

The Biodiesel Alternative for Duke University Transportation Services

By Environmental Alliance
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Introduction

Environmental Alliance is committed to improving the quality and cleanliness of campus transit. While many alternatives to diesel powered buses do exist, Environmental Alliance's own research suggests that biodiesel would be the least-cost, highest-impact alternative fuel for the Duke community. The aim of this report is to share the data which led us to that conclusion.

What is biodiesel? Biodiesel is a biodegradable, nontoxic diesel fuel substitute that can be used in unmodified diesel engines. Most biodiesel is now made from soybean oil and "yellow grease," which is recycled cooking oil that may include canola, palm, soy, and other oils. Because it is manufactured from farm crops, it is also considered a renewable fuel.

Benefits

Biodiesel has significant added value over petro-diesel.

1. Health Effects

- a. Many of the compounds found in diesel emissions are known to be cancer causing. According to the DOE's Office of Transportation Technology, emissions from vehicles using B100 contain 94% less carcinogenic particulate matter than petro-diesel emissions.¹
- b. A recent report by the Environmental Protection Agency showed that even short-term exposure to diesel emissions can significantly increase the risk of asthma and other respiratory ailments. This is of particular concern when breathing rates go up with activity, such as jogging, biking or walking along Campus Drive.

2. Campus Aesthetics

- a. While diesel smoke attracts negative attention to the buses on campus, even a 20% mix of biodiesel has been shown to reduce visible emissions by 35%.²
- b. According to Rick Fallon, the operations manager of University of South Florida's B100 fleet, "It burns very clean, the exhaust smells pleasant (by comparison to petroleum). No black smoke. I believe it improves the campus environment."

3. Performance

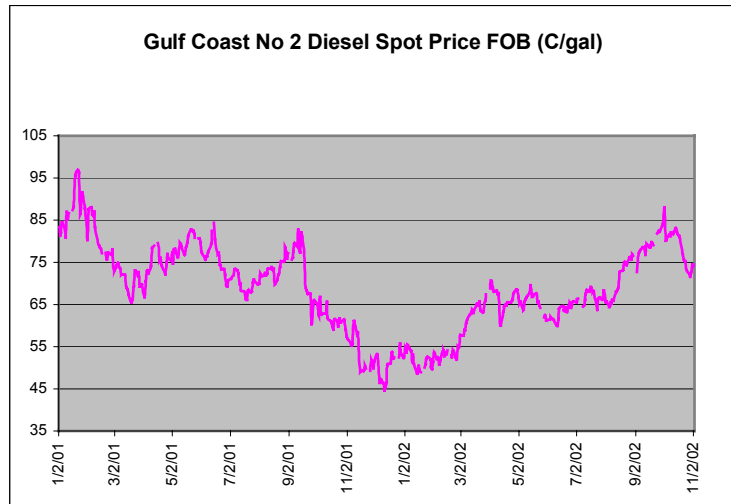
- a. Biodiesel is characterized by a far higher lubricity than petro-diesel, particularly low sulfur petro-diesels, which extends engine life and

reduces maintenance costs. Even a 1% blend of biodiesel improves lubricity by 65%.³

- b. B20 performs with equivalent torque, horsepower, fuel economy and haulage rates to petro-diesel. However, fuel economy with B100 is 10% lower than with petro-diesel. That is actually small compared with CNG's 40% penalty. (CNG contains 60% less energy per unit volume than petro-diesel, offsetting its cheaper cost.)⁴

4. Budgeting

- a. Using biodiesel makes budgeting easier because it protects the user from price spikes in the international oil markets. The price of biodiesel fluctuates far less than petro-diesel. One biodiesel supplier stated their price fluctuated only \$18 over the same time period charted at right. Most of that fluctuation is the result of higher feedstock prices during the winter months and can be accounted for in contracts in advance. (chart source: DOE)⁵



- b. Today, the US imports more than 53% of its oil. That number is projected to reach 70% by 2010. Because biodiesel is made from renewable, domestically grown crops, its use decreases the nation's dependency on oil imports while increasing the local farm economy.

5. Liability

- a. Biodiesel actually degrades about four times faster than petroleum-based diesel fuel when accidentally released into the environment.
- b. Biodiesel is safe to handle and transport because it is as biodegradable as sugar, ten times less toxic than table salt, and has a higher flash point than petro-diesel.
- c. The relative safety of biodiesel makes the cost of permitting and maintaining a biodiesel filling station cheaper than any other fuel.

