effective during the "summer" months of April through October; during the winter months, it is assumed that the amount of biodiesel blended with diesel would revert back to 5%.

would have at least 90 million gallons of capacity, which would provide sufficient biodiesel for a statewide B10 blend and more than 70 percent of a B20 blend. In the last two years, FUMPA Bio-Fuels in Redwood Falls ceased producing biodiesel (a loss of 3 million gallons of capacity) while the plant in Albert Lea was restarted by REG.

The RFS2 is likely to have additional impact on any increased production that occurs in Minnesota and elsewhere around the country. In September 2012, the EPA (which sets the rules for implementing the RFS2) set the mark of 1.25 billion gallons for biodiesel in 2013, 250 million higher than 2012. . Cellulosic fuels and biomass-based diesel sold in excess of RFS2 requirements will count towards the advanced biofuel and total renewable fuel volume requirements. Given that biodiesel earns 1.5 RINs per gallon, most of the advanced biofuels requirement for 2013 could be fulfilled by biodiesel. Thus, the RFS2 should prove an important driver of biodiesel production throughout the United States.

The RFS2 with the considerable value of biodiesel RINs could be a potent force to greatly expand the use of biodiesel. Finally, while the recent cost of biomass oil has been high, the world crude oil market has also proven to be very unpredictable. Some experts predicted that gasoline prices would exceed $4.00 per gallon before the summer of 2012, which means that diesel fuel would have been in excess of $4.50. In the end, it is questionable that the cost of biodiesel will remain higher than that of diesel even into the coming year.

Feedstocks

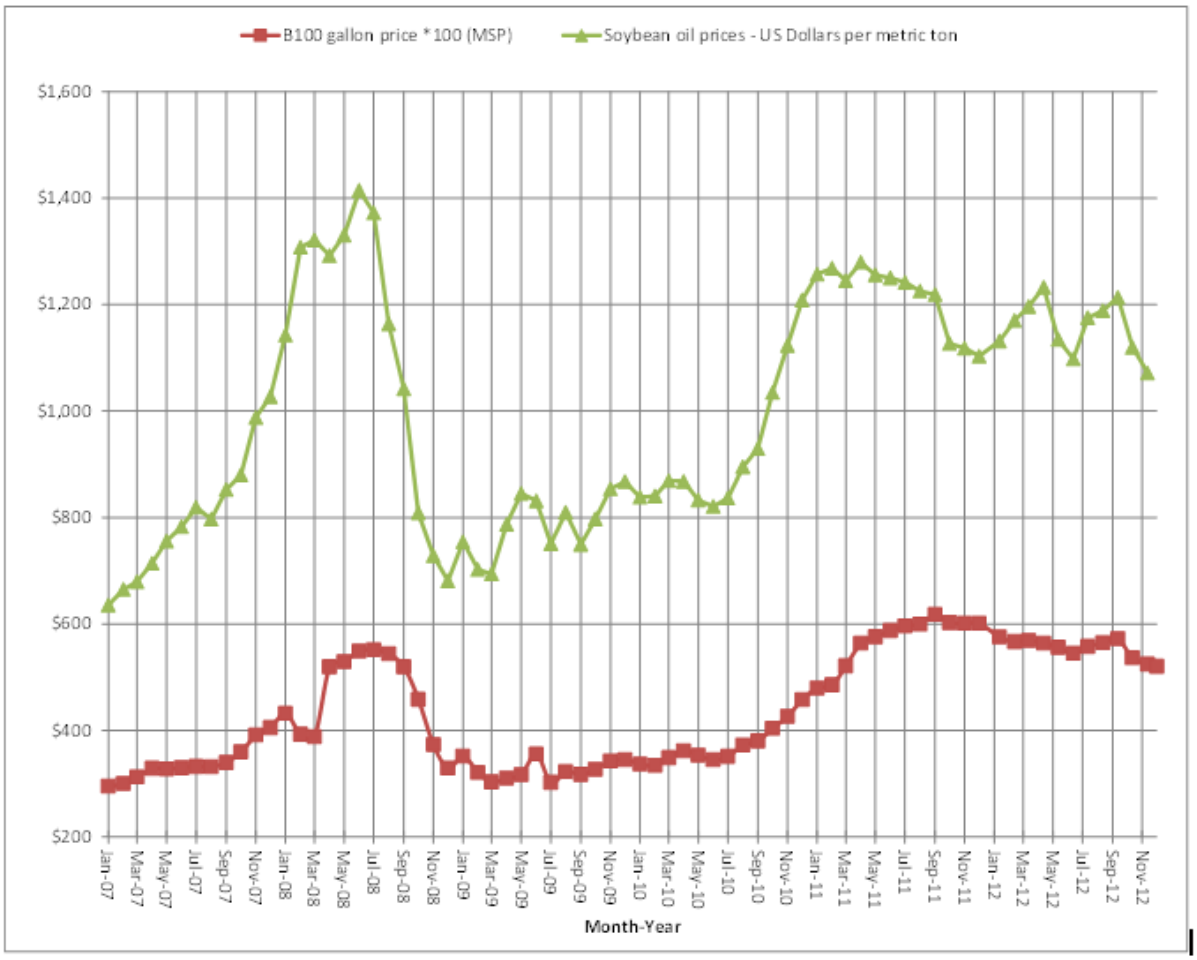
The feedstocks used at biodiesel plants are generally determined by the price and availability of various oil or fat products and the ability of plants to process the oil being considered. Minnesota Soybean Processors (MnSP) in Brewster will use oil from their own soybean crushing plant. The REG plant in Glenville has bought oil from various soybean oil producers; this past year they began a $20 million upgrade to the plant that will allow them to process lower cost fats and oils, such as inedible corn oil from ethanol plants, waste cooking oil and animal and poultry fats. The EverCat fuels plant in Isanti reportedly has the capacity to produce biodiesel out of plant and animal fat, spent cooking oil, or even fatty acid materials from various industrial sources.

Although various lipid feedstocks can be used, the large soybean oil crushing capacity in Minnesota suggests that much of the feedstock used in Minnesota's biodiesel plants can be sourced from Minnesota soybean oil producers.

The price of biodiesel continues to follow the price of soybean oil (see Figure 10). Thus, the capacity to process non-soy oils and fats when the price is advantageous further benefits a biodiesel processor when margins with other feedstock are advantageous.

Figure 11: Price of Biodiesel[14] (B100) times 100 and Soybean Oil Price per Metric Ton[15].

