

## **The Use of Biodiesel in Vermont**

---

### *An Introduction to an Alternative Fuel Source for the State of Vermont*

PRS Policy Brief 0607-04  
2 May 2007

Prepared by:

Patrick Pfeiffer  
Andrew Zabel  
Alex Belser

*This report was written by undergraduate students at Dartmouth College under the direction of professors in the Rockefeller Center. We are also thankful for the services received from the Student Center for Research, Writing, and Information Technology (RWiT) at Dartmouth College.*

*Contact:*

Nelson A. Rockefeller Center, 6082 Rockefeller Hall, Dartmouth College, Hanover, NH 03755  
<http://policyresearch.dartmouth.edu> • Email: Policy.Research@Dartmouth.edu

TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
1. INTRODUCTION	1
2. BIODIESEL BASICS	2
2.1 DEFINITION AND OVERVIEW	2
2.2 ADVANTAGES AND DISADVANTAGES	2
2.3 OVERCOMING DISADVANTAGES: BIODIESEL BLENDS	3
2.4 BIODIESEL FUEL STANDARDS	4
3. STATUS OF BIODIESEL IN VERMONT	4
3.1 CURRENT INCENTIVES	4
3.2 THE VERMONT BIODIESEL PROJECT	5
3.3 CURRENT LEVELS OF USE	5
3.4 CURRENT LEVELS OF PRODUCTION	5
4. LOCAL USE AND PRODUCTION	5
5. INFRASTRUCTURE	6
5.1 STORAGE	6
5.2 BLENDING	7
5.3 WARRANTY	7
6. ENVIRONMENTAL ASPECTS	7
6.1 CLIMATE CHANGE	7
6.2 EMISSIONS	8
6.3 LAND-USE ISSUES	9
7. CASE STUDY: MINNESOTA	9
8. POLICY OPTIONS	10
8.1 STATEWIDE MANDATE	10
8.2 BIODIESEL USE IN STATE VEHICLE FLEETS	11
8.3 TAX INCENTIVES	11
9. CONCLUSION	11

## **EXECUTIVE SUMMARY**

For reasons ranging from environmental health to the stability and long-term viability of petroleum as a fuel source, exploring alternative energy has emerged as an important issue for the state of Vermont. One aspect of this issue is the prospective wide scale use of biodiesel as a replacement for conventional petroleum diesel (petrodiesel). Although supply and cost constraints mean that biodiesel cannot currently be used to replace petrodiesel completely, it can be blended with petroleum diesel in order to reduce fossil fuel use.

This report investigates various environmental, economic, and feasibility issues pertaining to the use of biodiesel in the state of Vermont. It also identifies a number of policy options for the state of Vermont relating to the use of biodiesel.

Key findings in this report include:

1. Pure biodiesel (B100) can run in almost any diesel engine following minor modifications to the engine's gaskets and seals.
2. Biodiesel is primarily used for fuel when blended with traditional diesel. Low blends of biodiesel can be used in almost any diesel engine without modification.
3. Commonly used blends of biodiesel include: 2, 5, 10, and 20 percent.
4. Concerns for biodiesel use include: cold weather function, solvent properties of B100 and high blends, quality control, available infrastructure, warranty issues, and consumer awareness.
5. There are currently 17 biodiesel distributors in the state of Vermont; they were responsible for selling 275,000 gallons in 2005. In total, Vermont used 63 million gallons of petrodiesel in the same year.
6. Biodiesel use decreases carbon dioxide emissions and slightly increases nitrogen oxide emissions relative to petrodiesel use.
7. Farmable land and/or feedstock importation is required to make biodiesel.
8. Storage infrastructure will need to increase in order to provide more biodiesel distribution lines.
9. A key to increased biodiesel usage is to make it a cost-effective alternative to traditional petrodiesel. Currently, without taxes on petrodiesel or subsidies for biodiesel, biodiesel is not cost-effective.
10. Policy options for increasing state-wide biodiesel usage include: 1) a mandate that all diesel sold in the state contain a certain percentage of biodiesel; 2) a mandate that the state's diesel fleet use biodiesel instead of petroleum diesel; and 3) tax incentives for distributors or consumers.

## **1. INTRODUCTION**

The continued reliance on petroleum-based fossil fuels as a primary energy source has important implications for the environment, the economy, and reliance on foreign energy

sources. Recent scientific studies have confirmed the correlation between increased levels of carbon dioxide (which is produced when petroleum fuels are burned) in the atmosphere and the increase in the global mean temperatures over the last century.<sup>1</sup> In the coming decades global climate change could threaten aspects of Vermont's ecological and economic systems. In addition, some geologists expect that known and projected oil reserves could be considerably depleted by the end of this century.<sup>2</sup> Eventually, decreased availability of petroleum, all else equal, will lead to price increases. However, petroleum price increases could be mitigated by the use of alternative fuel sources. In 2004, Vermont used 63 million gallons of diesel fuel for transportation, all of which was imported from out-of-state.<sup>3</sup> By contrast, various alternative fuels have the potential to be produced domestically, providing a secure energy source and potentially negating some of the environmental costs imposed by fossil fuel use.

