

Waste Vegetable Oil from Dining Services to Fuel Campus Lawn Mowers

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Executive Summary

There are twelve operating diesel fueled lawn mowers used by Western Michigan University's Landscaping Service, each which emits 9.987kg of carbon dioxide per gallon (or 0.01 tons), according to Chris Caprara, an environmental studies student at Western, from the greenhouse gas emission inventory done this semester. With 1055.65 gallons of fuel used last year, that is over 10 tons of carbon emitted from just our landscaping service's lawn mowers annually,¹ which is equivalent to the annual emissions of two standard cars². This is a significant amount of a known greenhouse gas, which contributes not only to global warming but also to adverse human health effects. Not only is carbon dioxide emitted; nitrogen oxide, a contributor to ground level ozone, smog and respiratory ailments; particulate matter, which also contribute to adverse health effects; and carbon monoxide, which is known to worsen symptoms of heart disease³(<http://www.peoplepoweredmachines.com/faq-environment.htm>).

While we are operating twelve lawn mowers and many campus maintenance vehicles on diesel fuel, we are continually contributing to greenhouse gas emissions and worsening the quality of air, which could be prevented by switching to a more environmentally friendly fuel, like straight vegetable oil. By researching fuel alternatives at other campuses and working with the Director of Western Michigan University's Landscaping Services, Tim Holysz, we have provided analyses representing the success of vegetable oil use and the potential for Western Michigan University to implement alternative fuel as well. The case studies researched in detail are as follows:

- Bowling Green State University

Short descriptions of other universities who have also implemented SVO or biodiesel into their campus operations:

- Bowdoin University
- Furman College
- Warren Wilson College

By taking one step at a time, we could be lessening our adverse impact on the community, and for this, switching the Landscaping Services diesel fueled lawn mowers to straight vegetable oil is appropriate. Straight vegetable oil is a convenient alternative because it is compatible with diesel fueled engines while requiring light modifications to the diesel fuel tank. Included in our research is a way to use waste vegetable oil from campus Dining Services to provide Landscaping Services with the fuel. Judy Gipper has

¹ Figure 1055.65 gallons, according to Tim Holysz, which was received via e-mail correspondence. See Appendix 2. Ten tons calculated using the greenhouse gas emissions inventory figures for CO₂ emitted per gallon of diesel fuel. 1.008×10^{-2} MT CO₂/gallon converted into metric tons (MT) annually.

² Gasoline CO₂ emissions is 8.92×10^{-3} MT/gallon. Average miles driven annually, according to the EPA are approximately 12000mi at 20mpg. $12000/20=600$ gallons, $600\text{gall} \times (8.92 \times 10^{-3}\text{CO}_2/\text{gall})= 5.4\text{MT CO}_2$

³ Chart provided in Appendix 1 by <http://www.peoplepoweredmachines.com/faq-environment.htm> titled "The Six Common Air Pollutants"

approximately 2000 gallons of waste vegetable oil annually, while Tim Holysz is using 1055.65 gallons of diesel fuel annually in the lawn mowers. Therefore, there is plenty of oil available to fuel Landscaping services mowers. This is a way to recycle and reuse a resource on campus, which will eliminate some costs for the Landscaping Department and be an example to the wider college community how resourceful Western Michigan University can be.

As a result from our research and in conjunction with Tim Holysz and Judy Gipper, Director of Campus Dining Services, we found our first steps would be to run a pilot on one of the currently diesel fueled lawn mowers using straight vegetable oil as an alternative, and to closely monitor engine responsiveness, engine quality before and after the switch, maintenance, and other subjective inputs. The pilot could provide more information and data on the use of straight vegetable oil in campus lawn mowers.

In recognizing the magnitude of such an unsustainable practice we have in operation on campus, using straight vegetable oil in the campus lawn mowers would be an approach in fulfilling Western Michigan University's mission to becoming more sustainable by participating in just and ecologically sustainable resources, taking responsibility for the physical environment, and taking local action for the greater good of the global community. (WMU Sustainability website)

Introduction

Straight vegetable oil (SVO) is recycled waste oil that has been filtered but has not undergone transesterification which would chemically convert it into biodiesel. It is a renewable resource and is carbon neutral because the oil has already been accounted for. Although the Environmental Protection Agency reports that to date they have not certified the use of vegetable oil in diesel engines and have not further studied emissions or use of vegetable oil. Therefore, there is no hard scientific data regarding the use of vegetable oil, but because it is carbon neutral, it is considered a biofuel.

We first researched other campuses that have implemented biodiesel as an alternative landscaping fuel. As our research progressed, we found straight vegetable oil would be more conducive for the highly productive summer months of landscaping services, because biodiesel and SVO are both highly viscous and can be problematic in four-season climates if it is going to be used year-round. The gelling point for biodiesel can occur at just a few degrees below freezing point ($\approx 30^{\circ}\text{F}$) (journeytoforever.org). While the gelling point for SVO is closer to 20°F (<http://www.patentstorm.us/patents/7241321/description.html>). Implementing SVO for the landscaping services lawn mowers is feasible because they are only used in months above freezing point.

After corresponding with Matthew Hollander, former Western Michigan University student involved in the start up of the Biodiesel Cooperative in McCracken Hall,

through e-mail and interview, we found biodiesel when mass produced creates copious amounts of a byproduct called glycerin, which has not been properly disposed of and currently has no functional use. Also, in order to chemically convert the vegetable oil through the process of transesterification, a catalyst is needed. Methanol is the catalyst of choice for the Biodiesel Co/Op, which is costly and not environmentally friendly (E-mail correspondence with Matt Hollander). Methanol is a methyl alcohol and is a CNS depressant which can cause blindness if inhaled, ingested or absorbed through the skin, taking only four ounces and several hours to onset adverse health effects (Methanol).

The figure below demonstrates the pros and cons of biodiesel versus SVO, and alludes to why SVO is the more suitable choice for an alternative fuel.