[14] Price of biodiesel at the rack (Minneapolis-St. Paul average)



[15] Index Mundi, http://www.indexmundi.com/commodities/?commodity=soybean-oil&months=120

The Exceptions to Using Biodiesel Blends in Minnesota

Biodiesel Exceptions Summary

Per the language added to Minnesota Statute 239.77, subdivision 5, a peripheral look at the exceptions to the biodiesel mandate has been conducted. Recommendations for further study and research needs will be included following the overview.

The exceptions to the biodiesel mandate currently include the five types of equipment listed in 239.77, subdivision 3(a)(1)-(5):

(1) motors located at an electric generating plant regulated by the Nuclear Regulatory Commission;
(2) railroad locomotives;
(3) off-road taconite and copper mining equipment and machinery;
(4) off-road logging equipment and machinery; and
(5) vessels of the United States Coast Guard and vessels subject to inspection under United States Code, title 46, section 3301, subsection (1), (9), (10), (13), or (15).

In speaking with the various industries, it appears five major factors come into play when exceptions to the mandate are requested:

1) Fuel storage issues – biodiesel can degrade more quickly than petroleum diesel when long periods of storage are required by the application.
2) Moisture – biodiesel use in high humidity locations can lead to problems with the property whereby biodiesel takes on water more readily than its petroleum counterpart.
3) Temperature – when subjected to extreme cold temperature conditions, biodiesel can raise the pour point and cold soak filtration temperatures that are indicators of filter plugging potential.
4) Vintage engines – older engines built before the age of biodiesel could have trouble with engine parts and biodiesel use, some claiming this for 5% (B5) blends as well as higher percentage blends.
5) Critical Nature of Failure – should biodiesel use result in equipment failure, the nature of such failure could be truly catastrophic.

The interviews with the various sectors produced the following results that will be detailed in the following paragraphs and are summarized in Figure 11.

Figure 11: Issues with biodiesel blends related by sector.

Issue	Sector

	Nuclear	Railroad	Mining	Logging	Lake Superior vessels
Storage	X		X		X
Cold temperatures		X	X	X	X
Moisture			X		X
Vintage Engines	X	X			X
Critical Nature of Failure	X				X

X – Interviews related that this issue applied to their sector

Nuclear

Diesel generators on site at Minnesota's two nuclear power plants are used for safety equipment. These generators supply critical functions in the event of loss of outside power at the plant, and are run on a regular schedule, yet infrequently.

Storage capacity required at the facility for these emergency generators is 7 days of fuel for continuous use at Monticello, and 14 days for Prairie Island. Because of this, fuel can end up being stored for a long time.

Four of the six engines used in Minnesota Nuclear plants have been in service for about forty years, with the other two having been in service for over 20 years.

The combination of infrequent use (yet with the necessity for long term storage of a set amount of emergency fuel supply), the need for reliability and the age of the engines comprises the industry's request for an exception from using biodiesel blends.[16]

Railroads

Diesel engines used by Minnesota railroads have the primary issue of age (locomotive engines generally 40 years old or more), and therefore concerns over compatibility of engines with biodiesel. Of the 19 railroad companies operating in Minnesota, only 5 are considered to be Class I (annual operating revenue of $378.8 million or more), with the rest being Class III (annual operating revenue of $30.3 million or less). Class III railroads use engines that can be up

[16] Email 10-2-2012 from Terry Pickens, Director, Nuclear Regulatory Policy, Xcel Energy, Minneapolis, MN.

to 50 years old. As an estimate of a more specific number, an EPA emissions study done in 1998 reported just 15% of class II and III locomotives were manufactured after 1972.[17] Although these engines are older (also referred to as "legacy"), they are still very expensive. New locomotives range from $1.4 – $2.3 million, with rebuilt locomotives being half the price of new ones. A locomotive can travel about 1 million miles before it needs to be rebuilt.

In a document supplied by John W. Gohmann, President of Minnesota Commercial Railway, a number of specific concerns are made. These include:

- Locomotive engines, running at 300-500 rpm at full throttle are not made of high grade metallurgy as smaller commercial diesels that typically run at up to 5000 rpm.
- Diesel fuel is used to lubricate push rack and push rods of most locomotive engines. There are concerns with biodiesel blend's lack of lubrication and promotion of cleansing causing premature wear and tear. Ninetyfive percent of Minnesota's locomotive engines operate using this manual mode (no electronic fuel injection), and are likely to for decades to come.
- An experience was related where 8,000 gallons of a B5 blend was delivered by mistake to the Minnesota Commercial Railway, causing 40 fuel pumps and injectors to be changed in 5 to 7 locomotives. These parts normally last 45,000 engine hours but failed in 400–700 hours, with the entire piston seizing. The total cost was around $185,000 based on $5,000 per piston, with scour from the biodiesel on the upper cylinder walls and the seating of the intake and exhaust valves needing to be polished out.
- The concern over cold weather conditions also exists since locomotives are fueled outside from aboveground tanks.[18]

Mining

Copper and taconite mining in Minnesota occurs in remote locations where equipment and fuel storage is outside all the time. All cold weather issues (gelling, filter clogging) and remote location issues (fuel storage time, fuel degradation) apply to this sector. Moisture issues pertaining to fuel storage also apply, due to possible longer fuel supply turnover.

In addition to those issues, mining cites other, unique issues to their situation:

- Upcoming EPA emissions standards Tier 3 and 4 will require fuel filter size to be even smaller, leading to further increase in filter clogging probability.
- Lower energy of biofuel (and therefore the blend) would cause more fuel usage, which are concerns for efficiency and meeting air quality standards.
- Concern for seal and hose degradation. [19]

[17] United State Environmental Protection Agency, Office of Mobile Sources, Locomotive Emissions Standards, Regulatory Support Document; April, 1998. Page 100.
[18] Gohmann, John W., President, Minnesota Commercial Railway. Biodiesel and Its Impact on Railroad Locomotives.

Logging

Logging reported that they do used B5 all year long in their logging trucks and all year long except during winter in their logging equipment.

Their concerns are with cold weather operation and fuel storage during the winter months. They have experienced the typical cold weather problems in logging equipment in winter (fuel gelling, filter clogging). They believe the problems are due to biodiesel and extreme temperatures, as the logging equipment is outside 24 hours a day/7 days a week during the freeze season. Logging locations are in remote sites where it is not possible to heat equipment or fuel tanks.[20]

Lake Superior Vessels

Lake Superior vessel's exception was a recent addition to the list of industries on the exception list, with many of their reasons for request coming from experience in using biofuel. The United States Coast Guard wrote to Attorney General Lori Swanson March 12, 2012,[21] and the Lake Carrier's Association on September 29, 2011,[22] requesting exception from the biodiesel blending mandate. Each situation will be addressed individually.

