Vermont Biodiesel Report:

A Plan To Increase The Use Of Biodiesel In Vermont

Prepared for the

Vermont Department of Public Service

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NOTICE

This report does not necessarily represent final Vermont Department of Public Service decisions or positions. It is intended to present technical analysis of issues using data that are currently available. This draft report is to be reviewed and discussed at an upcoming public meeting in August 2009, before the final report is issued.

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Purpose

This report was prepared by Vermont Department of Public Service, pursuant to Act 92, section 34, which states:

On or before January 15, 2009, the department of buildings and general services, department of public service, and agency of transportation jointly shall submit a report to the house and senate committees on institutions, the house and senate committees on natural resources and energy, the house and senate committees on transportation, the house and senate committees on agriculture, the house committee on commerce, the house committee on ways and means, and the senate committee on finance with recommendations on increasing the use of biodiesel blends in state office buildings, state garages, and in the state transportation fleet.

The portion of the report prepared by the department of public service shall contain:
(A) A summary of the biodiesel fuel production capacity, storage facilities, and distribution facilities currently available in Vermont.
(B) Recommendations for increasing biodiesel fuel production, storage facilities, and distribution facilities.
(C) A summary of current information on the performance of biodiesel blends for use as heating fuel and as a motor vehicle fuel.
(D) A summary of the national and regional quality assurance and quality control measures in use for blending biodiesel fuel.
(E) A proposed work plan to increase biodiesel use.

Executive Summary

Biodiesel is a renewable fuel derived from virgin oilseeds or from reclaimed vegetable oil or animal fat. Numerous studies have concluded that biodiesel produces less atmospheric pollutants and has a 'low carbon intensity", compared to petrodiesel, which means lower greenhouse gas emissions at the point of combustion and on a full life cycle basis. Neat (pure) biodiesel contains no petroleum but it blends easily with distillate petroleum products (like No. 2 heating oil, diesel, and kerosene) thus biodiesel can be added to or replace these products for heating or transportation. Biodiesel blends are concentrations of biodiesel between 2 percent and 99 percent (called "B2" to "B99", with the number following the "B" indicating the percentage of biodiesel in a gallon of fuel, where the remainder of the gallon is petrodiesel).

The use of biodiesel as a fuel additive in transportation and heating fuels is well established in Vermont, although Biodiesel made from oilseed crops and used vegetable oil is being produced on farms and businesses in Vermont and at a commercial scale. The reduced pollution and greenhouse gas emissions from biodiesel (compared to using petrodiesel) are well documented and where it is available, biodiesel blends are typically only a few cents to ten cents more per gallon than their petrodiesel equivalent. And yet, for all the advantages of using this high performance, low emission renewable fuel, total biodiesel consumption is less than 3 percent of the state's annual distillate fuel use. There are still many parts of the state where it is unavailable and Vermont's population remains

relatively uninformed as to the benefits of using biodiesel blends in equipment designed to run on diesel or heating oil.

This report looks at the issues surrounding biodiesel production and use and makes the following recommendations to increase the use of biodiesel in Vermont:

1. Convene a *Vermont Biofuels Development Committee* as a subcommittee of the Vermont 25 x '25 Initiative. In the course of preparing this report, a number of issues surfaced to indicate that a stakeholder task force should review current opportunities and prepare a workplan that has industry and state government involvement and present a plan to the legislature to substantially increase the use of biodiesel in Vermont.
2. Strengthen the *Request for Proposals* for the state fuel contracts to expand the use of biodiesel and bioheat.
3. Continue to work with other states in the region on developing a *Low Carbon Fuel Standard* framework for the region that includes biodiesel as part of that framework.
4. Pursue opportunities to support the construction of an in-state biodiesel blending facility, through tax credits, loan guarantees, grants, etc.
5. When economic conditions allow, revisit the viability of offering biodiesel incentives, such as the rebates and fuel tax reductions proposed by Governor Douglas, and introduced in the Vermont Legislature in 2007.

Biodiesel sales to commercial and institutional customers began in Vermont in 2004 and by the end of 2008, 18 fuel dealers were selling biodiesel in Vermont. The amount of biodiesel blends consumed in the state has been rising, from 275,000 gallons in 2005 to approximately 5,618,000 gallons in 2008. In 2008 the amount of biodiesel *blends* consumed represented approximately 3 percent of Vermont's total distillate fuel sales (diesel, kerosene and heating oil).

Because biodiesel blends range from B2 to B40 or more, a convenient way to gauge the environmental impacts of using biodiesel is to calculate the portion of *pure* biodiesel (B100) consumed, and in 2008 - 480,000 gallons of pure biodiesel were sold. Calculations based on U.S. Department of Energy studies therefore, indicate that in 2008 Vermont's biodiesel customers avoided emitting over 3,800 tons of CO_2 (if they had instead been using only fossil fuels) and 1,417 barrels of crude oil were replaced with a renewable low-emission fuel.

The use of biodiesel in the State's fleets and facilities is counted in the above statistics but it is also worth noting that in 2008, biodiesel blends made up 18 percent of the fleet fuel purchased by the Vermont Agency of Transportation. Although the blend purchased by Vermont Buildings and General Services was higher (B20 compared to an average B5 at AOT), biodiesel blends accounted for $1/10^{th}$ of 1 percent of BGS fuel purchased in 2008.