Figure 1: Biodiesel versus Straight Vegetable Oil

<u>Biodiesel</u>		<u>SVO/WVO</u>	
Pros	Cons	Pros	Cons
More user friendly	Methanol is used in converting oil to biodiesel which emits 20% non-renewable CO2	No chemistry	Need to alter/modify engine. Veggie oil works most efficiently with a two-tank system
No start up cost related to modifying engine	Infinite need to chemically convert oil to biodiesel	No lifecycle emissions. Does not contribute CO2 to atmosphere	Start up cost to modify engines (\$-\$\$\$)
Good for large-scale operations	Gel point -> ~30°F	Good for small-scale operations like lawn mowing and tractors	Gel point-> ~20°F
If supply of biodiesel runs low, still have option of using petro diesel	Produces hazardous chemical byproducts, for example methanol and glycerin	Will not involve biodiesel co/op on campus, which has been an unreliable source for production of biodiesel. Could set up your own filtration system wherever storage is available and convenient for you	Vehicle resale would depreciate significantly after engine modification
	More expensive than using veggie oil	Oil will be cleaned from the choke because before turning off the engine, user switches back to diesel, cleaning the injectors out of oil	Machine wouldn't hold much diesel, so if oil supply runs low, would not be sufficient tank to run on diesel
		Potential increase in mileage, up to 20%	

* manipulations can be done on used vehicles: can be ran on veg oil 100,000 miles after vehicle has reached 200,000+ miles	
* two-tank systems have a longer lifespan than single tank systems	

According to Tim Holysz, the total annual diesel used in the lawn mower fleet last year was 1055.65 gallons. The total waste vegetable oil produced by Campus Dining Services from the 307 cases of vegetable oil purchased at 35lbs each from August to December of 2008, according to Judy Gipper with 25% absorption factors calculated in by Harold Glasser, is roughly around 2,000 gallons (e-mail correspondence with Judy Gipper and Harold Glasser). Currently, Dining Services has been lent a large collection container for their waste oil by Krueger Commodities, which is arbitrarily set to be picked up throughout the year free of charge (E-mail correspondence with Judy Gipper).

In connecting the different departments together we found the purpose for this case study is to provide the framework to implement the use of straight vegetable oil from campus dining services into landscaping services lawn mowers in an efficient, coalescent manner, and to provide logistics for a pilot to demonstrate our research in action.

The potential this project carries speaks to integrating parts of the Talloires Declaration, which ultimately lead to a closed loop system. The two points specifically related to this project are:

5.) **Practice Institutional Ecology:** Set an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations.

7.) **Collaborate for Interdisciplinary Approaches:** Convene university faculty and administrators with environmental practitioners to develop interdisciplinary approaches to curricula, research initiatives, operations, and outreach activities that support an environmentally sustainable future.

Methodology

There are a variety of processes involved in the obtaining, filtrating, use and disposal of straight vegetable oil as an alternative fuel that must be closely evaluated. Numerous locations and networks of individuals coincide to a working system that makes using this alternative fuel possible. With the help of research from community members and other Universities that have successfully incorporated SVO as an alternative fuel in their lawn serviced we have devised a system that is plausible for the use of alternative fuel on our campus.

The first key role in using SVO in the campus lawn service equipment is obtaining the food waste oil. The waste oil is a used vegetable oil that is found in restaurants or cafeterias that has been used to cook food in a deep fryer at approximately 350° Fahrenheit. After the

oil has reached the point where it is not clean enough for cooking, it must be disposed of in a separate waste container than average garbage, food waste, and recyclables. Typically another company either is paid for the service of picking up the waste oil or they will pay to take it and use it for their company, such as skin care products.

Currently Judy Gipper, the head of Western Michigan Universities Dining Services disposes their waste oil free of charge by having it picked up and transported by Krueger Commodities who uses it for their business. Krueger used to pay the Dining Services seventy five dollars per pick up to take the oil and use it for their products, yet due to a drop in the market they do not pay the dining services for their services. Fortunately, Judy was open minded to our proposal and is willing to donate her waste oil from dining services to the landscape services instead of Krueger Commodities. Thus, we had to calculate the amount of waste oil we would be able to receive and the amount needed for lawn services to decide if this process would be feasible.

Tim Holysz, the director of Western Michigan Universities Lawn Services used 1055.65 gallons of diesel fuel in his fleet of lawn services vehicles in 2008⁴. With diesel gas prices averaging close to \$2.815 between the months of May and September of 2008 that is roughly \$2972 spent on one season of gasoline for merely the lawn service vehicles⁵. While last year from August 8th, 2007 to July 31st, 2008 Judy Gipper used seven 774 cases (35lbs each) of trans-fat free canola oil, which is a total of 3,516 gallons. After subtracting fifteen percent (527.4 gallons) for the industries standard for absorption into food and an estimated ten percent (351.6 gallons) for spillage and loss from transfer we are left with a yearly accumulation of 2637 gallons of waste oil. Although for good measure we have determined on average the accumulation of waste oil can vary from 2000-2500 gallons for the year of 2009⁶. The lawn mowing season runs from about late April or early May to September. This is nearly perfect for the amount needed for lawn services fuel supply. There is also some leeway with these figures because the oil could potentially be stored in drums if more is needed or if the waste oil supply runs out near the end of the season, Tim Holysz could simply use petro diesel for the remainder of the time because there is no internal engine modification to the main fuel injectors.

After reaching the consensus that the waste oil can be obtained from the Dining Services we must indulge in where the waste oil will be transferred to for filtering and storage as well as who will be in charge of monitoring the process. Ideally, the process of obtaining the waste oil from dining services as well the transfer and filtration would be student run facilitation. Student run sustainability projects work well in Universities because it get students involved in a system that may be affiliated with their major or carrier path, in this case fields that correlate consist of environmental management, waste management, engineering, business and potentially more. Student run facilities can also be much more cost efficient because they could be volunteers in which no payments would be involved for their

⁴ Figure derived from an interview with Tim Holysz Wednesday March 25th.

⁵ Figure derived from email correspondence with Vicki Cox, see appendix three for chart.

⁶ Figure derived from email correspondence with Judy Gipper, refer to appendix two for entire conversation.

participation. Next, we must decide on a potential holding location that is affiliated with the campus and lawn services. Currently Tim Holysz sends his fleet of lawn services vehicles to the Fueling Depot located on Oliver St. This could be a perfect location for filtration because it would be located close to campus and the Physical plant where Tim is based. Tim's staff that is incorporated with the lawn services would also be familiar with the fueling depot which would make for a smooth transition from once fueling process to the next. There would also be materials and personnel within grasps for additional security for the process.