Coast Guard

The letter from the Coast Guard's Thomas Hayes references Coast Guard policy in regards to biofuels, as well as potential problems which would "jeopardize operational readiness and the Coast Guard's ability to fulfill its missions." They had recommended to Congress that "biodiesel fuel should not be used as B100, B5, B20, or any other blend for any deployable, tactical or search and rescue designated vessels," which encompasses "essentially all Coast Guard vessels."

Besides this, representatives of the Coast Guard related a unique problem they experienced with microbial growth. In a document entitled "Trip Report" dated February 28-March 4, 2011, the situation is documented where excess microbial growth was occurring due to condensation of moisture on the top of the ship's service tanks. The structure of the ship is such that different sides of the fuel tank border a range of temperatures, with the warmest side bounding the engine room (which is in the range of 96-115°F) and the outside ambient water temperature (fuel temperature being 44°F next to that side), giving an overall difference in temperature as high as 70°F. The two service fuel tanks next to each other both exhibited the same growth. These tanks have limited piping penetrations into the tank – one for filling at the top of the tank, one for suction at the bottom of the tank and one to the atmosphere for ventilation. Such temperature

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[19] Concerns with use of biodiesel fuel supplied to Assistant Commissioner of Agriculture Charlie Poster by the Iron Mining Industry, October 17, 2012.
[20] Email of 10-4-2012 from Wayne Brandt, Minnesota Timber Producers Association.
[21] Letter from Thomas Hayes, Chief, Office of Environmental and Real Property Law, United States Coast Guard, to Minnesota Attorney General Lori Swanson, March 12, 2010.
[22] Letter from James H.I. Weakley, President, Lake Carrier's Association, to Minnesota Attorney General Lori Swanson, September 29, 2011.

conditions were concluded to have a high potential for condensation of moisture from the air, and the microbial growth occurred at the interface of the fuel surface in the tank.[23] Despite the ability of these tanks to be recirculated through the fuel oil purifier, the water and microbiological growth remained excessive and impossible to mitigate.

When looking at storage tanks located in other locations of the ship where a temperature gradient did not exist, they found few signs of contamination. Before fuel is moved to the service tanks, it undergoes water stripping, leading them to conclude that the moisture in the tank was caused by condensation in this unique situation. Because they had never experienced problems previously before using the B5 blend, they concluded that the biodiesel aided in the conditions that produced the large accumulation of microbial growth. The fuel they were receiving in Minnesota was a 5% biodiesel blend with MGO (marine gas oil), not #2 diesel.[24]

As part of the conclusions in the trip report, the introduction of a biocide was listed as a remedy. In practice that is not possible with the service tank configuration in the USCGC Alder (the ship in question that harbors in Duluth). When speaking with representatives from the Coast Guard it was related that biocides can only be applied down the sounding tube. Because much of the biocide remains in the sounding tube, and the fact that there is nothing but passive circulation within the tank, the biocide is not able to work effectively on active microbial growth.[25] Coast Guard cutters also experienced similar problems with B2, though not as pronounced.[26]

Other issues included biodiesel's cleansing property when introduced to a tank that had recently not held biodiesel. This phenomenon would occur every time a cutter would leave Duluth for a period of time, being refilled with a straight hydrocarbon blend elsewhere, and then returning to Minnesota and refueling again with the biodiesel blend.

Emergency firefighting equipment required more frequent maintenance with both B2 and B5 blends. Their tanks are on the weather decks and are exposed to ambient air temperatures in an un-insulated metal canister. It was also noted that the extra maintenance time causes an increased burden for an already extended engine room staff.[27]

Lake Carrier's Association

The example of the Paul R. Tregurtha, a 1013.5 ft. long Great Lakes vessel was used to exhibit problems associated with a B5 blend of #2 diesel. #2 diesel is used to run the ships Caterpillar D399 generator sets that produce the electricity used throughout the ship for the bowthruster, lighting, etc. The ship also was using marine diesel oil (MDO) and intermediate fuel oil (IFO 280) to run the ship's two 6M43C main propulsion engines. The IFO was blended with a

[23] Trip Report, February 28 – March 11, 2011 supplied by U.S. Coast Guard regarding the United States Coast Guard Cutter (USCGC) Alder, stationed at Lake Superior, Duluth, MN.
[24] Ibid.
[25] Phone conversation with representatives of the U.S. Coast Guard – Dale Murad, Sam Alvord and Tolan Blanchard; October 12, 2012.
[26] Email of 10-22-2012 from Sam Alvord, Office of Energy Management, U.S. Coast Guard Headquarters.
[27] Ibid.

percentage of #2 diesel (which was B5) to achieve a specific viscosity target and grade of fuel. The addition of this biodiesel blend has been problematic with operational issues such as abnormal fuel purifier operation when bio-bunkers have been used.

Their story is unique in that they began using B2 at the start of the mandate in 2005 with no problems. When the mandate moved to 5% in 2009 they did begin to experience troubles. The main problems were in the generator sets that produce electricity that is used throughout the ship for the bow thruster; lighting, etc. The ship's lead engineer Rich Laksonen explained it in detail in a letter dated October 25, 2012:

> . . . we started seeing fouling of the primary fuel filters and the gumming up of fuel delivery and injection components on the engines. We also experienced a difference in the 'firing' of the ship service generators with the B5 product. The engines sounded like the fuel pump timing was off and we weren't getting a complete burn of the fuel. The sound using the B5 product was a very noticeable 'knocking.'
>
> With our deck engine for our hatch crane, we experienced difficulty in starting in cold weather. With our ship service generators, we had issues with fuel shuttle valves sticking and the engines not starting for lack of fuel pressure.[28]

The letter concludes saying that since returning to the non-biofuel products there have been no starting problems and the engines sound better. Three of the four service engines are needed to run the bowthruster which provides critical service when the ship is navigating narrow channels.

The Paul R. Tregurtha has four Caterpillar D399 engines that experienced shortened life cycles using the B5 product:

1) Fuel pumps – 16 per engine at a cost of $306 each
2) Pressure regulating valve – 16 per engine at a cost of $179 each
3) Fuel injector tips (nozzles) – 16 per engine at a cost of $55 each
4) Intake/Exhaust valves – 32 per engine at a cost of $67 each

This, in total, comes to $10,784 dollars per engine.[29]

Fueling of the ship is unlike fueling for over-the-road vehicles for both IFO and #2 diesel. Fueling requires large doses of compressed air for pressure testing and for purging fuel lines and manifolds at the end of each fuel delivery. The compressed air adds entrained moisture into the ship's bunkers at every fueling interval. Since biodiesel has a high affinity for water there is concern in the moisture category.