As part of a broader alternative fuels program, replacing petroleum diesel with biodiesel may relieve some of the aforementioned environmental, economic, and security concerns. Although petroleum will undoubtedly remain the primary fuel source for Vermont's transportation sector for many years to come, transition away from a petroleum-based fuel source could occur gradually. The early establishment of an alternative fuels infrastructure may ease the transition period between petroleum fuels and alternative fuel sources. This policy brief provides a general introduction to biodiesel, explains the current status of biodiesel in the state of Vermont, describes the environmental, quality-control, infrastructure, market, tax, and warranty issues associated with biodiesel use, and outlines various biodiesel policy options for Vermont.

## **2. BIODIESEL BASICS**

### *2.1 Definitions and Overview*

"Neat" or 100 percent biodiesel (B100) is an agriculturally produced renewable fuel alternative to conventional petroleum diesel (petrodiesel). Rendered from either vegetable oil (typically either soy or canola oil) or animal fats, biodiesel has chemical and physical properties similar to petrodiesel. However, the dissimilarities are such that B100 cannot be used as a direct replacement for petrodiesel in standard diesel compression-ignition engines. Therefore, biodiesel/petrodiesel blends, which can be used in unmodified engines, are typically pre-mixed and then sold to consumers.<sup>4</sup>

### *2.2 Advantages and Disadvantages of Biodiesel*

The advantages of using biodiesel include:

1. Biodiesel is a domestically produced renewable fuel. Pure biodiesel requires no importation and can be fully produced in the U.S. As such, it provides a more secure energy source than petrodiesel imported from unstable parts of the world.

2. The combustion of both pure biodiesel and various biodiesel blends produces fewer harmful emissions than the combustion of traditional petrodiesel.
3. Biodiesel is biodegradable and non-toxic. The U.S. Department of Energy reports that biodiesel is both less toxic than generic table salt and biodegrades quicker than standard cooking sugar.<sup>5</sup>
4. Biodiesel offers a potential solution to the issue of improving viscosity in the new low-sulfur diesel fuels.<sup>6</sup>
5. Domestic production of biodiesel would make use of farm-produced feedstocks and it represents an important area of potential economic growth for the agriculture sector.

The disadvantages of using biodiesel include:

1. Biodiesel is a solvent that can be incompatible with the rubber seals and gaskets in the fuel systems of some types of diesel vehicles. If users have not taken measures to properly adapt their engines to run on biodiesel, dissolution of dirt and rubber can result in clogged engine and fuel lines. As such, pure B100 cannot be safely used as a stand-alone fuel in conventional vehicles.
2. The energy content of biodiesel is lower than that of petroleum diesel. As a result, vehicles running on any blend of biodiesel will experience a small reduction in fuel economy (miles per gallon).<sup>7</sup>
3. The use of biodiesel in cold weather presents certain challenges. All diesel fuel “clouds” at low temperatures. Clouding indicates the formation of wax crystals, which can inhibit proper flow of fuel to the engine and clog fuel lines or filters. Conventional petrodiesel begins to cloud at approximately 0° F, while B100 has a clouding point of about 30° F.<sup>8</sup> The higher clouding temperature is an important consideration for the use of biodiesel during Vermont’s winters.
4. The Environmental Protection Agency reports that nitrogen oxide emissions are increased for biodiesel combustion versus petrodiesel combustion.
5. The increased use of feedstocks to produce biodiesel will likely increase prices in these agriculture sectors.

### *2.3 Overcoming Disadvantages: Biodiesel Blends*

Many of the disadvantages associated with neat biodiesel can be overcome by using biodiesel blends, which consist of petrodiesel mixed with a specified quantity of biodiesel. Biodiesel blends are labeled BX, where X is a number that indicates the percentage of biodiesel in the blend. For example, B20 is a mixture of 80 percent petrodiesel and 20 percent biodiesel. Common blends include: B2, B5, B10, and B20.

Biodiesel blends can overcome the inherent disadvantages of B100 in the following ways:

1. Blends up to a B20 (or even B35 in some cases) can be used with no alterations to a standard diesel engine.<sup>9</sup>
2. The use of certain additives can prevent cold-weather clogging issues associated with biodiesel use in the winter months.<sup>10</sup>
3. The addition of varying amounts of kerosene (depending on which biodiesel blend is used) has the ability to reduce nitrogen oxide emissions.<sup>11</sup>

#### *2.4 Biodiesel Fuel Standards*

In the United States, both biodiesel and petrodiesel are analyzed according to the standards set by the American Society for Testing and Materials (ASTM). Accordingly, in December 2001 the ASTM set standard D 6751, which covers blending B100 with petrodiesel in levels up to 20 percent by volume.<sup>12</sup> The D 6751 standard sets acceptable levels for a wide range of chemicals in biodiesel and is considered the industry wide benchmark for safe biodiesel.