One of the most important processes of converting waste oil to usable fuel is the filtration processes. When filtering waste oil the goal is to remove all the particulate matter, clots and build ups that are hazardous for the machine. There are a few options with what equipment is used for the filtration process. There are two ways to filter the vegetable oil: gravity filter or inline filtering, which requires a pump. In order to eliminate high costs gravity filtering seems to be a viable option, but to filter in higher quantities a pump system may be beneficial (Greasecar).

With a gravity filter system, it is recommended to use multiple filtering cloths at different filtering gradients to appropriately clean the oil for fuel. In our research, we found that three filtering sessions, where the oil is strained over a 24 hour period through the different cloths, is common. It is generally useful to begin with a 100-micron filtering sleeve, then to 50-micron, and lastly to a 10-micron filter. Depending on how much oil is needed for fuel would determine the receptacle used for storage/filtering (SVO Straight Vegetable Oil).

To finalize the project we must mechanical alter the lawn service vehicles to retrofit them in a way that vegetable oil can be the main source of fuel. Unlike bio-diesel there is no chemical alteration to the fuel, thus the engine cannot start up and run strictly on vegetable oil. Vegetable oil is not combustible by itself; therefore a start up process is needed to get the vehicle going. To do this we add a smaller additional fuel tank (approximately three to five gallons) that would be filled with petro-diesel fuel, while filling up the original main tank with the straight vegetable oil⁷. Next we incorporate a coinciding switch and valve between the two tanks enabling the fuel source for the engine to be switched from the one tank to the next while the vehicle is being operated. When the vehicle is turned on the fuel source is the small petro-diesel tank due its combustibility. The vehicle must also heat up to an appropriate temperature (170^o-180^o F) before the vegetable oil can be utilized as the main source of fuel (Addison, Journey to Forever). To achieve this, the operator of the vehicle will remain using the start up tank for about five to ten minute and then will use the switch that transfers the engines intake of fuel from the petro-diesel tank to the vegetable oil tank without turning off the vehicle⁸. Once the engine intake is switched from the petro diesel tank to the vegetable oil tank, the majority of the mowing process will be run using the vegetable oil. With approximately five minutes remaining before the engine is shut off, the

⁷ Figure regarding addition fuel tank size received from Duane Hamilton of BGSU in email correspondence, see appendix two for full conversation.

⁸ The duration of using petro diesel before switching to vegetable oil is based on current system used by BGSU and the figure is received by email correspondence with Duane Hamilton, see appendix two for full conversation.

operate will switch the valves back to the petro-diesel tank allowing it to run through the vehicle clearing the engine and choke of any remnants of vegetable oil prolonging the life cycle of the vehicle⁹.

Using waste vegetable oil as an alternative fuel at Western Michigan University would be a system of a multiplicity of benefits, environmentally and socially. Each gallon of diesel gas used by the lawn services emits 0.01 tons of carbon dioxide that leads to the increasing epidemic of decreased air quality due to pollution as well as an increase of green house gasses that alters our global climate (Chris Caprara, GHG Inventory). Although the Environmental Protection Agency has not put out formal literature on the emitted particular matter from vegetable oil they have proclaimed that it is carbon neutral and more environmentally sustainable than our current fuel practices (Environmental Protection Agency). The alternative fuel system would also have an increased social dynamic between students, faculty and Western Michigan University. The collaboration of organizations and individuals on campus could lead to an increased awareness to sustainable practices and healthy living, which is an ongoing goal for the University and the surrounding community. Furthermore, incorporating a student run facility for obtaining and filtering the fuel gives students a chance to work together and further indulge in volunteer work that affiliates to their higher education.

Bowling Green State University Vegetable Oil Program

One of our most useful and influential sources for incorporating vegetable oil into the lawn services as an alternative fuel is Bowling Green State University. BGSU was able to implement vegetable oil as an alternative fuel with the determination of Professor Dr. Enrique Gomezdelcampo and his students in an Environmental Sustainability course similar to the one we are currently participating in. As a student lead project, Dr. Gomezdelcampo and his pupils were able to negotiate with Duane Hamilton, BGSU's director of campus services, to receive the waste vegetable oil from their dining services. The class had begun working on the project in 2005, yet last July they reached a large stepping stone by receiving a \$50,000 grant from the Ohio Department of Natural Resources, and organization that donated \$400,000 in Grants to support recycling at fifteen colleges and universities across the state of Ohio (Duffy, Ohio Department of Natural Resources). BGSU was one of the three schools to receive the largest grant of \$50,000 each. With that money they were able to purchase top of the line holding tank and collection drums as well as materials to build a filtration system. With all the materials necessary they also used the money to begin modifying the vehicles into the two tank fueling system.

The system that BGSU was able to get on its feet is extremely similar to the proposed system we have created. A student run facility was set up to collect and filter the waste oil from the campus's dining services. The dining hall collects their waste oil into fifty five gallon storage drums made from recycled materials. Next, under the supervision of grounds

⁹ The amount of time before reverting back to the petro diesel is based on current system used by BGSU and the figure is received by email correspondence with Duane Hamilton, see appendix two for full conversation.

department the waste oil is transferred by student workers or full time staff in a tractor (Kubota Equipment) that is retrofitted with a collection tank, pump and retractable hose. This is then transferred to the filtration site where it is pumped into the filtration system. Once the filtration process is complete the newly acquired alternative fuel is pumped into a 550 gallon storage tank. The vegetable oil can then be directly pumped from the storage tank in to the maintenance vehicles¹⁰.

Short Descriptions of Waste Vegetable Oil use at Other Universities

Bowdoin College, Brunswick, Maine: Due to a fortunate coincidence of having a 500 gallon unused storage tank in their campus heating plant, with push from students, the head of the steam plant decided to use SVO in this storage tank in order to provide heat for campus. Oil is taken from dining services once a week, which is then dumped into a recycled stainless steel hopper for filtration which was created by the heat plant staff. After it has been thoroughly filtered it is released into the storage tank and is ready to be burned for heat. There are three dining halls contributing oil to the heat plant which totals to be about 1000 gallons annually. This saves the university from purchasing around 800 gallons of #2 oil per year (e-mail correspondence with Keisha Payson).