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[28] Letter from Rich Laksonen, M/V Paul R. Tregurtha, C/E, 10-25-2012

[29] Email fo 11-9-2012 from Ed Priem, Director, Marine Logistics and Energy Resources, Mormac Marine Group, Inc., Duluth, MN.

Cold weather considerations for Lake Carrier Association vessels play a large part in their fuel choices.

Lifesaving equipment and emergency power generation equipment is subject to ambient temperature variation and is set idle for long periods of time. As a matter of course, this equipment must be reliable or the consequences could be truly catastrophic.

LCA vessels sit idle from January 15 through March 20th, or longer, every year. During this time main engine work is performed. In the spring vessels restart and break in newly rebuilt engine components with fuel that has been sitting idle in inventory over the winter layoff. These winter main engine maintenance costs can easily exceed $250,000 per engine and $500,000 per vessel.[30]

Extending the Marine Exception

In an email from Barr Engineering's Ross Lovely, who represents Claumet LLC Superior, concerns were raised about the need to expand the exception to use of non-biodiesel blends (B0) in other marine sectors:

- Ocean-going vessels that deliver to Duluth, and have similar ships and concerns to both the marine sectors above.
- Foreign-flagged vessels including Great Lakes vessels are also subject to the biodiesel mandate as the exception is written currently (they are not subject to inspection by the Coast Guard, but also have similar ships).
- Vessels that are tasked with mobilizing in case of an emergency are currently not part of the exception from the mandate, and would like the exception for emergency situations.
- Cruise ships come through Duluth a couple times a year. Right now these vessels will not fill up in Duluth because they are not part of the exception. The exception for them is requested on the ground of public relations, as well as opening this and these other markets to the Duluth marine terminal. These ships are filling up elsewhere where they can get non-biodiesel blends, and thus costing business income to Minnesota and the Duluth region.[31]

Responses to Biodiesel Exceptions Summary from Members of the Biodiesel Task Force

Dustin Haaland, CHS, Inc.:

It would be helpful for me to understand the history behind the original exceptions. I am aware of the equipment/engine uncertainty related to (1) and (2), but is there additional information on

[30] Ibid.
[31] Email of 10-29-2012 from Ross Lovely, Environmental Scientist, Barr Engineering, Duluth, MN.

(3) and (4)? Were the original exceptions put in place due to unique fuel distribution challenges, storage, and/or equipment? Perhaps this is part of the research that needs to be conducted?

Doug Root, AURI:

My thoughts on the exemptions;

(1) Motors located at an electric generating plant regulated by the Nuclear Regulatory Commission; this exemption expires 30 days after the Nuclear Regulatory Commission has approved the use of biodiesel fuel in motors at electric generating plants under its regulation.

I do not see any benefit in changing this exemption. I believe that asking the NRC about the need for additional data might be appropriate, but that offer to provide data to the NRC should come from the National Biodiesel Board or the Minnesota Biodiesel Council.

(2) Railroad locomotives;

I believe that this exemption could be removed almost immediately. The engines involved are generally approved for use of biodiesel. The NBB has information on the use of biodiesel in railroad locomotives.

From NBB web-site; “NBB became a card-carrying member of the Locomotive Maintenance Officers Association (LMOA) and a report was prepared, “Current Status of Biodiesel in Railroads and Technical Needs Moving Forward”. It was presented at the LMOA annual meeting, and LMOA intends to publish it as an official LMOA technical paper next year. Both GE and EMD now support B5 in their locomotives, and a survey of biodiesel use in railroads identified over 3700 railroad months of successful biodiesel use—much more than had been anticipated. The report identified added work to achieve B20 acceptance as well.”

(3) Off-road taconite and copper mining equipment and machinery;

I believe that this exemption could also be removed immediately. It is important to coordinate with the mining industry, but there should be no technical limitations to the use of B10 in these vehicles.

(4) Off-road logging equipment and machinery; and

Similar to exemption (3) above. No technical reason for continuing the exemption, but a need for logging industry acceptance of biodiesel blends.

(5) Vessels of the United States Coast Guard and vessels subject to inspection under United States Code, title 46, section 3301, subsection (1), (9), (10), (13), or (15).

This exemption should be maintained until the Coast Guard is in agreement to use B5 blends (or higher amounts of biodiesel). The air quality benefits of biodiesel are much less important for boats and ships on Lake Superior. I think that the Coast Guard might be ready to adopt B10 blends as their standard of biodiesel.

Originally published Thursday, June 21, 2012 at 6:18 PM
Everett-based Coast Guard ship testing biofuel
By Doug Esser
The Associated Press
The Coast Guard's Everett-based buoy tender, Henry Blake, completed its first biofuel-propelled voyage Thursday. The Coast Guard is partnering with the Navy in research of algae-based biofuels for ships, a technology the Navy plans to demonstrate in the Rim of the Pacific military exercise that begins June 29. It fueled up Wednesday at its home port in Everett with a 50-50 blend of diesel and algae oil as the Coast Guard's first ship to test biofuel, officials said.[32]

As a practical matter, I would think that May 1, 2013 would be an ideal time to eliminate exemptions 2, 3, and 4. However, a more careful approach might target May 1, 2014. I would not eliminate these exemptions in the fall because the blended fuel may collect deposits from the vehicles fuel tanks and plug filters in cold weather. This is much less likely in warmer weather and after a summer of use the fuels systems will be cleaner and there will be less potential for problems. Exemptions 1 and 5 could be eliminated when the NRC and US Coast Guard are in agreement with the NBB. I suppose it is possible that this could happen by the spring of 2014. In a perfect world all exemptions would be ended by May 1, 2014.

Finally, I think any additional study of biodiesel to support the removal of the exemptions must be requested by the nuclear energy, railroad, mining, logging, of waterway shipping industries. AURI could do many of the studies that might be requested.

Best,

Doug Root
Agricultural Utilization Research Institute
Senior Scientist of Biomass & Renewable Products Technologies

[32] The algal-based biofuel referenced in this study is an F-76 MILSPEC drop-in diesel fuel (hydroprocessed renewable diesel, a technically identical biofuel to the petro fuel) – it is not FAME biodiesel. The U.S. Coast Guard maintains its technical findings that FAME biodiesel cannot be used in the marine environment. See U.S. Coast Guard Office of Energy Management: Energy and Fuel Matters, Vol. 3, Issue 1 – January 2013.

Chris Hill, Minnesota Soybean Growers Association (for the Minnesota Biodiesel Council and National Biodiesel Board):

On behalf of the Minnesota Biodiesel Council and National Biodiesel Board, we are pleased to provide the Minnesota Department of Agriculture with our input and comments on the draft document, "Biodiesel Exemptions Summary".