Currently, most biodiesel sold in the state is delivered pre-blended by transport loads from supply points in Albany (NY), and Montreal (Quebec). Most of the 18 fuel dealers carrying biodiesel store the blended product in bulk tanks for distribution to their customers. A few of them store heated biodiesel (B100) and "splash blend" it with diesel or No. 2 oil to achieve a B5 to B20 blend prior to delivery.

Biocardel Vermont, LLC is the only commercial producer in Vermont that meets the ASTM fuel spec and is moving to secure BQ-9000 accreditation (these fuel specifications and quality control measures are covered later in this report), thus a high quality fuel spec is assured from Vermont's largest commercial manufacturer. Their facility in Swanton is just coming on-line and the company projects 2009 production of 1/2 to 3/4 million gallons of SME (soy methyl esters, aka biodiesel), with four million gallons per year production capacity. Since Biocardel is producing pure biodiesel, it typically must be blended with No. 2 heating oil or diesel, and currently there is no proper blending terminal to accommodate this. One or more Vermont fuel suppliers are considering the infrastructure needed to establish in-state blending of biodiesel.

On average, a federal excise tax credit for biodiesel makes B5; $0.05 less, B20;$0.20 less, B100;$1.00 less, etc., than it would be without the tax incentive. The credit has indisputably driven market demand for biodiesel fuel products. However, the price of B20 for *heating or transportation* in Vermont has historically been ~ $0.20 per gallon higher and B5 has cost the same as, or a few cents per gallon more than, the comparable distillate product.

A significant number of government and peer reviewed studies have been conducted on the use and environmental impacts of pure biodiesel and biodiesel blends as a transportation fuel[1]. On average, a 20 percent blend of biodiesel (B20) will reduce tailpipe emissions of CO_2, PM (particulate matter or "soot"), sulfur and all regulated pollutants between 12 percent and 20 percent, compared to petrodiesel, with the exception of NOx.

A 2002 U.S. EPA report[2] indicated that B20 causes a 2 percent increase in NOx emissions. The engine dynamometer studies cited by EPA found that the tailpipe emissions from B100 could increase NOx by 10%. However, a more recent 2006 study conducted by the U.S. Dept. of Energy at the National Renewable Energy Laboratory (NREL) compared a variety of heavy-duty diesel equipment using B20 and petrodiesel in conditions that more closely resembled real world circumstances (i.e., dynamometer testing of the entire vehicle under load, not just the engine), and concluded, "…B20 has no net impact on NOx (tail pipe emissions)."[3] There has been no update on NOx and B100 since the EPA's 2002 report.

Performance issues associated with biodiesel or bioheat use are most evident in cold weather. *The proper blending, storage and use of biodiesel is critical during Vermont winters.* Even so, after research that took place at two Vermont oilheat labs and in over 200 homes using B20 during the 2006-2007 heating season, participating fuel dealers reported, "…B20 performed as well as No.2 fuel oil in a heating application". The same strategies and precautions that are used to maintain performance of diesel and heating oil in sub-freezing temperatures are also effective with biodiesel blends.

Questions often arise concerning warranties and the use of biodiesel in new equipment. Most engine and vehicle manufacturers approve the use of B5 fuel in their equipment, provided the biodiesel meets ASTM spec D6751 and/or the European biodiesel specification. Some OEM's (Original Equipment Manufacturers) also approve blends of B20.

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[1] See National Biodiesel Board, Reports Database: http://www.biodiesel.org/resources/reportsdatabase/

[2] Source: U.S. Environmental Protection Agency; A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions, EPA420-P-02-001. October 2002. nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1001ZA0.txt

[3] Source: Effects of Biodiesel Blends on Vehicle Emissions, by McCormick, R.L. et al. October 2006. http://www.nrel.gov/vehiclesandfuels/npbf/pubs_biodiesel.html

In July 2008, a new ASTM specification for fuel oils was passed to include requirements for up to 5 percent biodiesel. This revision paved the way for all oilheat appliances receiving UL (Underwriters Laboratory) approval, to use up to a B5 blend.

The widespread industry acceptance of a 5 percent biodiesel blend in heating and transportation applications and a variety of forces at work on fuel and energy markets has led to policies that favor increased biodiesel use in the nation and the region. Vermont is therefore poised to see improvements to its supply and distribution infrastructure in the near future. The following report outlines the current situation and emerging trends that are influencing this trajectory.

Overview Of Biodiesel Production, Storage, Distribution, And Use In Vermont

Vermont Biodiesel Consumption

At the end of 2008 there were approximately 18 fuel dealers selling biodiesel in Vermont. The total gallons of pure biodiesel and biodiesel blends sold in Vermont have gone from 275,000 gallons in 2005 to an estimated 5,632,000 gallons in 2008[4]. Of this amount, about 78 percent was consumed as heating fuel and about 22 percent was used in transportation. Because biodiesel blends range from B2 to B40 or more, by calculating the portion of pure biodiesel (B100) within the total amount of biodiesel blends sold, one can get a more accurate picture of the growth of biodiesel use in the state. For instance, during the period from 2005-2008 the amount of petroleum distillate that was replaced with B100 jumped from about 78,000 to 480,000 gallons. Another way of analyzing the impact of Vermont's biodiesel consumption is that in 2008, 1,417 barrels of crude oil were replaced with renewable low-emission fuel, thus Vermont's biodiesel customers avoided emitting over 3,800 tons of CO_2 (if they had instead been using only fossil fuels).