6. Flexibility

- a. Compared to other alternatives, such as compressed natural gas (CNG), a conversion to biodiesel does not represent a permanent commitment of resources. It is easy to phase in *and* phase out if necessary.

7. Air Pollution

- a. Duke's peer institutions, such as Harvard, Cornell, Tufts and UPenn have made commitments to meeting the Kyoto Protocols. As it is likely Duke will be called upon to make a similar commitment to reducing green house gas emissions, Transit Services could lead the way with biodiesel.

According to several studies, life cycle greenhouse gas emissions from buses running on B100 are 78% lower than those running on petro-diesel.⁶

- b. Biodiesel contains only trace amounts of sulfur.
- c. According to an EPA emissions study, biodiesel emissions contain far fewer of the regulated and unregulated compounds found in emissions:

Avg. Biodiesel Emissions Compared to Petro-Diesel

<i>Emission Type</i>	<i>B100</i>	<i>B20</i>
<u>Regulated</u>		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NOx *	+10%	+2%
<u>Non-Regulated</u>		
Sulfates	-100%	-20%**
PAH (Polycyclic Aromatic Hydrocarbons)***	-80%	-13%
nPAH (nitrated PAH's)****	-90%	-50%
Ozone potential of speciated HC	-50%	-10%

* Repeated studies show that retarded fuel injection timing reduces NOx emissions below petrodiesel while maintaining the other emissions reductions.⁷

** Estimated from B100 result

*** Average reduction across all compounds measured

**** 2-nitroflourine results were within test method variability

Costs & Savings

The major costs and savings associated with biodiesel fall into two categories: one-time infrastructure modifications and regular supply costs.

Infrastructure:

- **Modifications** - The engines do not need to be modified in order to use any blend of biodiesel. However, biodiesel will soften and degrade hoses and gaskets made with certain types of elastomers and natural rubber compounds over time. During routine maintenance, non-compatible hoses should be replaced with biodiesel compatible elastomers. (Low sulfur diesel has this same requirement.)
- **Fuel Filters** - Biodiesel burns cleaner than petro-diesel and breaks loose carbon built up by the combustion of petro-diesel. For this reason, fleet managers have noticed a need to replace oil filters more frequently during the period immediately following the switch to biodiesel.
- **Filling Station** - The current filling station and 10,000 gallon tank can be used for biodiesel with only small modifications. Because biodiesel has a

higher cloud point, it must be kept above 29°F. Duke’s above ground tank would need to be enclosed and/or heated with a steam ginny during the winter months. If Duke decided to install a separate facility for biodiesel, the costs of installing a biodiesel filling station are significantly less than installing either diesel or CNG filling stations because of the low flammability and low toxicity of biodiesel. A \$100,000 tax deduction would be available to offset the costs of installing a biodiesel filling station.⁸

- **Engine Life** - Because biodiesel burns cleaner and has far higher lubricity than diesel, it prolongs the life of engines and decreases maintenance costs.

Supply:

Duke is currently paying roughly \$1.41 /gal for petro-diesel from Couch Oil. Biodiesel is only marginally more expensive. The price of biodiesel varies greatly between suppliers depending on what feedstock they use in the refining process. Recycled yellow grease is less expensive than soybean oil. Therefore, suppliers that use primarily recycled yellow grease offer the lowest prices on biodiesel. The table below represents price quotes from 6 suppliers Environmental Alliance contacted. The “PF” column designates whether yellow grease (Y) or soy (S) are the suppliers primary feedstock.

Company*	Price	Shipping	Total	PF	Comment
Ocean Air Environ. Lakeland, FL	\$1.40	¢7-10	\$1.48	Y	Currently supplying B100 to University of South Florida
Biodiesel Industries Las Vegas, NV	\$1.35	¢20	\$1.55	Y	Current capacity committed to 2,500 gov’t fleet vehicles. New facility coming in spring.
World Energy Chelsea, MA	\$1.74	¢9	\$1.83	S	Supplies all of NCDOT out of Charlotte facility.
Griffin Industries Cold Spring, KY	\$1.69	¢10-12	\$1.83	S	
Couch Oil, Durham NC	\$2.25	-	\$2.25	S	Currently supplies Duke’s petro-diesel.
Filter Specialty Fayetteville, NC	\$2.25	-	\$2.25	S	Currently, building new facility. Starts in the spring.

*The full contact information for these distributors can be found on <http://www.nbb.org>

In most states where biodiesel use has caught on, an exemption from road taxes has been awarded for biodiesel but that has not happened in North Carolina yet. The road tax is ¢23 per gallon. However, Duke’s non-profit exemption from the road tax, using diesel, should apply to biodiesel as well. In order to verify this, Duke should contact the Motor Fuels and Tax Division.