Since the implementation of the Minnesota biodiesel mandate in 2005, the biodiesel industry has undergone significant change. US biodiesel production experienced growth from 250 million gallons per year (MM gpy) in 2006 to 700 MM gpy in 2008. Industry volumes decreased to 315 MM gpy in 2010 largely due to the worldwide recession and uncertainty about the national Renewable Fuel Standard-2 (RFS2) which resulted in consolidation and closing of some lower quality, higher cost production plants. RFS2 took full effect in 2011 and the industry set new production records in 2011 at over 1.1 billion gallons per year with production in 2012 already being over 1 billion gpy.

During this same time period diesel and diesel engines underwent significant change. The EPA mandated on-road diesel sulfur reduction from 500 parts per million (ppm) maximum to 15 ppm maximum (called Ultra Low Sulfur Diesel or ULSD) beginning in 2006. The law required traditional refineries to install new equipment and process diesel differently than prior to 2006. With the advent of ULSD, EPA then required diesel engines to install exhaust aftertreatment catalyst systems, which are poisoned by sulfur, to reduce emissions from new diesel engines by over 90% vs. 2004 levels. Today's 'New Technology Diesel Engines' using 15 ppm sulfur fuel now produce tailpipe emissions levels as low or lower than natural gas or conventional gasoline while providing superior power, fuel economy and durability. Diesel engines are also about 30% more efficient in providing useful work at the wheels than natural gas or gasoline, thus providing significant reductions in climate change related CO2 emissions. The use of ultra-low sulfur biodiesel, with its superior life cycle CO2 values vs. diesel, provides even more benefit in helping to reduce climate change.

Also occurring during this time period, the biodiesel industry improved biodiesel to meet the challenges—and opportunities—that have resulted from the new Ultra Low Sulfur Diesel and the New Technology Diesel Engines. Many of the changes and improvements in biodiesel specifications and fuel quality over the last several years help to address the technical concerns

and issues that gave rise to the existing set of exemptions, as well as those raised in the comments you received in preparing the 'Biodiesel Exemption Summary'. Others are actively being worked on by the biodiesel industry.

Directly below is a summary of the continuous improvement activity in the biodiesel industry over the past several years, and the various concerns related to the exemptions it addresses. Afterward is a summary of the current state of the biodiesel industry efforts to address the questions and needs of various exempted applications.

ASTM Specifications - There have been several improvements in ASTM biodiesel specifications since the mandate began in Minnesota.

2006 - Measurements for calcium, magnesium, sodium, and potassium were added to the ASTM D6751 B100 blend stock specification to help ensure proper long term operation of new diesel after-treatment catalyst systems.

2007 - A stability parameter was added to D6751 to provide minimum 6 month storage stability for B20 and lower blends.

2008 - After seeing some un-expected filter clogging with some of the new ULSD/biodiesel blends, the ASTM specification was further improved to add a measurement (cold soak filtration time, 360 seconds maximum year-round, 200 seconds maximum in cold weather) designed to control the minor compounds in biodiesel largely responsible for filter clogging above the cloud point of the biodiesel blend at the time.

2008 - ASTM approved finished blended fuel specifications of B5 and lower blends under the traditional diesel specification, ASTM D975, the traditional heating oil specification ASTM D396 and B6 to B20 blends under a new specification, ASTM D7467. Those specifications remain in effect today.

2012 - The biodiesel industry improved the specification by creating a voluntary grade of biodiesel in D6751 to further address some rare instances of un-expected filter clogging—primarily with some No. 1 diesel: A No. 1-B B100 grade. The previous specification values became the No. 2-B grade without change. The No. 1-B B100 grade is designed to provide even tighter controls than CSFT on biodiesel minor components for those rare cases where the biodiesel blend showed un-expected filter clogging above the cloud point of the blend. The No. 1-B grade contains all the same parameters as the previous specification, and simply adds a new specification for total monoglycerides of 0.40 mass % maximum and requires a year-round cold soak filtration value of 200 seconds maximum. Significant work is on-going in this area to provide additional data on the phenomenon and investigate improvements or advise to customers.

Quality - Also during this time period, the biodiesel industry lead efforts to help ensure the fuel being sold into the market meets ASTM specifications. The BQ-9000 program is a combination of an ISO 9000-like quality assurance program along with a requirement to meet D6751 and

physically analyze each lot of biodiesel prior to sale. According to the National Biodiesel Board, over 80% of the biodiesel produced in the US is made by a BQ-9000 producer and nation-wide reported biodiesel quality issues have been minimal over the last 2 years. ASTM D6751 has now been adopted as the legally enforceable specification in 48 of the 50 states and the industry encourages state fuel quality regulators to actively enforce the biodiesel specifications.

With this as background, we provide the following comments for consideration on the draft Biodiesel Exemptions Summary and stand ready to work with the Department and others in the state moving forward.

1) **Fuel Storage Issues** - The concern stated that biodiesel degrades more quickly than petroleum diesel when long periods of storage are required by the application. As stated above, a stability parameter was added to D6751 (B100) in 2007. This parameter was based on lack of sediment formation and other degradation to provide a minimum storage of 6 months for B20 and lower blends. In the testing conducted to support the specification, most of the fuels actually showed lack of degradation or deterioration for a predicted minimum of 12 months using ASTM D4625 long term storage stability test.[33] This testing also showed that use of stability enhancing additives is extremely effective, so if longer stability is desired this can be achieved through the use of relatively inexpensive additives. While most of the biodiesel blends showed predicted stability for a minimum of a year, the biodiesel industry currently recommends a 6 month storage life for biodiesel blends. Most of the fuel in the commercial market is used before 6 months, but if biodiesel blends are to be stored for longer than 6 months, monitoring of acid number and stability over time is recommended. If the acid number has not increased to the point of being out of specification, the fuel has not degraded to the point of being problematic, and further inclusion of stability additives can be used to increase the stability of aged fuel if needed. The success of these practices is evident through the lack of stability related field issues over the last two years in the US at a time when biodiesel production reached record highs. It is interesting to note that biodiesel stability is actually controlled more than petrodiesel, as there is currently no stability specification in D975 or D396 petrodiesel, where the B100 blend stock (D6751) and B6 to B20 blends (D7467) both contain stability specification parameters.

   We also believe it is important to understand that conventional petrodiesel specifications are not designed for and do not necessarily protect applications that involve 'long term storage' applications. While many not fully appreciate this fact, additional precautions—similar to those recommended by the biodiesel industry for long term biodiesel storage—are also referenced in the ASTM standard for petrodiesel. To quote the ASTM D975 standard[34] for petrodiesel:

[33] ASTM Stability Biodiesel Ballots, 2006 and 2007, ASTM International.
[34] ASTM D975, Appendix X3. Storage and Thermal Stability of Diesel Fuels, ASTM International.