BQ-9000 is a new accreditation program for both biodiesel producers and marketers. Instituted by the National Biodiesel Board, BQ-9000 is designed to ensure a quality systems program that includes storage, sampling, testing, blending, shipping, distribution, and fuel management practices.<sup>13</sup> A series of audits are in place to ensure that Biodiesel meets ASTM standards all the way through the supply network.

### **3. THE STATUS OF BIODIESEL IN VERMONT**

#### *3.1 Current Incentives*

Federal tax incentives currently favor the development of biodiesel. Whereas biodiesel was previously taxed the same way as diesel, several tax breaks have been in place since 2004. There is currently a one-penny per gallon credit on biodiesel, effective through 2008. A half-penny rate applies to waste vegetable oil. For example, B20 would get \$0.20 per gallon in credit, B5 would get \$0.05 cents, and B20 made with waste vegetable oil would get \$0.10 cents.<sup>14</sup> The tax credit became effective with the American Jobs Creation Act of 2004 and is paid directly to distributors. Additionally, B100 is not taxed in Vermont, but biodiesel blends are currently taxed and would continue to be without changes in the current law.

Although the federal government provides tax breaks for biodiesel production and use, there are no current state tax incentives to promote the use of biodiesel or any other biofuels in Vermont. The state provides incentives to promote the research and development of alternative fuels businesses and farms through the Agricultural Economic

Development Plan for Biofuels and the Alternative Fuel Vehicle Research and Development Tax Credit. The State Agency Energy Plan Transportation Requirements, adopted in July 2005, require that the Secretary of Administration investigate the environmental and economic feasibility of replacing the use of petrodiesel in state vehicles with biodiesel.<sup>15</sup> However, no state mandates currently require the use of biodiesel for state or private vehicles.

### *3.2 The Vermont Biodiesel Project*

The Vermont Biodiesel Project (VBP) was a two-year pilot project (2004-2006) to stimulate demand for biodiesel in Vermont and increase the supply of domestic biodiesel available to Vermont-based businesses. The project was a collaboration between the Vermont Biofuels Association, Vermont Fuel Dealers Association, Vermont Department of Buildings and General Services, Vermont Department of Environmental Conservation, and many other associations and ran commercial scale pilot programs that tested the feasibility of commercial scale biodiesel use.<sup>16</sup> The VBP's final report concluded that Vermont was ready and able to begin implementing biodiesel production on a large scale. However, further research may be necessary to corroborate the project's findings.

### *3.3 Current Levels of Use*

According to the Energy Information Administration, Vermonters used 63 million gallons of diesel fuel in 2004.<sup>17</sup> Before the VBP was initiated in 2003, Vermont consumed 9,000 gallons of biodiesel. That figure grew to 275,000 gallons in 2005,<sup>18</sup> of which the VBP's pilot programs were responsible for the use of 78,500 gallons (approximately 29 percent). In addition, the number of fuel dealers selling biodiesel in the state expanded from two in 2004 to 17 in 2006.<sup>19</sup> Given the relative scarcity of biodiesel, which constitutes less than one half of one percent of all diesel sold in the state, many areas lack easy access to biodiesel.

### *3.4 Current Levels of Production*

Currently there is a minimal level of biodiesel production in the state.<sup>20</sup> However, Biocardel Vermont has reached an agreement to open a plant in Swanton, Vermont and production is to begin in the spring of 2007. Within three years, the plant is expected to produce an annual average of four million gallons of biodiesel from soy oil.<sup>21</sup> It is noteworthy that the soy feedstock used to produce the biodiesel is expected to be imported from Canada.

## **4. Local Use and Production**

Currently, the market for biodiesel is very small, but growing. There is an estimated 60 to 80 million gallons per year of biodiesel produced and sold in the U.S., some of which is used for heating. An estimated 26 million gallons were used for transportation purposes in 2004.<sup>22</sup> In Vermont, 678 million gallons of petroleum, including 63 million gallons of

diesel fuel for transportation, were used in 2004.<sup>23</sup> Thus, in the same year, a B5 mandate affecting diesel vehicles would have required approximately three million gallons of biodiesel supply to blend with the petrodiesel.<sup>24</sup> To put that in perspective, the Vermont Biodiesel Project (VBP) reports only 9,000 gallons of biodiesel were used in the state for all applications, including home heating, in 2003. In 2005, aided by new demand generated by the project, that number grew to 275,000 gallons. The VBP estimates that number could top one million gallons by 2007 and five million gallons by 2008. This comes as Biocardel Vermont is set to open in Swanton in the spring 2007. The plant is expected to produce four million gallons of biodiesel in its first year. Currently, most of this fuel will be transported out of state and sold elsewhere,<sup>25</sup> but the company's establishment in Vermont suggests additional promise to the growing biodiesel industry in the state.