Furman University, Greenville, South Carolina: Furman University uses waste oil from their dining services to convert into biodiesel. The oil is picked up from the dining hall receptacle and taken to a separate building, which was specifically designed for converting oil into biodiesel. The original intent of the produced biodiesel was to fuel the campus lawn mowers, which now is used for other diesel fueled maintenance vehicles on campus. The facility is student operated under the instruction and oversight of Dr. Travis Perry. Furman students are trained in the chemistry needed to chemically convert the oil into biodiesel. They use Potassium Hydroxide in their conversion which is toxic and caustic. One restriction to the volume of biodiesel they produce to run their maintenance vehicles on is after 400 gallons are used for road use, the state of South Carolina requires the university to pay a fuel tax (e-mail correspondence with Travis Perry).

Warren Wilson College Asheville, North Carolina: Warren Wilson College has a student-initiated biodiesel program. They run B20, which is a blended biodiesel fuel 20% biodiesel and 80% diesel, in their tractors which are still covered under warranty with this blend. They have switched to a lawn mower which operates on propane, the Ventrex 31hp in order to cut their emissions of hydrocarbons. They have set up a program with their local biofuel producer to pick up the dining services grease, filter and clean, and distribute to the campus facilities for use.

¹⁰ The alternative fuel process for Bowling Green State University was described to us in and email correspondence with Duane Hamilton, refer to appendix two for full conversation.

Pilot Outline

In order to create a feasible system in which waste vegetable oil is transformed into an alternative fuel for Western Michigan Universities dining services, a series of steps must be well established.

1. Deliberate where the waste oil will be obtained.
 - Campus Dining Services
2. Figure out who will be in charge of collecting and filtering waste oil once obtained.
 - Student Run Volunteer Facility
3. Decide on where the waste oil will be filtered and stored prior to the pick up by landscape services.
 - Fueling Depot on Oliver St
4. Devise a filtration system.
 - Purchase pre-made filtration kit
 - Build own filtration system
5. Manipulate lawn service vehicles for ability to use vegetable oil as main fuel source. (With help from Tim Holysz and Staff)
 - Add additional three to five gallon fuel tank to each vehicle
 - Add valve and switch allowing the engines intake of fuel to be altered from start up tank (filled with petro diesel fuel) to main tank (filled with vegetable oil)
6. Obtain potential funding from outside source.
 - Apply for Grant Money and or Research Scholarships

Western Michigan University Campus Workings

Currently Western Michigan University has Bronco Biodiesel, which is a research oriented program, who is studying biodiesel and its chemical processes (interview with Matt Hollander). Also, there is the Biodiesel Co/Op, which is a loosely run student initiative, which currently does not employ any Western Michigan students. It is located in McCracken Hall, and is not funded by the university. They receive oil donations from Food Dance, a local restaurant and Pfizer free of charge. This in turn supplies about 24 members with 10 gallons of biodiesel fuel approximately every two weeks (interview with Ian Smith).

Tim Holysz and Judy Gipper are both interested in closing the loop of waste oil on campus to be used as an alternative fuel for the lawn mowers. The interest is here, it just needs a little push.

Limitation of Analysis

Upon investigating implementing a closed loop program for fueling landscaping service's lawn mowers with waste vegetable oil from the campus dining services we found the most limiting factor to be that the labor input in transporting the oil needs to come from students. We found that both Judy Gipper and Tim Holysz do not have the manpower to allocate to this part of the project. Therefore, a student initiative is necessary.

Yet, implementing this program would also make for one more biofuel initiative on Western Michigan University's campus, which has a negative stigma for follow through currently. This project serves as a framework for a waste vegetable oil program and to integrate the two departments on campus.

Also, in order to retrofit the engines of the lawn mowers, a schematic of previously successfully retrofitted engines would be beneficial, which were not included in this report. Corresponding through e-mail with multiple people from the universities mentioned in this project was not always reliable, and the schematics were never obtained.

The next steps in order to see this project to the finish would require further investigation of a storage container for the waste oil from dining services, setting up a method for transfer of the oil, and to set up a permanent filtration site. A possible tool for transferring the waste oil from dining services to landscape services could be reusing out dated university vehicles. Once vehicles become outdated they hold an auction in which interested participants bid on low cost vehicles. Next we must finalize a filtration system to transform the waste oil into an alternative fuel and there are a variety of methods to do so. Our options consist of simply pouring the waste oil through micron-cloth into a holding drum. This is the least expensive and complicated process, yet also the least efficient in regards of removing particulate matter. Other options consist of purchasing a pre-made filtration system costing between four hundred and two thousand dollars¹¹. Currently we have projected the Fueling depot located on Oliver St, to be a potential filtration and storage site. This is the current center in which petro-diesel is stored for filling up the lawn service vehicles.

To truly see this project come to fruition it will be necessary to continually work with Tim Holysz and his maintenance crew to retrofit his lawn mower engines and follow up after the pilot with data concerning engine quality.

¹¹ The estimation for purchasing a filtration system derived from researching a variety of filter for sale online refer to references for available site for purchasing pre-made filtration systems.

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Appendix 1: The Six Common Air Pollutants

<http://www.peoplepoweredmachines.com/faq-environment.htm>

The Six Common Air Pollutants:		
Pollutant	Its Sources	Health Effects
Carbon Monoxide	Combustion processes, such as in gas mowers, cars & industry. Any burning of organic material.	Replaces oxygen in the bloodstream; aggravates heart disease; impairs alertness.
Lead	Smelters, battery plants & refineries; the exhaust of equipment that use leaded gasoline; lead-based paint or pottery.	Increased risk of harm to central nervous system, especially in children.
Nitrogen Oxide	Combustion processes, such as	Impairs breathing, increases lung

	in gas mowers, cars & power plants.	infections & worsens existing lung disease.
Ozone	Formed when heat & sunlight mix with pollutants from industry, gas powered equipment & household products.	Irritates eyes, nose & throat; increases asthma attacks & impairs athletic performance.
Particulate matter	Dust, pollen, soot & other small particles suspended in the air.	Irritates lungs' pathways which can increase respiratory infection & asthma attacks & worsen disease.
Sulfur Dioxide	Oil- and coal-burning power plants; some industrial processes.	Increases respiratory infections & asthma attacks; worsens chronic lung disease.