“Consistently successful long-term fuel storage or use in severe applications requires attention to fuel selection, storage conditions, handling and monitoring of properties during storage and prior to use.”

“Normally produced fuels have adequate stability properties to withstand normal storage and use without the formation of troublesome amounts of insoluble degradation products. Fuels that are to be stored for prolonged periods or used in severe applications should be selected to avoid formation of sediments or gums, which can overload filters or plug injectors. Selection of these fuels should result from supplier user discussions.”

“Certain distilled refinery products are generally more suitable for long-term storage and severe service than others. The stability properties of middle distillates are highly dependent on the crude oil sources, severity of processing, use of additives and whether additional refinery treatment has been carried out.”

“The composition and stability properties of middle distillate fuels produced at specific refineries can be different. Any special requirements of the user, such as long-term storage or severe service, should be discussed with the supplier.”

The D975 appendix goes on further to define ‘long term storage’:

“long-term storage—storage of fuel for longer than12 months after it is received by the user.”

Thus, it is common for petrodiesel used in these applications to undergo special sampling and fuel quality practices to help insure trouble-free operation and it does not seem unreasonable that biodiesel blends would require precautions as well if stored for long periods. Indeed, the precautions for long term storage of biodiesel blends (monitor acid number, stability) are perhaps more understood than those for ULSD.

Two of the currently exempted biodiesel blend categories, Nuclear and Tactical Military Vessels on Lake Superior, already contain additional specific requirements for petrodiesel above and beyond that contained in ASTM D975. Since these are both low volume applications for biodiesel, the biodiesel industry has not yet invested resources to work with two applications to determine if the current practices to insure long term storage of petrodiesel are sufficient for biodiesel blends or whether additional, specific guidance is needed for biodiesel blends. We believe these issues are well within the technical capability of being addressed to the satisfaction of the users of fuel in these applications if the proper resources are applied. The biodiesel industry is currently planning effort to address these needs, as is outlined later, however we believe the need for further work in this area puts both of those applications in the category of continued exemption—at least for the time being.

***Based on the stability specifications in place now for B100 and the improvements in fuel specifications and fuel quality since the installation of biodiesel use in Minnesota, we

see no technical reason why the storage is a bigger barrier to biodiesel blend use for the mining industry than for others in the state and we do not believe there is a technical basis for the continued exemption of biodiesel use by the mining industry on the grounds of storage.

2) **Moisture** - Several comments and issues were surrounding the premise that biodiesel may take on more water than petrodiesel. Since very few areas of the US are zero humidity, moisture present in the ambient air coming in contact with fuel—whether petrodiesel, a biodiesel blend, or gasoline—can make its way into any fuel. Moisture can continue to accumulate in the fuel until the fuel reaches its water saturation point, when any additional moisture added to the fuel will no longer stay in suspension but will fall the bottom of the tank. While the natural saturation level of pure biodiesel (approximately 1000-2000 ppm) is higher than that of petrodiesel (100 to 300 ppm). B5 has the same saturation level as petrodiesel and requires no special handling or housekeeping.

   To protect any fuel from excess moisture, good tank housekeeping practices for storing petroleum diesel, biodiesel, and biodiesel blends should be followed. This includes routinely monitoring for water, keeping caps and covers securely fastened, and monitoring the quality of fuel entering the tank. These tank housekeeping practices will ensure minimal water issues with consumers using either petroleum diesel, biodiesel, or biodiesel blends

3) **Temperature** - Another question raised was that of cold weather operability. The cold weather performance of B5 and lower blends has been well documented throughout the use of biodiesel in Minnesota. There were several issues of un-expected filter clogging experienced with biodiesel blends in Minnesota and other locations in the US as the industry learned more about ULSD and as the industry put increased focus on fuel quality and meeting the ASTM specifications. Most of the examples of un-expected filter clogging can be attributed to the use of out of specification biodiesel or use of biodiesel produced prior to the implementation of the new cold soak filtration test into the specification and more recently the use of No. 1-B biodiesel for blending. In addition, biodiesel companies and petroleum blenders have become more familiar with their own individual needs for blending and cold flow control for biodiesel blends in a similar way as they have become adept at dealing with the cold flow issues of No. 2 petrodiesel over the years. Most of the blenders who believe they need a No. 1-B type of biodiesel for blending in Minnesota already adopted this specification—or the blending of kerosene, use of ever improving cold flow additives, or heated tanks/storage—and these practices have reduced un-expected filter clogging issues with B5 and lower blends to similar levels that are experienced with petrodiesel alone.

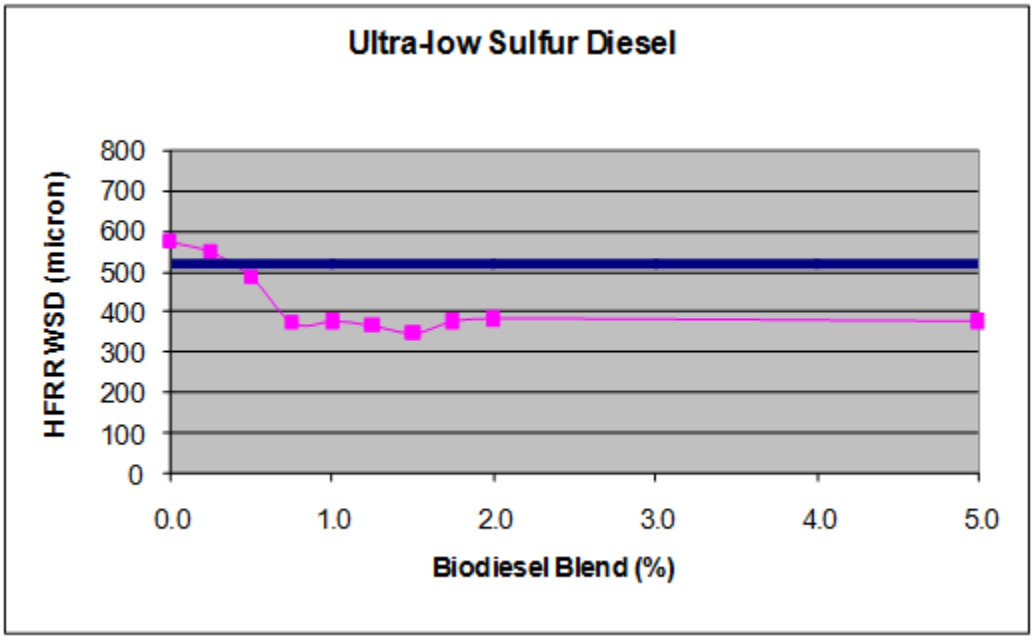
   ***Based on the improvements in the biodiesel specifications, an increased understanding by both the biodiesel producers and petrodiesel blenders on how to successfully manage cold weather operation with B5 and lower blends and the success of

B5 use in other applications in the state we do not believe there is a technical basis for continued exemption for the currently exempted industries on the basis of cold flow performance.