Table 1.

VT Biofuels Development 2002-2008

The Growth of Biodiesel Consumption and Production in Vermont

	2002	2003	2004	2005	2006	2007 approx	2008 approx
B100 Gallons Consumed	550	9,000	41,000	54,000	364,000	378,000	392,000
B100 Gallons Produced	550	5,000	9,000	20,000	43,000	61,700	76,000
B100 Gallons Production Capacity	1,000	6,000	12,000	50,000	138,000	140,000	4.48* mill.
Total Biodiesel Consumed		9,000	55,000	275,000	1.4 mill.	4.9 mill.	5.6 mill.

*Biocardel has 4 mmgy B100 capacity

[4] Source: VT Fuel Dealers surveyed by VBA and VSJF 2003-2008

In 2004, the Vermont Agency of Transportation garage in Berlin began using a 20 percent blend (B20) of biodiesel in several of their trucks. By the end of FY '06, VTrans had switched to using a 5 percent blend (B5, to prevent exposure to warranty related issues and improve cold weather performance) but their total consumption increased to almost 220,000 gallons by FY'08. This represents 18 percent of the Agency's total FY'08 bulk diesel purchase of 1.233M gallons (the pure biodiesel portion was 11,000 gallons).

The state office building in Brattleboro began heating with B20 in 2004. In FY'08 the Brattleboro facility used 6,000 of B20 biodiesel. This represents 3/10 of 1 percent of total BGS heating fuel purchase of ~2.175M gallons (the pure biodiesel portion was 1,200 gallons.)

Biodiesel Production, Storage & Distribution

Although there are several farms and a few micro-processors making biodiesel in Vermont, the sole producer of ASTM spec biodiesel in the state is Biocardel Vermont, LLC. The company, which began production in early 2009, is projecting first year production of 1/2 to 3/4 million gallons of SME[5] (soy methyl esters, aka biodiesel). The fuel will be sold by transport load (7,500 gallons +/-) from their Swanton plant in its neat form. This must then be blended to produce the fuel used in vehicles and buildings. The Biocardel plant has a current production capacity of 4 million gallons per year (MGPY) and they anticipate reaching capacity by the end of 2010 and expanding to 8 MGPY as able.

Currently, most biodiesel sold in the state is delivered pre-blended by transport loads from supply points in Albany (NY), and Montreal (Quebec). Fuel dealers store the blended biodiesel in bulk tanks, typically ~ 10,000 gallons each and later distribute the fuel to their customers. An estimated 112,000 gallons of dedicated biodiesel storage serves Vermont, from 11 locations (see footnote for locations[6]).

Included in these bulk storage volumes is a Lebanon/White River Junction supplier who "splash blends" their heated B100 with diesel and distributes B5 to B20 blends wholesale to fuel dealers that sell at retail. Until recently, there was also one in-state 'rack' or fuel depot, located in Essex Junction, with year-round biodiesel blending capacity. The Essex terminal had been storing up to 10,000 gallons of B100 in a heated facility, and then custom splash blending[7] for Chittenden County fuel dealers. According to the company that supplies fuel to the Essex terminal, lack of demand led to discontinuing the biodiesel blends. However, "lack of demand" was because of the high price of the diesel portion at the Essex plant, and not the biodiesel, according to one Chittenden County fuel dealer, interviewed for this report. The owner of the Essex terminal, D & C transportation, has

[5] Source: Meeting, Stephen Daigle, General Manager Biocardel LLC. 5/5/2009

[6] Dealers with biodiesel tankage serving Vermont: Allen Bros/Westminster, Bourne's Energy/Morrisville, Champlain Valley Plumbing & Heating/Middlebury, Evans/Lebanon, NH & White River, Fleming Oil/Brattleboro, Jack F. Corse/Jeffersonville, Jackman's/Bristol, Owner Services/Proctor, Patterson Fuels/Richmond, R.L. Vallee/St. Albans, Rymes Heating/Concord, NH

[7] Splash blending is when neat biodiesel and diesel fuel (or No.2 oil) are loaded separately into the storage or delivery vessel. The turbulence created when one fuel is added to the other and/or the agitation that occurs when the delivery truck is driving down the road, is usually sufficient for thorough mixing. Difficulties in mixing can be encountered if the biodiesel is not heated first, when blending under very cold conditions.

expressed their intention to relocate the 10,000 gallon heated storage to their bulk facility in Newport, VT and set up on-site blending capacity in 2009-2010[8].

Cost of Biodiesel

Biodiesel produced in the United States is eligible for a federal excise tax credit or "blender's credit" of between $0.50 and $1.00 per gallon[9]. This is paid (or credited) to the biodiesel producer or the fuel blender of ASTM spec fuel, and some or all of the savings is passed along to the end user. On average, the federal excise tax credit makes B5; $0.05 less, B20;$0.20 less, B100;$1.00 less, etc., than it would be without the tax incentive. The credit has indisputably driven market demand for biodiesel fuel products.