Appendix 2: E-mail Correspondence:

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Furman College:

From ▶ Angela Halfacre <angela.halfacre@furman.edu>
 Sent Monday, February 23, 2009 5:25 pm
 To Camilla Voelker <camilla.voelker@wmich.edu>
 Cc Frank Powell <Frank.Powell@furman.edu> , Travis Perry <Travis.Perry@furman.edu> , James Wilkins <james.wilkins@furman.edu>
 Subject Re: Biodiesel Inquiry

Dear Ms. Voelker and Mr. Madle:

We have some general information on our sustainability website at

www.furman.edu/sustain. However, for more specifics, Dr. Frank Powell and Mr. James Wilkins in our Center for Sustainability may have more information as well as our biodiesel faculty coordinator, Dr. Travis Perry. Happy to continue to assist, and hopefully this will be a good start. Best, Dr. Angela Halfacre

Camilla Voelker <camilla.voelker@wmich.edu> writes:

>Dear Angela Halfacre-

>

>This is Camilla Voelker and Bryan Madle, and we are environmental studies majors at Western Michigan University.

>

>We are working on a biodiesel/straight vegetable oil(SVO) pilot for one of the diesel lawnmowers used for campus landscaping in order to research ways to make our campus more sustainable.

>

>In our research we found your institution has implemented a similar method. We are interested in finding out more about the successes or tribulations you have experienced throughout the process in order to better understand what direction we need to take.

>

>Mainly we would like to know if you have any documents or other resources we could reference? Also, do you know or have contact with other universities that have implemented biodiesel/SVO in their maintenance fleets?

>

>Thank you for your time,

>Camilla Voelker

>Bryan Madle

From ▸ Travis Perry <Travis.Perry@furman.edu>

Sent Tuesday, March 24, 2009 3:52 pm

To Camilla Voelker <camilla.voelker@wmich.edu>

Subject Re: Biodiesel Inquiry

Camilla and Bryan,

at Furman we convert waste vegetable oil from our dining hall into to biodiesel. Biodiesel can be used in any diesel engine without performing any engine modification.

Diesel engines can also operate on pure vegetable oil. However, this process does require a mechanical modification of the vehicle. Specifically, it requires that the vegetable oil be heated to around 180 degrees F before passing through the injection system and into the diesel engine. Usually, two separate fuel tanks are installed in a vehicle with this set up. One tank contains petro diesel or biodiesel and is used to start the engine and heat the vegetable oil. Once the oil is hot, the tanks are switched and the vegetable oil is used to operate the engine.

For biodiesel production there are several considerations:

First, you must know that biodiesel production requires the use of methanol (toxic and HIGHLY flammable) and either Sodium Hydroxide (toxic and caustic) or Potassium Hydroxide (a little milder than Sodium Hydroxide but still both toxic and caustic). We use Potassium Hydroxide in our production process. Extreme caution must be used with these chemicals and your institution should have the appropriate safeguards and insurance for liability purposes.

It is my understanding that only 400 gallons of biodiesel per year can be used for road use before the producer must pay a fuel tax. This may be specific to South Carolina but you will need to check the rules and regulations specific to Michigan. To avoid this complication, we only use biodiesel for on campus purposes, concentrating on grounds equipment (lawn

mowers, tractors, etc).

Our production facility consists of a stand alone building containing a modified hot-water heater, pumps, barrels for holding waste oil and finished biodiesel, biodiesel filters, and a graduated, inverted cone holding tank for washing biodiesel. Our methanol is housed in a separate facility that is approved for flammable chemical storage.

These are a few general considerations. Please respond with more specific questions and I'll do my best to answer them. I'd recommend the book, Biodiesel Basics and Beyond.

best,

Travis Perry

Camilla Voelker <camilla.voelker@wmich.edu> writes:

>Good afternoon Travis Perry-

>

>This is Camilla Voelker and Bryan Madle, environmental studies students
>from Western Michigan University, and have been in touch with Frank
>Powell in regards to your biodiesel operations. He referred us to you in
>getting more information about your program, as we are investigating
>implementing one at our university.

>

>If you have any information you could forward to us, we would greatly
>appreciate it.

>

>As of recently, we have been looking into using vegetable oil to fuel our
>campus vehicles, but we would like to know more about the process and
>politics others have had to go through in implementing any sort of
>alternative fuel for campus vehicle fleets.


>

>We appreciate your time,

>Camilla Voelker

>Bryan Madle

Warren Wilson:

From  Margo Flood <mflood@warren-wilson.edu>
Sent Monday, February 23, 2009 5:02 pm
To Camilla Voelker <camilla.voelker@wmich.edu>
Cc Stan Cross <scross@warren-wilson.edu> , tlamurag <tlamurag@warren-wilson.edu> , Ray Cockrell <rcockrel@warren-wilson.edu>
Subject Re: Biodiesel Inquiry

Camilla,
Thanks for your inquiry about our biodiesel usage. I cannot answer your question adequately and am copying Stan, Tom and Ray as I feel confident one of them can provide you with the information you need. Please do get back in touch if you need additional information. I am happy to try and assist.
Best regards,
Margo

Camilla Voelker wrote:

> Good Afternoon Margo Flood-

>


> This is Camilla Voelker and Bryan Madle, and we are environmental studies majors at Western Michigan University.

>

> We are working on a biodiesel/straight vegetable oil(SVO) pilot for one of the diesel lawnmowers used for campus landscaping in order to research ways to make our campus more sustainable.

>
> In our research we found your institution has implemented a similar method. We are interested in finding out more about the successes or tribulations you have experienced throughout the process in order to better understand what direction we need to take.
>
> Mainly we would like to know if you have any documents or other resources we could reference? Also, do you know or have contact with other universities that have implemented biodiesel/SVO in their maintenance fleets?
>
> We called and left you a message regarding this, however here is our contact information and feel free to contact us whichever way is more convenient for you.
>
> Thank you for your time,
> Camilla Voelker, camilla.voelker@wmich.edu (616.826.0156)
> Bryan Madle, bryan.f.madle@wmich.edu (517.282.3408)
--

Margo N.Flood
Executive Director, Environmental Leadership Center
Chief Sustainability Official
Warren Wilson College
828.771.2002
mflood@warren-wilson.edu
CPO 6323
P.O. Box 9000
Asheville, NC 28815-9000

From  Ray Cockrell <rcockrel@warren-wilson.edu>
Sent Wednesday, February 25, 2009 9:25 am
To camilla.voelker@wmich.edu
Subject RE: Biodiesel Inquiry


-----Original Message-----

From: Margo Flood [mflood@warren-wilson.edu]
Sent: Monday, February 23, 2009 5:02 PM
To: Camilla Voelker
Cc: Stan Cross; tlamurag; Ray Cockrell
Subject: Re: Biodiesel Inquiry

Hello all, We engaged with our local biofuel maker as they built their business and made local sustainable jobs. We let them harvest our grease at the cafeteria and make very clean (and certified) fuel. We run B20 in our diesel pumps because we have warranty tractors. We have run B100 with little trouble. Grease is another issue. In the cold up there (and here) grease isn't the best but can be used with a preheater kit installed. It is cold here down in the south too, being as we are in the mountains. We use propane mowers (Ventrex 31hp) and really cut hydrocarbons. For the most benefit convert to gas mowers and your local Propane Council will help. Nationally it is called PERC propane education and research council. I'm not saying biofuel isn't great, I'm saying propane is better. The B20 offroad is also known as BIOHEAT and can be used in all oil furnaces and works very well on down to 0 degrees. www.blueridgebiofuels.com Or call Bryan WYnslett who is brilliant. Let me know what you think. Talk to you soon. Ray Cockrell Supervisor of the Autosshop.