Vermont's biodiesel market is still in its' infancy, with relatively low quantities of product filtering down to local consumers from large regional and national suppliers. For example, World Energy Alternatives of Chelsea, MA sells to local distributors. Prices vary widely but are often reported above \$3 per gallon.<sup>26</sup> There is at least one piece of anecdotal evidence that transportation costs are partly behind this: In a pilot program using biodiesel, Sugarbush Resort worked through its diesel distributor to get biodiesel from Alliance Energy in Holyoke, MA. The reported transportation costs increased 50 percent over petrodiesel.<sup>27</sup> Transportation costs are greatly influenced by the relatively small quantities being transported and the lack of biodiesel presence on the traditional trucking routes.

## **5. INFRASTRUCTURE**

Although biodiesel is a workable new technology because it can be used in existing diesel engines, some investment in infrastructure (i.e., creation of biodiesel storage tanks, the replacement of certain gaskets and other corrodible parts of the fueling pumps, etc.) is required for its use. This is especially true as the biodiesel market expands and as higher percentages of the fuel are used in place of petrodiesel.

### *5.1 Storage*

Put simply, biodiesel is a new fuel that must be stored somewhere. The price of underground storage tanks varies widely and can exceed \$100,000 per tank.<sup>28</sup> If fuel dealers and gas stations continue selling regular diesel in addition to biodiesel, they will need a new tank to store the biodiesel. However, stores will not be required to buy new tanks if they convert completely to a biodiesel blend. For example, the Evans Expressmart gas station in Fairlee, which is run by a fuel dealer who has committed to selling biodiesel, has switched completely to B20 and is no longer carrying pure petrodiesel. Alternatively, existing non-diesel storage tanks can also be used. For example, Dan and Whit's General Store in Norwich stopped selling kerosene, cleaned the kerosene tank, and began using it to store biodiesel.

If biodiesel blends greater than B20 are used, however, it is more likely that a new storage tank will be needed. First, the solvent properties of the biodiesel will actually clean out buildup and sediment that has accumulated on the sides of the tank. Second, the biodiesel may degrade any rubber components. Third, the biodiesel may also react poorly with certain metals in the tank, since it has the potential to “oxidize brass, bronze, copper, lead, tin and zinc, leading to additional sediments, gels or salts that may lead to fouling of fuel delivery systems or leaks in storage systems.”<sup>29</sup>

### *5.2 Blending*

There are various modes of blending fuel, all of which involve care and require certain containers and equipment in which to do the mixing.<sup>30</sup> In a transportation setting, consumers would normally purchase biodiesel pre-mixed at the pumps (just like gasoline), but fuel dealers and those who run municipal government vehicle fleets or school buses may have to blend down from B100.

### *5.3 Warranty*

A major concern about biodiesel use, even in its blended form, is that it could void warranties for vehicles and other equipment that use it. Currently, most manufacturers allow use of a B5 blend without voiding the warranty, and a few manufacturers approve of using B20 or even B100. However, this is only the case when the biodiesel used meets the government’s ASTM D 6751 definition. Generally, policymakers and consumers using blends greater than B5 should be aware that they might have trouble with their warranties.

## **6. ENVIRONMENTAL ASPECTS**

### *6.1 Climate Change*

There is now general scientific consensus that a continuing increase in mean global temperatures will result from increased levels of CO<sub>2</sub> in the atmosphere.<sup>31</sup> The use of petrodiesel in conventional engines leads to an output of CO<sub>2</sub> and other atmospheric pollutants. Due to varying environmental concerns, it is important to evaluate the environmental benefits of switching to alternative fuels. By phasing in alternative sources to petroleum-based diesel fuel, Vermont would be able to decrease its environmental impact; thus, contributing to the global initiative to reduce emissions.

Although the regulation of CO<sub>2</sub> was not originally included in the Clean Air Act, a recent ruling by the Supreme Court of the United States suggests that the EPA must reconsider regulating carbon emissions.<sup>32</sup> The absence of regulation for this pollutant (and greenhouse gas) inspired states to join together in a commitment to achieve CO<sub>2</sub> reductions. The Regional Greenhouse Gas Initiative (RGGI) joins Mid-Atlantic and Northeastern states, providing a framework in which alternative energy markets can develop.<sup>33</sup> “Central to this initiative is the implementation of a multi-state cap-and-trade

program with a market-based emissions trading system. The proposed program will require electric power generators in participating states to reduce carbon dioxide emissions.”<sup>34</sup> The use of alternative fuels such as biodiesel would help Vermonters achieve these carbon reductions.