Despite the federal biodiesel credit, end users in the Northeast generally pay a premium compared to petrodiesel. How much more varies considerably, primarily as a result of the overall volatility in diesel and heating oil markets, but also as a result of the low number of biodiesel suppliers in any given area and thus, less competition to keep the price differential in check. BGS reports in FY'08, paying an average of $2.69 per gallon for No.2 oil and $2.98 per gallon for B20 *heating fuel* ($0.29 more per gallon). AOT reports paying an average of $0.13 more per gallon for their B5 *transportation fuel* blend in FY'08, compared to their cost for petrodiesel in the same period. Since the Vermont Biofuels Association began tracking and comparing listed prices of petrodiesel and biodiesel in 2005, the price differential between biodiesel blends at the rack have been, on average, $0.02 to $0.14 per gallon higher than their distillate counterpart. Yet that differential fluctuates by the time the product reaches the customer. Historically, the price of B20 for *heating or transportation* in Vermont has been ~ $0.20 per gallon higher and B5 has cost the same as, or a few cents per gallon more than, the comparable distillate product.

Performance Of Biodiesel Blends In Heating And Transportation

Emissions, efficiency, and cold weather

All of the key issues associated with the use of B20 to B100; from emissions and cold flow properties to blending, storage and use are well documented in the U.S. Department of Energy's "Biodiesel Handling and Use Guidelines"[10]. The handbook was last updated in 2008, and it is an indispensible guide and recommended reading for a full understanding of the benefits, precautions and the proper use of biodiesel as a transportation fuel. Much of the information also applies to biodiesel as a heating fuel.

A significant number of government and peer reviewed studies have been conducted on the use and environmental impacts of pure biodiesel and biodiesel blends as a transportation fuel[11]. On average, a 20 percent blend of biodiesel (B20) will reduce tailpipe emissions of CO_2, PM (particulate matter or "soot"), sulfur and all regulated

[8] Source: Phone interview, Scott Oescheger, D & C Transportation, 5/14/2009

[9] The federal credit equates to one penny per percent of biodiesel in a fuel blend made from agricultural products like vegetable oils, and one-half penny per percent for recycled oils. It was recently extended to Dec. 31, 2009.

[10] Source: Biodiesel Handling and Use Guide. National Renewable Energy Laboratory. September 2008. http://www.nrel.gov/vehiclesandfuels/npbf/pubs_biodiesel.html

[11] See National Biodiesel Board, Reports Database: http://www.biodiesel.org/resources/reportsdatabase/

pollutants between 12 percent and 20 percent, compared to petrodiesel, with the exception of NOx.

A 2002 U.S. EPA report[12] indicated that B20 causes a 2 percent increase in NOx emissions. The engine dynamometer studies cited by EPA found that the tailpipe emissions from B100 could increase NOx by 10%. However, a more recent 2006 study conducted by the U.S. Dept. of Energy at the National Renewable Energy Laboratory (NREL) compared a variety of heavy-duty diesel equipment using B20 and petrodiesel in conditions that more closely resembled real world circumstances (i.e., dynamometer testing of the entire vehicle under load, not just the engine). The NREL study summarized the results this way: "Individual engines may show NOx increasing or decreasing, but on average there appears to be no net effect or at most a very small effect, on the order of +/- 0.5%, …considering all of the data available, we conclude that B20 has no net impact on NOx (tail pipe emissions)."[13].

Although there have been fewer studies conducted on the impacts of biodiesel in heating applications, a Brookhaven National Laboratory study reports that using biodiesel blends as a heating fuel *decreases CO_2 and all regulated pollutants, including NOx*[14].

In transportation or stationary applications, the higher the percentage of biodiesel in the blend, the greater the reductions in greenhouse gas forming CO_2 and harmful emissions, compared to using petroleum distillates. The one exception is NOx, which goes down in stationary equipment and shows no net change up to B20 in vehicle use.

As far as the performance of biodiesel as a transportation fuel, a B20 blend contains about 1-2 percent less energy (1-2 percent lower BTU) than petrodiesel, therefore efficiency or net delivered power is only marginally reduced and is not detectable during operation (i.e., in torque, horsepower, or heat output). The use of biodiesel blends in peer-reviewed fleet vehicle studies has been shown to have no effect on fuel economy[15], however some local fleets and individual drivers have consistently reported increased mileage of between 2 and 8 percent using up to B20.

Regarding performance as a heating fuel, in 2006, the VT Biofuels Association and VT Sustainable Jobs Fund conducted research for Vermont Fuel Dealers Association and National Oilheat Alliance, on the use of B20 (aka "bioheat", a blend of biodiesel and No.2 oil) in residential space heating equipment. The study was designed around lab and field-testing in Vermont. Although test results indicate there was a 0.5 percent drop in combustion efficiency, compared to No.2 oil, oilheat professionals claim, "Reduced combustion efficiency values of less than 1 percent are negligible in practical terms and should not discourage those considering the use of B20"[16]. In the 26 test units used in the

[12] Source: U.S. Environmental Protection Agency; A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions, EPA420-P-02-001. October 2002. nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1001ZA0.txt
[13] Source: Effects of Biodiesel Blends on Vehicle Emissions, by McCormick, R.L. et al. October 2006. http://www.nrel.gov/vehiclesandfuels/npbf/pubs_biodiesel.html
[14] Source: Brookhaven National Laboratory website: http://www.bnl.gov/est/erd/biofuel/bnl.asp
[15] Source: NREL report: McCormick, Proc et al http://www.biodiesel.org/resources/reportsdatabase/reports/tra/20061001_tra-55.pdf
[16] Source: The Vermont Biodiesel Project; Laboratory and Field Testing of Biodiesel in Residential Space Heating Equipment, 2006. http://www.vsjf.org/biofuels/resources.shtml

2006 Vermont bioheat study and in over 200 additional homes under observation that winter using B20, participating fuel dealers reported, "…B20 performed as well as No.2 fuel oil in a heating application", and "… We experienced no more problems with the boilers and furnaces (using B20 bioheat) than we would expect from units running on No.2 fuel oil".