I am enclosing a link or two that have more info.

Bowdoin:

From  [Keisha Payson <cpayson@bowdoin.edu>](mailto:Keisha.Payson@bowdoin.edu)
Sent Tuesday, March 17, 2009 10:59 am
To [Camilla Voelker <camilla.voelker@wmich.edu>](mailto:Camilla.Voelker@wmich.edu)

Cc bryan.f.madle@wmich.edu

Subject FW: Fwd: Biodiesel Generation Unit Meeting

Hi Camilla,

Here is an e-mail that I sent to folks at the University of Southern Maine earlier this year that may answer your questions about our WVO system at Bowdoin...

Take care,
keisha

From: Keisha Payson

Sent: Tuesday, January 27, 2009 11:10 AM

To: 'Dudley Greeley'; David Barbour

Subject: RE: Fwd: Biodiesel Generation Unit Meeting

Hi Dudley and Dave,

At Bowdoin we've actually saved money by burning our WVO (not converting it to bio-diesel). Bowdoin used to keep a heated dumpster on campus that Baker Commodities would empty on a regular basis - so we paid them to take it away and we spent money on heating the dumpster.

Back in 2005/2006 the students were really pushing for having their own bio-diesel processor on campus. Facilities worked with them to look for a potential location and grant monies for purchasing the equipment, but ultimately we worried about the continuity of this as a "student project", and about the liability of such a process on campus. The head of the steam plant suggested he could burn the straight WVO in the plant without bothering with the lye and methanol to convert the WVO into biofuel.

We were fortunate to have an indoor tank inside our heating plant that was sitting empty (it used to be used for #2 oil back when Bowdoin burned #6 - we used the #2 oil in that boiler to preheat the incoming #6 oil).

Our dining staff now delivers the WVO on a weekly basis from each of the dining halls, dumps it into a hopper that filters out the oil and it goes into the WVO tank. It sits there until we are burning #2 oil in the plant (we are dual fuel and burn primarily NG) - at that point we stream the WVO in with the #2 oil.

Between our three dining halls, we burn about 1000 gallons of WVO per year, offsetting the cost of about 800 gallons of #2 oil.

Below is from a presentation that one of our facilities guys did on the conversion. I tried to attach the presentation - but I guess the photos were too big - so I'll just cut and paste the text below. This was put together in the spring of 2007. We have been doing this for 2+ heating seasons now.

Let me know if you have any more questions.

best,

Keisha

slide 1: SEVERAL MONTH AGO WE WERE DISCUSSING WAYS TO USE OUR SPENT VEGGIE OIL. THE OTHER PROCESSES WERE COSTLY AND QUITE DIRTY. THAT IS WHEN CHARLES "MR. WIZARD" BLIER SAID, LET ME BURN IT. AND THE REST IS HISTORY!

Slide 2: Photo of dining's canola oil...A 35 POUND CONTAINER (ABOUT 4 1/2 GALLONS) OF CANOLA FRYING OIL IN LIQUID FORM

Slide 3: Slide of fryolator with oil...THIS IS WHERE THE OIL IS USED TO MAKE THOSE DELICIOUS FRENCH FRIES, ONION RINGS AND OTHER TREATS! THE OIL IS USED FOR ABOUT ONE WEEK AND THEN CHANGED WITH NEW PRODUCT

Slide 4: Photo of heated WVO dumpster...THIS IS WHERE THE USED VEGETABLE OIL USE TO GO

AT A COST TO THE COLLEGE OF OVER \$140 PER MONTH! NOT TO MENTION THE UNSIGHTLY CONTAINER AND THE OBNOXIOUS ODOR!

Slide 5: Photo of custom hopper outside the heating plant....NOW THE USED VEGETABLE OIL IS TAKEN BY DINING SERVICES TO THE HEATING PLANT AND EMPTIED INTO A CUSTOM HOPPER DESIGNED BY THE HEATING PLANT STAFF. THE TIME AND DISTANCE TRAVELED TO THE DROP ZONE HAS BEEN CUT BY 1/3 AS WELL.

THE HOPPER, WHICH IS A RECYCLED STAINLESS STEEL SINK FROM CAMPUS, HAS A REMOVEABLE SCREEN TO CATCH THE LARGE SOLIDS THAT COULD CLOG THE INJECTOR PUMP

Slide 6: Photo of the WVO storage tank ...THE OIL IS PIPED TO A 500 GALLON TANK THAT WAS USED WHEN THE COLLEGE BURNED #6 FUEL. IT HAS BEEN FITTED WITH SPECIAL FILTERS, A CIRCULATOR, AND A SPECIAL INJECTOR PUMP. WHEN WE ARE BURNING OIL, A SMALL STREAM OF VEGGIE OIL IS INJECTED INTO THE #2 OIL STREAM. THIS IS BURNED QUITE EASILY AT FLAME TEMPERATURES APPROACHING 2500 DEGREES!

Slide 7: Photo of Boiler that burns #2 oil...HERE IS WHERE THE OIL FINALLY ENDS UP. FOR EVERY 1000 GALLONS OF VEGGIE OIL WE BURN, WE SAVE 800 GALLONS OF #2 FUEL OIL THAT WE DO NOT HAVE TO BUY!