4) **Vintage Engines** – There was a suggestion that engines built before the biodiesel era could have problems with biodiesel at the B5 level and higher. Specifically, questions were raised by the railroad industry regarding use of different metallurgy, the lubricity of biodiesel, and impact on seals and elastomers in older engines when using B5. In comments from the Minnesota Commercial Railway, its president Mr. John Gohmann, commented, "Experience, as well as biochemical engineering, has proven that even when a slight amount of the biodiesel is introduced into the locomotive fuel, this ingredient, which is a form of an alcohol base, significantly to totally eliminates the lubricating qualities of the diesel fuel." On the contrary, the superior lubricity of biodiesel—in low blends with petrodiesel, especially ULSD—has been well documented. The lack of technical understanding and the mere fact this statement is being utilized as a major reason for continuing the railroad exemption by Mr. Gohmann brings into serious question the technical credibility of his comments.

   Biodiesel blended with petroleum diesel fuel offers distinct chemical and physical properties which enhance the lubricity of the fuel blend. The chemical properties of biodiesel being an ester (not an alcohol) allows it to increase lubricity of a fuel blend. Lubricity is measured by the High Frequency Reciprocating Rig (HFRR) apparatus. Within ASTM D975 and D7467, lubricity measurement is conducted by ASTM D6079, "Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR)". To evaluate lubricity a wear scar is measured from the exposure of the test fuel within the apparatus and contact between a metallic substrate. Limits within both D975 and D7467 allow a maximum wear scar of 520 micron maximum. The chart below shows HFRR evaluation with biodiesel blended with petroleum diesel fuel.

HFRR wear scar reduction with biodiesel addition



In the above chart, showing analysis conducted by Southwest Research Institute, the blue line represents the ASTM wear scar limit of 520 microns. The pink line represents dosing of an ULSD sample with incremental small amounts of biodiesel. As the data shows, just the addition of one percent (1%) biodiesel lowered the wear scar to 380 microns which represents a sixty six percent (66%) increase in lubricity over the base ULSD. The data in the chart also reflects there is no penalty for "over-dosing" as the lubricity benefit of additional biodiesel levels out and does decrease. This data—as well as significant amounts of other data not shown here, shows conclusively that biodiesel increases the lubricity of the blend and any claims to the contrary are simply not factual.

Regarding the potential metallurgy issue with various grades of steel used for older diesel engines, the viscosity specifications for finished biodiesel blends of B20 and lower are the same as those of conventional petrodiesel, and the lubricity has been demonstrated to be higher than that of most petrodiesel. In addition, the Steel Tank Institute has reported—through testing performed by Southwest Research Institute, that biodiesel and biodiesel blends are compatible with both carbon and stainless steel.[35] This testing was done with both 1500 ppm and with 15 ppm sulfur diesel fuel. Based on this data, there are no expected issues regarding metallurgy of various steel type engine components regardless of the age of the engine.

A significant amount of technical information has been amassed regarding the compatibility of pure biodiesel and biodiesel blends with the seals and elastomers used diesel fuel systems. None of this information has indicated potential issues with B5 and

[35] Steel Tank Institute Study, getting reference.

lower blends. A good example of this work was the report prepared by the National Renewable Energy Laboratory and Southwest Research Institute[36]:

"Six elastomers (N1059, N674, N0497, V747, and V884) commonly used in automotive applications were tested with the following fuels:

- Certification diesel fuel
- Certification diesel fuel blended with 15% ethanol
- Certification diesel fuel blended with 20% soy-derived biodiesel.

The elastomers were examined for thickness, diameter, and break load both before and after soaking in these fuels for 500 hours at 40°C. Additionally, a control set was exposed to dry air only for the same length of time.

The results indicate that all of these elastomers appear to be fully compatible with 20% biodiesel blends."

Based on this and other biodiesel materials compatibility work, support of B5 by all major OEM's, and the lack of elastomer issues with B5 in the market thus far in both the US in Europe over the last 20 years, we believe the issues with B5 and lower blends with elastomers—even in older systems—have already been adequately addressed.

***Based on the technical information above—and the positive experience with B5 in the Minnesota market by non-exempt applications, we do not believe there is a sound technical basis for continuance of the exemption of the use of biodiesel in Minnesota by the railroad industry.

Chris Hill, Minnesota Soybean Growers (for M.E.G. Corporation)

December 20, 2012

Report on use of Biodiesel in Railroad and Surface Mining Industries

by MEG Corp

RAILROADS

A. Northern cold climate states

1) The Twin City and Western Railroad Company – **Contacted by phone**

- Minnesota Prairie Line started using biodiesel in October 2004.
- Biodiesel has been used throughout their entire fleet
    - 3 EMD and 9 CAT powered locomotives
- Biodiesel is utilized whenever it is a better price than petroleum diesel.

[36] Technical Report NREL/TP-540-38834, November 2005.

- The TC&WRC has used biodiesel in winter.
    - Blend of No.1 and No.2 in winter for all their diesel fuel. •
- They have not had any fuel related problems that were caused by biodiesel.
- In 2011 they used 800,000 gallons of B5.

2) Burlington Northern Santa Fe Railway – **Reviewed a study and contacted by phone**

- BNSF took part in a study on a GE switch engine in Montana. The study was conducted by Montana State Northern University.
- Used B20 made from canola, camellina and mustard seed oil from a local biodiesel producer.
- Hauled the B100 to the rail yard and used a mixing tank from which the locomotives were refueled. The University doesn't think the engines were ever shut off and they had heated fuel tanks.
- The engine reported no cold weather or fuel-related problems.
- The injectors were pulled and inspected by GE four times over the year. They found no problems.
- BNSF does not want any published info released on this test.
- Montana State is trying to put together a test of B100 in a rail line from Montana to Seattle in the near future if the BNSF corporate office will approve it.