Performance issues associated with biodiesel or bioheat use are most evident in cold weather. *The proper blending, storage and use of biodiesel is critical during Vermont winters.* A B20 blend will begin to "cloud" at about 7 degrees Fahrenheit (indicating the bio-waxes present in the fuel are beginning to crystallize), compared to No.2 oil or diesel, which have a cloud point of ~17 degrees (F). Lab tests show that soy-based B20 blends can begin to "gel" at ~1 degree (F) leading to plugged fuel lines, however actual results of using B20 in vehicles and heating appliances in Vermont during cold weather vary widely. They range from power loss or shut down with temperatures in the single digits, to start-up and smooth operation in sub-zero (F) temperatures. It is assumed that biodiesel feedstock, equipment make, model, age and condition and the characteristics of the petroleum portion (the larger portion) of the fuel blend, all are factors that effect performance.

The same strategies and precautions that are used to maintain performance of diesel and heating oil in sub-freezing temperatures are also effective with biodiesel blends, i.e., the use of 'anti-gel' additives or kerosene, and greater reliance on indoor or underground fuel storage, garages and block heaters. For vehicles or heating appliances that have trouble with B20 during Vermont's winters, switching to B5 has eliminated fuel related performance issues. It is recommended that fleets using biodiesel modify their blend as the mean temperatures drop; typically using B20 from April 1 to Oct 31 and B5 from Nov 1 to March 31.

Provided bioheat fuel is stored indoors or underground in clean tanks, and the heating appliances are serviced annually, B20 bioheat has been shown to be a reliable heating fuel in Vermont. However, since heating equipment manufactures and the oilheat industry has only recently given its full support for the use of up to B5 bioheat, DPS encourages the use of B5 in heating applications, until such time as the industry moves to approve higher blends.

The choice of feedstocks is another factor that affects fuel performance, for instance, biodiesel made from tropical oils such as palm, jatropha or animal fat (tallow or lard) are even less tolerant of cold weather. Table 1 lists lab results that illustrate this comparison[17]. Whether used for transportation or heating, because of their higher *Cold Filter Plug Point (CFFP – see footnote*[18] *for definition)*, tropical oil and tallow feedstocks in B20 blends and above, should be avoided at the onset of cool weather. A Certificate of Analysis (C of A) accompanies each load of biodiesel from the production facility through the chain of custody to the fuel supplier. The C of A is used to determine the origin of the biodiesel, the source of oil or feedstock in a biodiesel blend and also verifies that the fuel met its industry standard for quality, at the time it was sold to the blender. A copy of the C of A is available by requesting it from the fuel supplier. Especially in the

[17] In Table 1, data was available for tallow, but not palm. However, tallow and palm oil have almost the identical CFFP
[18] Cold Filter Plug Point is the absolute lowest operating temperature a vehicle will operate

case of commercial or institutional scale deliveries, it is recommended that the customer obtain a copy, and pay careful attention to the information it contains.

Table 2. Cold Filter Plug Point (Fahrenheit)

	Soybean	Canola	Tallow	No.2
				-9°
B100	28°	25°	57°	
B20	1°	0°	27°	
B5	-2°	0°	2°	

Storage

Neat biodiesel has solvent and detergent characteristics. When storing concentrations of B20 or less, these effects will be minimized. However, accumulated sediments in storage tanks that held petrodiesel or No.2 oil may get released into the system and lead to filter plugging during the initial weeks of B20 use. Using B5 bioheat or biodiesel appears to have no discernible effect on fuel system performance or filter plugging. In older systems, take precautionary measures when introducing B20 for the first time by cleaning or replacing the fuel filter(s) after the first week, and monitoring the fuel storage and supply lines carefully during the first month.

Engine Warranties

Most engine and vehicle manufacturers approve the use of B5 fuel in their equipment, provided the biodiesel meets ASTM spec D6751 and/or the European biodiesel specification. Some OEM's (Original Equipment Manufacturers) also approve blends of B20. Engine and equipment manufacturers provide a warranty that covers materials and workmanship on their products but these warranties do not cover damages caused by external circumstances, for instance the type of fuel used. The U.S. DOE "2008 Biodiesel Handling and Use Guidelines" publication states, "If an engine that uses biodiesel experiences a failure unrelated to the biodiesel use, it must be covered by the OEM's warranty. Federal law prohibits the voiding of a warranty just because biodiesel was used – it has to be the cause of the failure. If an engine experiences a failure caused by biodiesel use (or any other external condition, such as bad diesel fuel), the damage will not be covered by the OEM's warranty".

For a complete list of OEMs and their position statements on biodiesel use, visit the National Biodiesel Board web site at www.biodiesel.org

Oilheat Appliance Warranties

In July 2008, a new ASTM specification for fuel oils was passed to include requirements for up to 5 percent biodiesel. This revision paved the way for all oilheat appliances receiving UL (Underwriters Laboratory) approval, to use up to a B5 blend.