Judy Gipper:

From Judy Gipper <judy.gipper@wmich.edu>

Sent Monday, April 6, 2009 12:39 pm

To Harold Glasser <harold.glasser@wmich.edu>

Cc Bryan Madle <bryan.f.madle@wmich.edu>, Camilla Voelker <camilla.voelker@wmich.edu>, Tim Holysz <tim.holysz@wmich.edu>

Subject Re: Thanks for coming to the Green Gala // Waste Oil Question

Harold,

I agree with the range.

Thank you so much,
Judy

>>> Harold Glasser <harold.glasser@wmich.edu> 4/6/2009 12:24 PM

>>>

Dear Judy,

Thanks very much for your additional thoughts. Given how tight a ship you run and the care you put into things, I suspect that your intuitions are particularly insightful.

How about if we use an estimate of 2,000-2,500 gallons of waste oil as a rough range? (and include the caveats you added).

Thanks again and all the best,

Harold

On Apr 6, 2009, at 11:49 AM, Judy Gipper wrote:

> Harold,

> That number looks good to me but I don't have any real experience in the food science of fryer oil.

>

> I have been thinking more about your question, and while 15% is the industry overall standard, I have seen the number be as high

> as 35-40% for potatoes, and we fry a lot of french fries (I started

> looking up frying vegetables, and they are known to absorb the most

> fat) Additionally, while I stated 10% lose for transfer, I started

> thinking more about the cold temperatures. Oil gets pretty thick

> when chilled.

>

> So, I'm not much help here.....

>

> Maybe to be safe, put a number of 2000 gallons per year in your

> planning.

>

> Sorry to be unsure on this,

> Judy

>

>>>> Harold Glasser <harold.glasser@wmich.edu> 4/3/2009 5:04 PM

>>>>

> Dear Judy,

>

> Thanks for the very detailed and extremely helpful data—this is

> just

> what we needed.

>

> Based on what you sent we will assume that there is somewhere, in

>

> rough numbers, around 2,500 gallons of waste oil/yr potentially

> available (I used the extra 10% loss factor that you estimated).

> Does

> this seem reasonable to you too?


>
> Cheers,
>
> Harold
>
> Begin forwarded message:
>
>> From: Judy Gipper <judy.gipper@wmich.edu>
>> Date: April 3, 2009 4:37:07 PM GMT-04:00
>> To: Harold Glasser <harold.glasser@wmich.edu>
>> Cc: Bryan Madle <bryan.f.madle@wmich.edu>, Camilla Voelker
>> <camilla.voelker@wmich.edu
>>>
>> Subject: Re: Thanks for coming to the Green Gala // Waste Oil
> Question
>>
>> Hi Harold,
>> Here is the information you are looking for:
>>
>> 1. How much vegetable oil do you purchase yearly (in gallons)?
> and
>> 2. How much waste oil would you estimate that Dining Services
>> produce
>> during the year (in gallons)?
>>
>> From 8/1/08 - 12/22/08: purchased 307 cases (35 lbs each) =
> 1343
>> gallons - 15%* = 1142 gallons (estimated waste oil)
>> (We do not have our purchases loaded in our system for this
>> semester, but could get that to you next week. The person that
> does
>> that is on vacation this week.)
>> This year we are using a trans-fat free soybean oil.
>>
>> Last years number:
>> 8/1/07 - 7/31/08 - 774 cases (35 lbs. each) - 3516 gallons -
>> 15%*
> =
>> 2878 gallons (estimated waste oil)
>> Last year we used a trans-fat free canola oil.
>>
>> *Industry standard for absorption into food is 15%, however
>> true
>> losses are much greater due to burn off, loss in transfer,
> spillage,
>> etc. My educated guess would be another 10% is lost.
>>
>> 3. What is your current waste oil collection protocol? How
>> much
>> does
>> this cost yearly?
>>
>> Camilla was in communication with Paul Choker earlier this
> semester
>> with this question as she was looking at a biodiesel project,
>> so
> she
>> may have additional information that was obtained by Paul.
>>
>> Krueger Commodities picks up the oil. There is no exchange
> of
>> money between Dining and Krueger. Krueger provides to us a
>> collection bin at each dock, free of charge, and does the pick
> up

>> free of charge. About three to five years ago, Krueger use to
> pay
>> us \$75 per semester for our waste oil, but the market price
> dropped
>> so much that they no longer paid us, but do the pick up service
> and
>> provide the collection bins. We are happy with this
> arrangement
>> because the last we looked into this, the next closest
rendering
>> company was in Cleveland, and we would be paying for this
> service.
>>
>> All of our dining halls, except Hoekje/Bigelow Dining
> Service
>> close during the summer, so we only have one unit opened during
> the
>> summer. Krueger has a route, and they pick up a variable
amount
> of
>> times per semester. For example, at Davis, they are only
picked
> up
>> once per semester. I really don't know what there process is,
> but I
>> do periodically see them at a dining dock doing a pick up.
>> If a different direction is taken with our waste oil, we
> will
>> continue to need large sturdy collection bins outside. We need
> to
>> have the oil picked up in an efficient sanitary manner.
>>
>> If I have missed anything, please get back to me.
>>
>> Thank you,
>> Judy

>>>> Harold Glasser <harold.glasser@wmich.edu> 4/1/2009 3:55 PM
>>>>
>> Dear Judy,
>>
>> Thanks for coming to the Green Gala event this afternoon.
>>
>> I have a group in my Campus as a Living, Learning Laboratory
> class
>>
>> working with Tim H. to explore the feasibility of using waste
> oil
>> to
>> run campus lawnmowers. Tim is excited about the possibility
and
> we
>>
>> would like to examine the feasibility of using waste oil from
>> Dining
>> Services to run the lawn mowers. This dovetails with President
>> Dunn's
>> request for us to investigate the feasibility of signing on to
> and
>>
>> meeting the requirements of the ACUPCC.
>>
>> Here are our questions:

>>
>> 1. How much vegetable oil do you purchase yearly (in gallons)?
>> 2. How much waste oil would you estimate that Dining Services
>> produce
>> during the year (in gallons)?
>> 3. What is your current waste oil collection protocol? How
>> much
>> does
>> this cost yearly?
>>
>> Thanks very much for your assistance—I look forward to seeing
> you
>> at
>> next Thursday's PUSC meeting.
>>
>> Cheers,
>>
>> Harold
>

Matthew Hollander:

From  Matthew Hollander <m4hollan@gmail.com>
Sent Tuesday, January 27, 2009 8:02 pm
To Camilla Voelker <camilla.voelker@wmich.edu>
Cc Harold Glasser <harold.glasser@wmich.edu> , Sarah Campbell <scampbe@gmail.com> , steven.bertman@wmich.edu
Subject Re: Current Glasser student with question

Camilla,

I would be happy to help you with your project and am sure I have quite a bit of information for you. However, as I have not been directly involved in the biodiesel co-op for some time, I think it would be appropriate to initiate a meeting with a few key people. My suggestions would be the two of us along with Dr. Glasser, Sarah Campbell, the co-op manager, and Dr. Bertman in Chemistry. Sarah, a former ENVS 4100 student, has been working at WMU for the past several months to set up a composting program for dining services' food waste. She probably has a good grease volume estimate by now and would be an invaluable contact for you within the university. I was a cofounder of the Biodiesel Co-op of Kalamazoo, along with Dr. Bertman and Dr. Perkovic. Dr. Bertman is still one of the faculty directors of the co-op.