Carbon neutrality, the ability to reduce one’s carbon output to the point in which there is a net-zero increase of the gas, is an underlying goal and potential solution to climate change. As an essentially carbon-neutral fuel source (carbon dioxide is absorbed when new plants are grown to produce more biodiesel and then released when burned), biodiesel use has the potential to reduce carbon dioxide emissions significantly. The plants used to make biodiesel require three essential elements in order to grow: the sun, water, and CO<sub>2</sub>. Thus, during the growing process, these to-be biodiesel plants remove CO<sub>2</sub> from the atmosphere and incorporate it into biomass. After the plants are harvested and rendered into biodiesel, combustion of the fuel in an engine releases the sequestered CO<sub>2</sub> back into the atmosphere. Unlike petroleum-based fuels that add geological reserves of CO<sub>2</sub> into the atmosphere, biodiesel simply utilizes current environmental CO<sub>2</sub> within a closed cycle.

## 6.2 Emissions

A standard diesel engine releases emissions that directly relate to the quality of the environment. These include Nitrogen Oxides (NO<sub>x</sub>), Sulfur Oxides (SO<sub>x</sub>), Carbon Monoxide (CO), Particulate Matter (PM), volatile organic compounds (VOCs), and Carbon Dioxide (CO<sub>2</sub>); all of which negatively affect Vermont and the global environment. The use of biodiesel can help reduce these emissions.

In accordance with efforts to curb the release of the aforementioned emissions, various measures within the Clean Air Act (1990) set limits on emission quantities. With the transportation demands of Vermont increasing, the consequent increase in diesel usage across the state means that *these emission ceilings are being approached*.

The Clean Air Act is intended to curb the release of smog-related and general atmospheric pollution at the state, regional, and national levels. The NAAQS (National Ambient Air Quality Standards) are the particular levels of emissions that states cannot exceed (based upon varying per volume amounts).<sup>35</sup> The regulated emissions (SO<sub>x</sub>, NO<sub>x</sub>, PM, CO, and ozone), also called the “criteria pollutants,” are controlled by regulating the machines (i.e. engines) that produce them. Currently, Vermont is within the legal limits of all of the criteria pollutants. However, the state should be mindful of NO<sub>x</sub> emissions levels, for it is with this emission that they are closest to exceeding the allowable maximum amount.<sup>36</sup>

Introducing any blend of biodiesel (B1-B100) into the mainstream diesel market would decrease most undesirable emissions. However, the change in emissions levels varies with the individual biodiesel blend that is used. Table 1 provides the percentage changes in various emissions (relative to those from conventional petrodiesel) for various biodiesel blends. Generally, as the percentage of biodiesel blended with diesel increases,

there is a concomitant reduction in harmful emissions. A notable exception is NOx emissions, which increase slightly with biodiesel use. *Since Vermont is close to the Clean Air Act NOx cap, the effect upon NOx emissions levels from an increase in biodiesel use requires careful analysis.* Overall, however, biodiesel has the potential to reduce harmful emissions from current levels by up to 80 percent. This is equivalent to removing roughly 4,000 of the 5,000 registered diesel vehicles on Vermont roads each year.<sup>37</sup>

**Table 1. Percentage Changes in Emissions from various blends of Biodiesel relative to Petrodiesel.**<sup>38</sup>  
PM = Particulate Matter; HC = Hydrocarbons; CO = Carbon Monoxide; NOx = Nitrogen Oxides; SOx = Sulfur Oxides; CO<sub>2</sub> = Carbon Dioxide. These data are graphically illustrated in Figure 1.

% Biodiesel	PM	HC	CO	NOx	SOx	CO <sub>2</sub>
1	-0.64	-1.11	-0.65	0.10	-1.00	-0.78
5	-3.14	-5.44	-3.23	0.49	-5.00	-3.92
10	-6.18	-10.59	-6.35	0.98	-10.00	-7.85
20	-11.99	-20.06	-12.30	1.98	-20.00	-15.69
30	-17.43	-28.53	-17.87	2.98	-30.00	-23.54
50	-27.33	-42.86	-27.97	5.02	-50.00	-39.23
80	-39.99	-59.16	-40.84	8.15	-80.00	-62.76
100	-47.19	-67.36	-48.11	10.29	-100.00	-78.45

### 6.3 Land-Use Issues

Switching to an agricultural fuel sector (as opposed to the traditional petroleum-based energy sector) diminishes the environmental impacts associated with petroleum exploitation. However, it does present an array of environmental concerns. In particular, the increased demand for farmland associated with increasing cultivation of corn, sugarcane, soy, and other alternative fuel stocks will place added stress on the environment. Such concerns include the use (and misuse) of pesticides and increased nitrogen-based fertilization. These issues will need to be addressed; ideas may include the use of organic farming methods.