National And Regional Quality Assurance And Quality Control

The rack or fuel terminal operator is responsible to the jobber (fuel distributor) for following proper biodiesel blending practices and maintaining fuel quality in storage and at the point of sale. In the case of biodiesel blends, details about the type of feedstock used and its adherence to ASTM specs (see below) are made available to the jobber in the form of a Certificate of Analysis, which every biodiesel producer is responsible for generating on each batch of fuel they make (and sell). If there is a question of fuel quality once the jobber delivers to their customer, or at any point "downstream" from the fuel terminal, the "C of A" is often the only point of reference a jobber has to verify the source and quality of the fuel that was purchased. However, the C of A is incomplete in most cases, since it says nothing of the quality of the fuel *once it was blended.* The National Biodiesel Accreditation Program or BQ-9000 (see below) is a voluntary program that adds greater quality assurance than ASTM specs alone can provide.

ASTM

The ASTM specification for biodiesel, ASTM D6751, sets the production standards of pure biodiesel (B100) prior to blending with conventional diesel fuel. ASTM standards specify that the fuel shall conform to a range of performance and environmental requirements prescribed for such things as cetane number, flash point, water and sediment, sulfur, pour point, etc. It is the benchmark for quality in the U.S. that all commercial producers of biodiesel used for *on-road* purposes must adhere to, by law. The biodiesel made by small producers for use in farm and construction equipment, and other off-road uses, is exempt and often does not meet the ASTM spec. Even though such off-road, non-ASTM spec fuel may be of high quality, it is recommended that only ASTM spec (or better) fuel be used.

For establishing quality standards for *blended biodiesel*, ASTM International recently published several new specifications that include:

- ASTM D975-08a, Specification for Diesel Fuel Oils: used for on- and off-road diesel applications; revised to include requirements for up to 5 percent biodiesel.
- ASTM D396-08b, Specification for Fuel Oils: used for home heating and boiler applications; revised to include requirements for up to 5 percent biodiesel.
- ASTM D7467-08, Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to 20): a completely new specification that covers finished fuel blends of between 6 (B6) and 20 (B20) percent biodiesel for on- and off-road diesel engine use.

BQ-9000

To provide an assurance protocol and documentation that fuel quality has been maintained from the time it leaves the biodiesel producer and is blended with distillate fuels, the National Biodiesel Board established the National Biodiesel Accreditation Program (NBAP) in 2005. The program is called BQ-9000 and it is a cooperative and voluntary program for the accreditation of producers and marketers of biodiesel fuel. BQ-9000 combines the ASTM standard for biodiesel and a quality systems protocol that

includes storage, sampling, testing, blending, shipping, distribution, and fuel management practices.

NBAP materials state, *"Certification is awarded following a successful formal review and audit of the capacity and commitment of the applicant to produce or market biodiesel fuel that meets the ASTM D-6751 Specification for Biodiesel Fuel (B100) Blend Stock for Middle Distillate Fuels. The certification process is comprehensive and includes a detailed review of the applicant's Quality System documentation, followed by a formal audit of the applicant's conformance to its System".* [19]

The largest supplier of biodiesel to Vermont, Sprague Energy, is a certified BQ-9000 fuel marketer, selling ASTM-spec fuels. They deliver out of the Albany, NY fuel terminal. There are currently no BQ-9000 fuel producers or marketers in Vermont, however, Biocardel Vermont LLC has signaled their intention to become enrolled in the program. It is recommended that fuel purchasers choose BQ-9000 producers and fuel marketers whenever possible.

Vermont Fuel Quality Regulation Program

At the state level, Vermont Department of Agriculture/Food & Markets oversees the State's Fuel Quality Regulation program[20]. There are currently no proactive tests conducted for fuel quality, however, when a complaint is made the department will investigate.

Recommendations for increasing biodiesel fuel production, and storage and distribution facilities

Achieving significant reductions in greenhouse gas emissions is one of the greatest challenges society and industry face. The first goal of a carbon reduction strategy is to lower energy demand by increasing the efficiency of buildings, heating appliances and vehicles, and implementing alternatives to fossil fuels. In the process of meeting efficiency and conservation goals, DPS is also interested in developing policies that favor transportation and heating fuels with a low "life-cycle carbon intensity", such as biofuels.

Biodiesel production and distribution will likely increase as:

- Policies and markets meet the challenge of climate change
- Advanced biofuels technologies improve the efficient conversion of biomass-to-fuel
- End-user demand for biodiesel grows

The primary obstacles impeding end-user demand today are:

- The limited availability of the product (at retail) around Vermont.
- Lack of product information for the biodiesel end-user
- The disparity in price (between bio- and petro-diesel)

DPS recommendations aimed at addressing these issues start by exploring some of the key policy, industry and outreach issues below.

[19] For more information on the BQ-9000 program see: http://www.bq-9000.org/

[20] Primary Contact for VT fuel quality program is Ray Cioffi. Phone: (802) 241-4369. Email: ray.cioffi2@state.vt.us

Policy

In December 2008, Vermont's Commissioner of the Department of Environmental Conservation joined representatives from ten other Northeastern States in a commitment to develop a regional Low Carbon Fuel Standard (LCFS). These states are working together "in an effort to analyze low carbon fuel supply options and develop a framework for a regional LCFS in the Northeast/Mid-Atlantic region, in order to ensure sustainable use of renewable fuels in the region."[21]

- DPS is exploring opportunities with its regional counterparts to include biodiesel blends as a low carbon fuel supply option for transportation and heating fuels, and supports this multi-state effort to develop a LCFS framework.