I have to warn you - this is a BIG project and will require total dedication if you want it to work. I don't want to scare you away from it, because I think it is a GREAT idea, but the devil is in the details and there are far more of them than it may seem.

Also, please forward this email to the current BCK manager as I don't know who it is anymore.

Let me know what you want to do.

Cheers,

Matt

On Jan 27, 2009, at 5:03 PM, Camilla Voelker wrote:

> Hi Matt Hollander-
>
> My name is Camilla Voelker and am currently taking Dr. Glasser's
> sustainability class. He mentioned your name as a resource for some

> information on dining services. I am simply writing the proposal
> for my project right now. I am proposing fueling the diesel run
> lawnmowers on campus with biodiesel fuel/mixture of biodiesel
> instead. I am aware of the biodiesel co/op in McCracken Hall and
> have spoken to the current person in charge about delivering dining
> service grease to them to convert into the fuel for landscaping
> services, who has expressed willingness to get involved. My
> question to you then, would be do you have any information on the
> amount of grease wasted in any of the dining halls? or how they rid
> of the grease now?
>
> If you could provide me with any information, or if you are able to
> fill in any gaps with information you feel would be relevant to my
> topic, I would greatly appreciate it!
>
> I am not contacting Judy Gipper at this time, because the project,
> as of now, is merely a proposal. I would, however, like to obtain
> more information regarding each component of the proposition just to
> be sure it is feasible.
>
> I appreciate your time-
> Camilla Voelker

From [Duane Hamilton <dhamil@bgsu.edu>](mailto:dhamil@bgsu.edu)
Sent Monday, April 13, 2009 7:09 am
To "camilla.voelker@wmich.edu" <camilla.voelker@wmich.edu> , "bryan.f.madle@wmich.edu" <bryan.f.madle@wmich.edu>
Cc [Scott Edward Euler <eulers@bgsu.edu>](mailto:Scott.Edward.Euler@bgsu.edu) , [Enrique Gomezdelcampo <egomezd@bgsu.edu>](mailto:Enrique.Gomezdelcampo@bgsu.edu)
Subject RE: Waste Veggie Oil Questions

Hello Camilla and Bryan

1. Tanks: We have elected not to modify the original diesel tank. Instead, we have constructed and mounted a second tank (approx 5 gal) on the side of the tractor. We have not yet determined the amount of diesel it takes to warm up the oil or to purge the oil at the end of the day. We predict 5-10 minutes at the beginning and end of each operating day. We do not yet have any illustrations to offer.
2. Filtration: We purchased a Filtration Kit from Fryer to Fuel (see www.fryer-to-fuel.com). It works great and saved us a lot of time and development.
3. The program is simple:
 - Dining halls collect oil in a 55 gal drum.
 - Under supervision of the Grounds Department, either student workers or full time staff drive a Kubota equipped with a collection tank, pump and retractable hose to each location (~ once per week), collect the oil and transport back to the filtration containers.
 - After oil is filtered, it is pumped into a (550 gal) storage tank.
 - Oil is pumped from the storage tank into the tractors.
4. Hopefully we will have a much more complete story to tell. At this time, these are some highlights of the program.

Duane

-----Original Message-----
From: Scott Edward Euler
Sent: Thursday, April 09, 2009 6:50 AM
To: Duane Hamilton
Subject: FW: Waste Veggie Oil Questions

-----Original Message-----
From: Camilla Voelker [camilla.voelker@wmich.edu]
Sent: Wednesday, April 08, 2009 3:57 PM

To: Scott Edward Euler
Subject: Waste Veggie Oil Questions

Good Afternoon Scott-

My name is Camilla Voelker, and my partner Bryan Madle, both environmental studies majors, and I are working on implementing a waste vegetable oil fueling program for our landscaping services on our campus at Western Michigan University.

We have found the BGSU has already implemented something like this, and we were wondering if you would be able to answer some questions in regards to your operations.

- 1.) We understand from your website you are using a two-tank system on your lawn mowers. So, we are wondering in order to modify our lawn mower engines, how large are your second start-up/shut-down diesel tanks? How much diesel do you use per mower in one use? Are you able to provide any illustrations of what you've done?
- 2.) What kind of filtration system do you use? Have you purchased a filtrater from a manufacturer or have you set up your own?
- 3.) How is your program run? Is it student run or is their a department that is heading it?

We would greatly appreciate any answers you are able to provide.

Thank you for your time,
Camilla Voelker (camilla.voelker@wmich.edu) phone: (616)826.0156
Bryan Madle (bryan.f.madle@wmich.edu) (517)282.3408

Appendix 3: Contact List:

Name	Phone Number	Email
Sara Campbell		scampbe@gmail.com
Paul Choker	269.387.4847	paul.choker@wmich.edu
Stan Cross	828.771.3782	scross@warren-wilson.edu
Margo Flood	828.771.2002	mflood@warren-wilson.edu
Judy Gipper		judy.gipper@wmich.edu
Harold Glasser	269.387.2713	harold.glasser@wmich.edu
Duane Hamilton		
Angela Halfacre		angela.halfacre@furman.edu
Matthew Hollander		m4hollan@gmail.com
Tim Holysz	269.387.8582	tim.holysz@wmich.edu
Keisha Payson	207.725.3086	cpayson@bowdoin.edu
Travis Perry		travis.perry@furman.edu
Frank Powell		frank.powell@furman.edu
Ian Smith		itsmitty@gmail.com
James Wilkins	864.294.2076	james.wilkins@furman.edu