## 7. CASE STUDY: MINNESOTA

In March 2002 Minnesota passed statute 239.77<sup>39</sup> mandating that all diesel fuel sold or offered for sale in the state of Minnesota contain at least two percent biodiesel.<sup>40</sup> The mandate took effect in September 2005 and was designed to stimulate economic growth in the state’s agricultural and industrial sectors. Minnesota was the first state to require that all petrodiesel sold is blended with biodiesel.

On December 23, 2005 the state issued a variance dropping the two percent mandate because of numerous reports of problems with filter plugging and clogging.<sup>41</sup> It was found that batches of fuel did not meet the American Society for Testing and Materials (ASTM) D 6751 specifications for biodiesel blends lower than five percent. As a result,

Minnesota increased quality control for biodiesel, requiring all biodiesel producers to become accredited under the BQ-9000 program established by the National Biodiesel Board. In addition, the state required a certificate of analysis for each batch of biodiesel produced.<sup>42</sup> Since the new specifications were introduced and the B2 mandate was reinstated, no quality issues have been reported with biodiesel.

Whatever policy route the state may ultimately decide upon, ensuring fuel quality is of the utmost importance in maintaining and expanding Vermont's biodiesel market. The experience in Minnesota vividly illustrates this point. To that end, Vermont may consider following Minnesota's lead and require certification that each batch of biodiesel produced meets ASTM D 6751 specifications for biodiesel. Inspections done at the point of blending would allow testing centers to be centralized around distribution points. Further studies are needed to determine a testing program's exact protocols. In addition, Vermont may consider mandating that all biodiesel producers selling in the state be accredited under the NBB's BQ-9000 quality control program. Utilizing these two means of quality control has the potential to ensure that Vermont consumers get biodiesel that meets fuel quality standards.

## **8. POLICY OPTIONS**

Vermont has a number of available options with respect to statewide policy on biodiesel. Further studies are needed to determine the impact of the policy options outlined below.

### *8.1 Statewide Content Mandate*

One way to introduce a statewide biodiesel standard would be to implement a program that is similar in approach to that of Minnesota. The state could set regulations on fuel mix and quality but leave the means of meeting the aforementioned regulations to the private sector. For example, Vermont could require that all diesel sold in the state contain 2 percent biodiesel.

The cleaning properties of 'neat' biodiesel and higher biodiesel blends have already been discussed (sections 3.1-3.2), but these deserve significant attention by policymakers considering a statewide mandate. In cars, fuel filters can become clogged with sediment accumulated inside the engine during initial use. Rubber hoses and gaskets could deteriorate, and consumers may experience noticeable single-digit percentage decreases in fuel mileage performance. Warranty issues (discussed in section 10) may also arise with use of higher blends of biodiesel. Most of these issues are irrelevant for low-blend biodiesel use. Thus, a mandate requiring the use of low-blend biodiesel could conceivably be implemented without significant risks to consumers. Policymakers should also consider the issue of consumer awareness since misleading information about this complex topic could easily propagate.

In addition, the novelty of biodiesel use in Vermont necessitates a significant implementation period if the state decides to require that all petrodiesel be blended with

biodiesel. Minnesota's program gave fuel producers, suppliers, and retailers three years to meet the state's new diesel fuel standard. Given the current small scale use of biodiesel in Vermont, the state should consider allowing a period of time in order to allow businesses to transition to a biodiesel standard and secure adequate supplies. Additionally, a statewide biodiesel mandate has the potential to spur growth in Vermont's biodiesel industry, although additional studies are needed to determine the full economic impact of such a mandate.

### *8.2 Biodiesel Use in State Vehicle Fleets*

Vermont's biodiesel market and usage would increase by requiring that all diesel vehicles in the state's fleet use biodiesel blends. This would likely increase the availability of biodiesel statewide since retailers and suppliers would have a guaranteed market for their product across the state. However, the increased cost associated with biodiesel may be a drain on the resources of state agencies. Nonetheless, requiring state vehicle fleets to use biodiesel blends has the potential to stimulate growth in the state's biodiesel market without the creation of a consumer-oriented statewide biodiesel program.

### *8.3 Tax Incentives*

Vermont might explore the use of tax incentives to spur biodiesel use within the state's borders. Although the economic impact of tax incentives on biodiesel use lies outside the scope of this report, the state has the ability to utilize tax incentives to stimulate the use of biodiesel. Specifically, implementing tax rebates for either retailers who sell biodiesel or consumers who purchase it instead of conventional petrodiesel has the potential to expand Vermont's biodiesel market. The state may wish to explore the efficacy of tax incentives in expanding the use of biodiesel.

## **9. CONCLUSION**

The use of biodiesel may significantly reduce certain detrimental human-caused stresses on the environment. The data presented here shows how most harmful criteria emissions are reduced as the use of petrodiesel is replaced with biodiesel. In addition, the transition to biofuels as an alternative energy source may mitigate energy security concerns for the state. However, at the same time, the switch could be very expensive.