At the federal level, the renewable fuel program (RFP), also known as the renewable fuel standard (RFS), outlined in the Energy Independence and Security Act of 2007 (EISA), created new renewable fuel production requirements that will ramp up domestic production to 36 billion gallons per year by 2022 (ethanol and biodiesel). Of that total, a *minimum* of 13% or ~5 billion gallons must be biodiesel. The revised RFS is aimed at reducing overall greenhouse gas (GHG) emissions and developing more domestic fuel sources. The new standards and supporting tax and production credits will affect all commercial processors in the United States making ASTM spec fuel, including Biocardel Vermont, LLC.

The EISA further specifies of the 2022 total, 21 billion gallons must be derived from non-cornstarch products (e.g. sugar or cellulose), thus only 'advanced biofuels' would qualify in this category. *Advanced biofuels* are fuels generally derived from non-food-based feedstocks and defined in federal law as those that yield a net lifecycle reduction in greenhouse gas emissions of at least 50 percent compared with fossil fuels. According to numerous studies of many biofuel feedstocks and conversion pathways, *advanced biofuels* offer the greatest potential benefit for the environment and the economy[22].

- This (federal) requirement to increase the production of advanced biofuels, like algae-to-biofuel and cellulosic fuel technologies, will move the country towards more efficient and less controversial sources of biomass-based fuels.

Industry

While biodiesel blends in transportation fuel are gradually increasing in the state, the use of biodiesel as a heating fuel additive has jumped considerably in Vermont over the last two years. This is due in large part to the new ASTM fuel standards that came as a result of rigorous testing by NORA (National Oilheat Research Alliance) and ASTM.

[21] Source: January 5, 2009. Massachusetts Executive Office of Energy and Environmental Affairs, Press Release: http://www.mass.gov/?pageID=eoeeapressrelease&L=1&L0=Home&sid=Eoeea&b=pressrelease&f=090105_pr_lcfs&csid=Eoeea

[22] Source: 2008. http://www.vtbio.org/www.vtbio.org/PRESS_RELEASE.html

- With the passage of new ASTM heating oil specifications (see Section III above), came full industry backing of a B5 bioheat fuel blend and a nationwide campaign, led by the National Biodiesel Board and NORA, to promote the distribution and use of (up to) B5 Bioheat® fuel.

Marketing an oilheat fuel with reduced environmental impacts is seen as a growing imperative by the oilheat industry, according to Matt Cota, Executive Director of the Vermont Fuel Dealers Association and other fuel suppliers interviewed for this report. Mr. Cota notes there is support from within the VFDA membership, and among his regional counterparts, for a "Low Carbon Fuel Standard" (LCFS) heating oil; a blend of ultra low sulfur No.2 oil (15 ppm) and (eventually) up to 20 percent biodiesel[23].

A switch to B5 in all of Vermont's heating oil would require ~6,700,000 gallons a year of B100 (given current consumption). This amount of B100 would reduce annual CO_2 emissions by nearly 54,000 tons and offset the consumption of more than 159,000 barrels of crude oil per year, compared to using straight No.2 oil. In addition, Vermont's oilheat suppliers have often cited a need for - and lack of - dedicated biodiesel storage as a major impediment to increased biodiesel distribution and use.

- By creating a regional fuel standard that included biodiesel, not only would the Northeast states improve air quality and reduce CO_2, the change would obviate the need for separate, dedicated biofuel storage and distribution.

Vermont consumes close to 216 million gallons of imported distillate fuel for combined heating and transportation [24] each year. Biocardel Vermont, LLC will soon have in-state production capacity to more than meet 5 percent of the heating oil portion of this total. In other words, the producer would be capable of meeting a B5 heating oil requirement for the entire state. However, until there is a facility (or facilities) to properly blend and store this product year round, it isn't certain that Biocardel's product would be consumed in Vermont. The State of Vermont has made considerable investments in Biocardel through VEDA and VEPC tax credits, and would stand to benefit for the reasons cited above, from an in-state blending facility.

- DPS recommends that efforts be made to attract and support a qualified entrepreneur to establish such a facility. Once a blending facility (or facilities) are operational, the components would be in place for a fully integrated, statewide biofuel production and delivery system capable of meeting nearly 4% of the current distillate fuel demand for transportation and heating.

<u>Outreach and Collaboration</u>

Between 2004 and 2006, DPS and other public and private sector partners worked closely together to build the early biodiesel market under the Vermont Biodiesel Project (VBP)[25].

[23] Source: phone conversation with Matt Cota, VFDA, December 6, 2008. Phone conversation with John Rymes, Rymes Heating Oil, March 11, 2009.
[24] According to U.S. Dept of Energy, Vermont consumed ~147M gals of heating oil and kerosene and ~69M gals of diesel in 2006
[25] Vermont Biodiesel Project final report available at: http://www.vsjf.org/biofuels/resources.shtml

The Vermont Biodiesel Project succeeded with a strategy that emphasized cooperation, education and outreach among fleet and facility managers and fuel dealers, and it delivered measurable results, in short, establishing a biodiesel sector in Vermont where none previously existed.

- In the course of preparing this report, a number of issues surfaced to indicate that a stakeholder task force should convene to review current opportunities and prepare a workplan that has industry and state government involvement and present a plan to the legislature to increase the use of biofuels in Vermont.