Duke does have one other supply option: refining its own biodiesel. Biodiesel Industries in Las Vegas, NV manufactures Modular Processing Units (MPUs) that they claim would allow Duke to refine its own biodiesel for 70 cents

per gallon with only two staff and student assistants. This could be a valuable educational experience (chem. engineering, business school, etc.), as well as generate a profit from the sale of biodiesel to other fleets in the area. Biodiesel Industries claims an MPU facility will pay for itself in about 4 years.

Worst-case Scenario:

The total one-time infrastructure cost is going to depend largely on whether or not the University decides to build a separate filling station for biodiesel or convert the current station to biodiesel (and all the vehicles that use it). In either case, the permitting and equipment costs for biodiesel are negligible when compared to other alternatives that require new buses, such as CNG or hybrid technology.

As for supply, let's assume \$1.83 is the lowest price Duke could secure for a biodiesel contract. This is quite conservative considering 2 out of the 6 suppliers contacted by Environmental Alliance quoted prices significantly below that. Let's also assume that Duke decides to blend biodiesel with diesel up to the point where the price per gallon is no more than 20 cents more than straight diesel. For our \$1.83 example, Duke would use a blend of 50% biodiesel with 50% diesel, which gives an increase of 20 cents per gallon. At the fleet's current rate of 7500 gallons every 10 days, the total additional cost of biodiesel purchasing would amount to \$52,000 per year.

In a more likely scenario of say, \$1.60 per gallon, the cost of using 100% biodiesel would be less than the 20 cent limit and the total additional cost would still be \$52,000 a year. In effect, Duke can ensure that the additional cost of biodiesel purchasing never exceeds \$52,000 a year by using the 20 cents per gallon cut off.

Risk Assessment

While biodiesel used to be considered an experimental fuel, it has now been proven so reliable in 200 fleets and over 40 million road miles that the EPA modified the EPAct to make biodiesel the primary alternative for military and federal fleets. Similarly, states and school districts have been moving to mandate the use of biodiesel. Current users of bio-diesel include:

- U.S. Department of Agriculture
- General Services Administration
- Department of Energy
- Several National Parks
- Numerous State Transportation
- Departments
- U.S. Postal Service
- School Districts
- Transit Authorities
- Numerous Utilities

- Environmentally conscious private companies

This growth has largely mitigated any risk involved with a transition to biodiesel. A final specification (D-6751) for the formulation of biodiesel has been developed and is available from ASTM at <http://www.astm.org>. Similarly, initial concerns about warranties have proven needless. The use of biodiesel in existing diesel engines does not void parts and materials workmanship warranties of any engine manufacturer.

As mentioned above, because biodiesel and diesel can be blended at different percentages or used interchangeably, fleets are protected from price shocks in either market.

For first hand information on making the switch in a university setting, Rick Fallon, the Transportation Coordinator at the University of South Florida, is a valuable resource. He can be contacted at rfallin@admin.usf.edu, (813) 974-3256.

Conclusion

Biodiesel represents a viable and immediately available alternative to diesel fuel. As the health and environmental risks associated with petrodiesel are becoming more and more undeniable, it is imperative Duke move to cleaner fuels. The relatively low cost of biodiesel infrastructure, the competitiveness of its pricing and the flexibility it offers the fleet make it a natural choice for implementation here at Duke.

¹ DOE's Office of Transportation Technology www.ott.doe.gov/pdfs/jtb_biodiesel.pdf

² US Department of Energy Clean Cities Program <http://www.ccities.doe.gov/pdfs/biodiesel101.pdf>

³ DOE's Office of Transportation Technology www.ott.doe.gov/pdfs/jtb_biodiesel.pdf

⁴ According to a January 2000 study by the Harvard Center for Risk Analysis <http://www.cai-infopool.org/downloads/cng-vs-diesel-risks-harvard.pdf>

⁵ http://www.eia.doe.gov/oil_gas/petroleum/info_glance/prices.html

⁶ Summary of life cycle studies http://www.biodiesel.org/pdf_files/LifeCycle_Summary.PDF

⁷ Several studies citing lower NOx: http://journeytoforever.org/biodiesel_nox.html

⁸ Deductions for Clean-Fuel Vehicles and Refueling Property
http://www.dsireusa.org/dsire/library/includes/incentive2.cfm?Incentive_Code=US30F&State=Federal¤tpageid=1