Biodiesel's status as a new fuel and the issues that arose from the implementation of Minnesota's biodiesel program reinforce the need for strict quality-control measures that will assist in the establishment of a reliable and efficient supply network. Thus, Vermont may aim to establish these measures *prior* to the implementation of any mandated policy requiring biodiesel use in the state. Currently, Vermont lacks a sound and extensive in-state supply network for biodiesel, although expansion is occurring. The potential benefits and incurred costs of implementing a biodiesel market in Vermont warrant further study.

- 
- <sup>1</sup> IPCC, Working Group I. "Climate Change 2007: The Physical Science Basis-Summary for Policymakers". February 2007, Geneva, Switzerland. pp. 2.
- <sup>2</sup> Miller. Environmental Science. Ed. G. Tyler Miller Jr. United States: Thomson Brooks/Cole. 2006.
- <sup>3</sup> Delhagen, Edward. "The Vermont Biodiesel Project: Building Demand in the Biofuels Sector". October, 2006.
- <sup>4</sup> Alternative Fuels Data Center. "Alternative Fuels: Biodiesel". 14 June 2006. United States Department of Energy: Energy Efficiency and Renewable Energy. 7 Nov. 2006. <<http://www.eere.energy.gov/afdc/altfuel/biodiesel.html>>.
- <sup>5</sup> National Renewable Energy Laboratory. "Biodiesel Handling and Use Guidelines". 29 March 2007. <[http://www.nrel.gov/vehiclesandfuels/npbf/feature\\_guidelines.html](http://www.nrel.gov/vehiclesandfuels/npbf/feature_guidelines.html)>.
- <sup>6</sup> Radich, Anthony. United State Energy Information Administration. "Biodiesel Performance, Costs, and Use". June, 2004.
- <sup>7</sup> Radich, Anthony. United State Energy Information Administration. "Biodiesel Performance, Costs, and Use". June, 2004.
- <sup>8</sup> Bickel, Kenneth and Kelly Strebig. "Final Report for Soy-Based Diesel Fuel Study". University of Minnesota Center for Diesel Research. June, 2000.
- <sup>9</sup> U.S. Department of Energy. "Biodiesel". 29 March 2007. <<http://www.eere.energy.gov/cleancities/blends/pdfs/5450.pdf>>.
- <sup>10</sup> U.S. Department of Energy. "Biodiesel". 29 March 2007. <<http://www.eere.energy.gov/cleancities/blends/pdfs/5450.pdf>>.
- <sup>11</sup> Radich, Anthony. United State Energy Information Administration. "Biodiesel Performance, Costs, and Use". June, 2004.
- <sup>12</sup> "Fuel Fact Sheet: Standards and Warranties." National Biodiesel Board. 11 Nov 2006 <[http://www.biodiesel.org/resources/fuelfactsheets/standards\\_and\\_warranties.shtm](http://www.biodiesel.org/resources/fuelfactsheets/standards_and_warranties.shtm)>.
- <sup>13</sup> "BQ-9000: The National Biodiesel Accreditation Program." BQ-9000. 11 Nov 2006 <<http://www.bq-9000.org/>>.
- <sup>14</sup> "A Biodiesel Primer: Market & Public Policy Developments, Quality, Standards & Handling." Methanol Institute and International Fuel Quality Center. 2006. p. 8.
- <sup>15</sup> "State Incentives and Laws: Vermont." Alternative Fuels Data Center. United States Department of Energy: Energy Efficiency and Renewable Energy. 11 Nov 2006 <[http://www.eere.energy.gov/afdc/progs/view\\_ind.cgi?afdc/5754/0](http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5754/0)>.
- <sup>16</sup> Delhagen, Edward. "The Vermont Biodiesel Project: Building Demand in the Biofuels Sector". October, 2006.
- <sup>17</sup> Vermont Office of the Governor. "The Governor's Bio-fuels Proposal". 4 January, 2007. Available at: <[http://www.vermont.gov/governor/priorities/Bio-Fuels\\_25\\_x\\_25\\_Initiatives\\_2007.pdf](http://www.vermont.gov/governor/priorities/Bio-Fuels_25_x_25_Initiatives_2007.pdf)>.
- <sup>18</sup> Delhagen, Edward. "The Vermont Biodiesel Project: Building Demand in the Biofuels Sector". October, 2006.
- <sup>19</sup> Delhagen, Edward. "The Vermont Biodiesel Project: Building Demand in the Biofuels Sector". October, 2006.
- <sup>20</sup> Delhagen, Edward. "The Vermont Biodiesel Project: Building Demand in the Biofuels Sector". October, 2006.
- <sup>21</sup> Vermont Economic Development Authority. "VEDA Loan Boosts Canadian Firms' Plans to Develop First Large-Scale Biodiesel Fuel Production Facility in Vermont". 17 Aug 2006. Vermont Economic Development Authority. 7 Nov 2006. <<http://www.veda.org/interior.php/pid/3/sid/14/nid/18>>.
- <sup>22</sup> "Biodiesel Handling and Use," p. 50.
- <sup>23</sup> Delhagen, Edward. "The Vermont Biodiesel Project: Building Demand in the Biofuels Sector." Vermont Biodiesel Project. p. 4.
- <sup>24</sup> Netaka White, Vermont Biofuels Association, 23 October 2006. Telephone-Interview.
- <sup>25</sup> Netaka White, Vermont Biofuels Association, 23 October 2006. Telephone-Interview.
- <sup>26</sup> "Biodiesel Stations in Vermont." User-compiled web page. Available: <<http://biodieselpumps.wikispaces.com/Vermont>>
- <sup>27</sup> "Sugarbush Resort Biodiesel Pilot Project: Experiences in Using B20 Biodiesel in our 2004-2005 Mt. Ellen Winter Operations: A Report to the Vermont Sustainable Jobs Fund." Sugarbush Resort. Available: <<http://www.sugarbush.com/uploadedFiles/AboutUs/biodieselgrantreport.pdf>>