This task force or *biofuels development committee* would be looking at such things as the state of biodiesel production and distribution in the region, Vermont's role in the eastern state's low carbon fuel standard initiative, the national Renewable Fuel Standard as well as state biodiesel incentives, advancements in sustainable biofuels research and development[26], and biodiesel's function in a fossil fuel and GHG reduction strategy.

- The *biofuels development committee* should convene as one of the subcommittees of the Vermont 25 x '25 Initiative and include representatives of DPS, AOT and BGS, the VT fuel and biofuel industry, the research and academic community and economic development organizations.

[26] To review progress being made on third party certification of sustainable biofuels, see: Roundtable on Sustainable Biofuels; http://cgse.epfl.ch/page65660.html and Sustainable Biodiesel Alliance; http://www.sustainablebiodieselalliance.com/FAQ.html

Proposed Workplan To Increase Biodiesel Use

The following section builds on the preceding recommendations and identifies five key strategies to increase biodiesel use in Vermont.

1. Convene a *Vermont biofuels development committee* as a subcommittee of the Vermont 25 x '25 Initiative. The Biofuels Development Committee would:
   - Be comprised of industry and state government stakeholders
   - Be tasked with reviewing the state of biodiesel production and distribution in the region, and opportunities to increase biodiesel use
   - Be tasked with submitting a workplan to the legislature in January 2010 to substantially increase biodiesel use in Vermont.
2. Strengthen the *Request for Proposals* for the state fuel contracts to expand the use of biodiesel and bioheat by:
   - Including a statement of preference to purchase biodiesel and bioheat
   - Continuing the practice of requiring state fuel contractors to list their mark up over the floating base price (Albany rack price).
   - Including a system of entering bids so that any fuel supplier that can supply biodiesel or bioheat has the opportunity to submit their mark up for biodiesel or bioheat blends to any location.
   - Giving preference to fuel suppliers who can offer biodiesel or bioheat blends at the same or lower cost than the alternative, or can offer biodiesel within 3% of the cost of the petrodiesel counterpart for town contracts.
3. Continue to work with other states in the region on developing a Low Carbon Fuel Standard framework for the region that includes biodiesel blends.
4. Pursue opportunities to support the construction of an in-state blending facility (or facilities), through tax credits, loan guarantees, grants, etc.
5. When economic conditions allow, revisit the viability of offering biodiesel incentives, such as the rebates and fuel tax reductions proposed by Governor Douglas, and introduced in the Vermont Legislature in 2007[27].

As society makes a transition from its dependence on fossil fuels to a diversified energy portfolio, *some of the foreseeable challenges* include:

1. Cost
   - Market research shows that pure biodiesel is likely to command a higher price (over its distillate counterparts) for the foreseeable future, however:

[27] Governor Douglas proposed a rebate to heating fuel distributors for B2 or B5 biodiesel blends and a reduction in the diesel fuel tax rate by 2 cents on biodiesel blends sold for transportation purposes. These incentives were introduced by the Legislature in H.524 and H.540 respectively. See the Vermont Legislature web site, 2007-2008 session, Bills introduced: http://www.leg.state.vt.us/docs/legdoc.cfm?URL=/docs/2008/bills/intro/H-524.HTM and http://www.leg.state.vt.us/docs/legdoc.cfm?URL=/docs/2008/bills/intro/H-540.HTM

- Blended in concentrations of 5% to 10% (B5-B10), the incremental cost has historically been low, averaging $0.00 to $0.05 per gallon.
- Legislated incentives passed in other states have reduced the state excise taxes on biodiesel blends, often creating price parity between bio and petrodiesel. Other types of tax incentives are possible.

2. Availability (at retail)
   - There are still regions of Vermont where customers cannot purchase biodiesel (because there isn't a fuel dealer carrying the product), however:
     - Promoting the use of biodiesel using any of the strategies outlined above will increase end-user demand and translate into an expansion on the supply-side
3. Performance
   - Using blends of B20 and above in Vermont between December and March have in some instances led to loss of power or vehicle shut down, however:
     - By educating fleet and facilities managers and the general public on cold weather performance issues, steps can be taken to reduce or eliminate the risk of gelling.
     - The use of palm oil as a biodiesel feedstock has been shown to have cold weather performance issues, as well as negative environmental impacts, and should be avoided, especially in state contracts[28].

Benefits And Outcomes Of Increased Biodiesel Use In Vermont

1. Local Production of a Renewable Fuel
   - Building a market demand for in-state biofuel production is consistent with Vermont 25x'25 goals, "meeting 25% of Vermont's energy demand with renewables, principally from our farms and forests, by 2025"
   - An increasing number of Vermont farms are producing biodiesel from oilseed crops and at least one algae-to-biofuel system is currently in development in the state. These distributed models of fuel production represent new forms of revenue and increased fuel security for Vermont.
   - Biocardel Vermont, LLC has installed biodiesel production capacity of 4 million gallons per year, with plans to double production within 2 years.

[28] Cold weather performance issues and environmental impacts of palm oil-based biodiesel are well documented (see appendix).

- Once a blending facility (or facilities) are operational, the components would be in place for a fully integrated, statewide biofuel production and delivery system capable of meeting nearly 4% of the current distillate fuel demand for transportation and heating.

2. Air Quality
    - Biodiesel use lowers GHG and other pollutants
    - Increased use of biodiesel in transportation and heating carries with it air quality benefits, human health benefits, and helps to meet the Governor's Commission on Climate Change recommendations and RGGI goals.

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