3) Canadian and Pacific - **Internet Search**

- C&P tested B5 from November 2009 to March 2010.
- The primary focus of the study was to assess the feasibility of using up to a B5 blend in freight locomotives operating in cold weather service.
- Four GE AC4400CW diesel-electric locomotives were held in captive service on the CP mainline between Calgary and Edmonton for this period.
- ULSD was splash blended with soy-based biodiesel to produce the resulting B5.
- Fuel quality was ensured through independent third party testing.
- All fueling was performed by way of direct truck-to-locomotive fueling.
- Mechanical assessments were performed prior to and after the test period to determine impacts on locomotive engine performance and components.
- The project successfully demonstrated the viability of B5 biodiesel use in cold weather freight rail service. Despite temperatures below -40F, CP experienced no temperature-related interruption of service.
- GE's engine inspections further demonstrated no negative mechanical effects from the use of B5 biodiesel.
- Following the completion of the demonstration project, GE approved the use of up to B5 biodiesel in their family of locomotives powered by FDL and Evolution engines. This approval requires that the biodiesel blend be compliant with ASTM D975-09a and the B100 blend stock be compliant with ASTM D6751-09.
- **CP Biodiesel Demonstration Report Link** http://www.cpr.ca/en/in-your-community/environment/Documents/CP-Biodiesel-Demonstration-Final-Report-June-2010.pdf

4) Bartlet Grain Company in St. Joseph MO – **Internet Research**

- Ran biodiesel in 1990's.
- Conducted a test for a couple of years.
- Ran about B10 with no problems except in winter.

5) Eastern Washington Gateway RR – **Contacted by phone**
   - Ran B25 from a local biodiesel plant in a 3600 HP EMD in warm weather with no problems.

6) US Navy: Crane Naval Base, IN – **Contacted by phone**
   - Eight older locomotives from the 1940s; some have been refurbished.
   - Have been using B20 in everything on base except stationary gensets since 2006.
   - Have not had any problems, but they do keep the older locomotives that have not been refurbished running continuously in the coldest weather.

7) U S Steel in Gary, IN – **Internet research**
   - They have tested B5 and B10 in switch engines.

8) Iowa Interstate Railroad – **Internet research**
   - IAIS also has begun to test bio-diesel.
   - The regional is working with a Renewable Energy Group plant in Newton, Iowa, to test the blended fuel in one unit at a Council Bluffs, Iowa, yard.
   - The tests, which began in June, call for measuring wear and tear on movable engine parts, horsepower ratings and emissions.

9) BNSF and UP in Illinois – **Contacted by phone**
   - Take advantage of cost savings – buy B11 and blend down to B5
   - MEG helped UP this past summer. Tanks had water problem..

B. Southern railroads that used high blends

1) Norfolk Southern Railway – **Contacted by phone**
   - They are using B20 in a train from Meridian, MI to New Orleans, LA.
   - They have tested both methyl ester biodiesel and Fisher Tropsch diesel made from animal byproducts under agreement with Tyson Foods.

2) Florida Tri-Rail – **Contacted by phone**
   - Began using biodiesel in 2008.
   - Used B99 palm and soy biodiesel.
   - Implied they may use some lower blends dependent on availability.
   - Did emission and power tests at SWRI, tested hoses and o-rings in B99. (Note: even really old EMDs did not have any rubber in their fuel systems.)

3) Sierra Railroad Corporation in CA – **Contacted by phone**
   - Conducted a one year test on a GE locomotive had no problems with B100.

4) San Francisco Bay L B Railroad – **Contacted by phone**
   - They have been using B50 for 3 years in their two Alco six cylinder locomotives with no problems. These are very old locomotives from the 1940s.

5) 5. Eastman Chemical Company yard in Kingsport TN – **Internet research**
   - They have been using B20 in summer and B10 in winter since 2007 in their switching locomotives.

C. Other related use of high blends

1) ADM did a year-long study on river boats with EMD engines - **Contacted by phone**
   - These are the same engines as used in railroad locomotives.
   - Ran one engine on B20 and other on petrol diesel.
   - No difference and no problems.
2) Testing of a genset combined with wind farm in MN – **Kelly Strebig conducted study**
   - Testing was done to produce continuous renewable electricity over a two year test period.
   - Two genset powered by a CAT 3516 engine was run on B100.
   - After the demonstration one cylinder was torn down and inspected.
   - No difference could be found as compared to other 35 series engines run on petro diesel.
   - The 3516 engines are also used in railroad locomotives
3) Southwest Research– **Internet research**
   - SWRI found a reduction in power of only 0.7 percent with B20 on a locomotive they tested.
   - The power reduction with B5 would be so small it would have miniscule effect on locomotive performance.

MINING

1) North American Coal Corp in ND - **Contacted by phone**
   - They used over a million gallons of B10 at the Freedom Mine in the spring to fall of 2006. B10 went into all their diesel engines. They had no problems but were afraid to use in winter. Do not currently use it because of difficulty getting biodiesel in ND and high cost.
2) U S Steel's two taconite mines in MN - **Contacted by phone**
   - Use B5 periodically.
   - Could not find out why or how much they use.
3) Martin Marietta in Iowa - **Contacted by phone**
   - Have used biodiesel in their 40 plus surface operation mines when biodiesel is cheaper than petro diesel.
4) Kelly Strebig spoke to someone at an unnamed western mining company that has a portal entry mine at elevation.
   - The diesel equipment comes out every day for service and refueling and remains outside overnight.
   - The fuel tank is outside and they use up to B50 in summer and B20 in winter made with winter blend and additives to get a CFPP of -20F.
   - Most of their engines are 150 to 300 HP.
   - They experience ambient temperatures down to -20 F.
5) It appears that some western surface mines have been sold B5 by their fuel distributor when it is cheaper than straight diesel without telling the mine because B5 meets the ASTM spec for number 2. No documentation of this, only verbal.

6) Most underground non-coal mines use various biodiesel blends to meet the diesel emission standards for underground mines. They use high blends, B25 to B99. No one in the mining industry has mentioned any problems even with high blends.

7) In April of 2005 Kelly contacted four MN taconite mines and asked what they thought of biodiesel: He found:

- Two mines didn't even know what biodiesel was.
- One mine had concerns:
  - Fuel cannot deteriorate their equipment or increase maintenance costs.
  - Cannot increase operating cost
  - Cannot decrease power
  - Concerned about storage, stratification or contamination or gel point. If these issues were addressed he doesn't see where they would have an issue with using biodiesel.
- Another mine said their concerns would be:
  - Engine compatibility and warranty
  - Cold weather operability
  - Cost: cost is the biggest thing, they use over 25 million gallons of diesel per year
- There are currently six operating taconite mines in MN and only one uses rail haulage- Northshore Mining

Appendix A: Minnesota Biodiesel Task Force Member Comments

There were no comments from the task force for the final report.