- 
- <sup>28</sup> Telephone interview with Ellen Kahler, Vermont Sustainable Jobs Foundation, 23 October 2006. Kahler estimated a separate tank costs \$50-100,000. The researchers have not been able to verify this figure.
- <sup>29</sup> “Fact Sheet: Biodiesel and Underground Storage Tank Systems.” Land Quality Underground Storage Tank Program, Department of Environmental Quality, State of Oregon. 2006. Available: <<http://www.deq.state.or.us/wmc/pubs/factsheets/tank/BiodieselUSTSystems.pdf>>
- <sup>30</sup> U.S. Department of Energy “2004 Biodiesel Handling and Use Guidelines.” Energy Efficiency and Renewable Energy, U.S. Department of Energy. p. 39. Available: <http://www1.eere.energy.gov/biomass/pdfs/36182.pdf>
- <sup>31</sup> Intergovernmental Panel on Climate Change. “Summary for Policymakers”. February 2007. Available at: <http://www.ipcc.ch/SPM6avr07.pdf>.
- <sup>32</sup> Washington Post. “What Will Really Bring Cleaner Air”. James Handley. Available at: <http://www.washingtonpost.com/wp-dyn/content/article/2007/04/16/AR2007041601435.html>
- <sup>33</sup> Vermont Office of the Governor. ‘Governor Douglas Leads on Climate Change’. 8 November 2006. Available at: <http://www.vermont.gov/tools/whatsnew2/index.php?topic=GovPressReleases&id=1642&v=Article>
- <sup>34</sup> Regional Greenhouse Gas Initiative. ‘About RGGI’. 10 November 2006. Available at: <http://www.rggi.org/>.
- <sup>35</sup> Wikipedia. ‘National Ambient Air Quality Standards’. 10 November 2006. Available at: [http://en.wikipedia.org/wiki/National\\_Ambient\\_Air\\_Quality\\_Standards](http://en.wikipedia.org/wiki/National_Ambient_Air_Quality_Standards).
- <sup>36</sup> Vermont Department of Environmental Conservation. ‘2005 Annual Report on Air Quality’. 12 November 2006. Available at: <http://www.anr.state.vt.us/air/Monitoring/hm/2005AnnualReport.htm>.
- <sup>37</sup> Bureau of Transportation. ‘Vermont Fast Facts: 2000’. 10 November 2006. Available at: [http://www.bts.gov/publications/state\\_transportation\\_profiles/vermont/html/fast\\_facts.html](http://www.bts.gov/publications/state_transportation_profiles/vermont/html/fast_facts.html)
- <sup>38</sup> Biodiesel. ‘Emissions Calculator’. 10 November 2006. Available at: <http://www.biodiesel.org/tools/calculator/default.aspx?AspxAutoDetectCookieSupport=1>
- <sup>39</sup> Morris, David. “Biodiesel Mandate – Minnesota”. New Rules Project. Mar 2002. 5 Nov. 2006. <http://newrules.org/agri/biodieselmn.html>.
- <sup>40</sup> Minnesota Statute 239.77 Accessed 1 Nov 2006. [http://www.eere.energy.gov/afdc/progs/view\\_ind.cgi?afdc/5452/0](http://www.eere.energy.gov/afdc/progs/view_ind.cgi?afdc/5452/0)
- <sup>41</sup> Zerman, Nicholas. “Remember December”. Biodiesel Magazine. Oct 2006.
- <sup>42</sup> Methanol Institute and International Fuel Quality Center. “A Biodiesel Primer: Market and Public Policy Developments, Quality, Standards and Handling”. April, 2006.