UR Biodiesel

Business Proposal to Charles and Janet Forbes Entrepreneurial Competition

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Executive Summary

One of the most pressing issues of the 21st century is global climate change. Reports from the United Nations have indicated that increases in "greenhouse gases," particularly carbon dioxide, are responsible for changes in global climate. In their role of educating the world's next generation, universities have a responsibility to stress the importance of sustainability and environmental responsibility. The University of Rochester has already demonstrated an interest in environmental responsibility in various ways, including the building and implementation of the Cogeneration Utility Plant. The University continues to express an interest in supporting these important issues.

Waste vegetable oil (WVO) from dining centers can be used to efficiently produce biodiesel to use in diesel engines. The use of biodiesel as a fuel has been proven all over the country as an effective way to power diesel vehicles. Though it can be purchased from a supplier, biodiesel can be produced through a simple process that can easily be completed by a University student. The WVO is mixed with different chemicals to produce biodiesel. This process has been well analyzed and commercial products are available for aiding in the production of this fuel. A mix of biodiesel and petrodiesel will prolong engine life because of its lubricating qualities. In addition, combustion of biodiesel results in significantly lowered emissions of carcinogenic and polluting chemicals, some of which contribute to global warming. The performance of biodiesel is comparable to conventional petrodiesel.

Our proposal is to create a subsidiary company of the University of Rochester, called UR Biodiesel. Currently, University Dining Services pays a private contractor to dispose of WVO from various campus dining centers. UR Biodiesel plans to remove WVO from University dining centers and convert it into biodiesel. This new fuel can be used to fuel university vehicles and offset the diesel fuel currently consumed each month. There is great potential for expansion of UR Biodiesel by reaching out to local businesses to remove their WVO. This will drastically increase the supply of WVO to UR Biodiesel. Businesses around the University have already expressed interest in working with UR Biodiesel to cut their WVO disposal costs and become a part of the University's growing sustainability program.

UR Biodiesel is a project that will not only strongly support the University's environmental responsibility programs, but it will also save the University money. Initial capital necessary is in the range of $3,500, and UR Biodiesel will save the University $1,000 in its first year of implementation. After UR Biodiesel expands to local businesses, it has the potential to save the University more than $24,000 per year. In addition to the money-saving opportunities afforded to the University if this proposal is implemented, the expansion of the sustainability movement in the Rochester area will bring public recognition to the University. The implementation of the UR Biodiesel plan would greatly improve the reputation of the University while making the University a pioneer in renewable energy. UR Biodiesel will offer new research and internship opportunities to supplement classes and allow students to better understand the production of biodiesel. UR Biodiesel will provide many money-saving opportunities for the University while improving the reputation of the University's efforts in the field of sustainability, renewable energy and environmental responsibility.

The Technology

Background

When Rudolph Diesel first introduced the diesel engine to the world in the late 1800s, he used peanut oil to run his engine. He hoped this would allow smaller industries and farmers to compete with the large monopolizing energy industries. However, the discovery of inexpensive petroleum replaced the use of peanut and vegetable oils.[1] Though petroleum diesel, or petrodiesel, has been the dominant fuel for over a century in diesel engines, biodiesel continues to have comparable performance and reliability while also having other advantages. Although some still have doubts about the fuel, it is the most thoroughly investigated alternative fuel on the market. Numerous independent studies show its comparable performance and advantages.[2]

Biodiesel refers to all diesel fuels made from renewable sources. The form of biodiesel of interest involves creating fuel via a chemical reaction known as transesterification. The oil for this reaction can be derived from any number of renewable sources, including soy, canola, palm oil, hemp, algae, animal fat, etc. Waste vegetable oil (WVO) can also be used, which is any combination of the above oil products after it has been used for cooking, such as in a deep fryer or left over from a grease trap. UR Biodiesel is specifically interested in collecting WVO from local dining establishments to process into biodiesel. This biodiesel can be used in any diesel-fueled engine without modifications. It can be used as a pure fuel or can be blended with any amount of petrodiesel. The use of B20, a blend of 20% biodiesel and 80% petrodiesel, has become a common way to significantly reduce emissions while maintaining performance and lowering costs.

The use of biodiesel has become increasingly popular at universities as they realize its advantages. Aside from producing less harmful emissions than petrodiesel, the carbon being put into the atmosphere comes from plants used to produce the fuel. Therefore, the process of combusting the biodiesel is a carbon neutral cycle. Universities such as the University of Colorado at Boulder, the University of Vermont, Duke University and many others are currently using B20, B100, or both in university-owned buses.[3] Many other universities, such as the Massachusetts Institute of Technology[4] and Cornell University[5] are in the process of bringing biodiesel to their campuses.

Making Biodiesel from WVO

Biodiesel is made through the chemical process of transesterification in which the glycerin in the WVO is separated from the fat or vegetable oil. The process is a relatively simple one. A catalyst, such as lye (sodium hydroxide), is mixed with methanol and the WVO. The ensuing reaction yields two products: biodiesel (methyl esters) and glycerin. The glycerin can be disposed of in several ways, including using it to produce soap. Some of the methanol can also be recovered, cleaned, and reused in another reaction.[6]

In order to purify the WVO, simple filtration to remove solid particulates is necessary. The WVO, stored in steel drums, is then raised to 120°F with electric heating bands. This will allow any water in the vegetable oil to separate, and anhydrous oil will be siphoned out. A sample is then taken so that a titration can be performed to assure proper levels of lye for the transesterification reaction.[9] Lye is then combined with methanol in plastic mixing carboys based on the ratio found in the titration. It is important to perform this mixture in a well-ventilated area because vapors of methanol are toxic and highly

combustible. Safe storage of methanol away from potential ignition sources is made more convenient by using portable carboys. The WVO and lye/methanol mix are then introduced into the reaction tank with an electric pump, which acts as a mixing apparatus to begin transesterification.[10] The mixture is left for approximately 6 hours so that the denser glycerin can settle to the bottom of the conical tank. The glycerin (10-12% of mixture volume) is drained from the tank and unwashed biodiesel is left. The water wash process then begins which removes any remaining glycerin. Again the reaction tank is left so that the denser water can settle to the bottom and be drained. The washed biodiesel is of ASTM D6751 quality and can be used directly to fill a fuel tank with the attached nozzle, or kept in steel drums for storage[1.0]

Biodiesel Processor Design Selection

The processor kit is the largest start-up expense for the UR Biodiesel venture. Research was conducted to confirm design requirements pertinent to the desired scale of operation. Optimal processing capacity would be approximately 80 gallons per batch. This would minimize operator time by allowing 1-2 batches to be processed per week to meet demand, based on the amount of available WVO. The most widely available products on the market of this processing scale vary little in design or material used. This design has been well tested and implemented by many university facilities, such as Chico State College and Sacramento City College. A comparison of three such products is provided in Table 1. UR Biodiesel has selected the Home Biodiesel processor as the best choice for this venture. It is the most cost effective per 80-gallon batch and offers a one-year parts and labor warranty and unlimited free customer service. It also offers a separate storage unit for methanol in a carboy shelving system, which is important for safety measures as stated previously. Furthermore, the company has worked with organizations of higher education on similar ventures in the past and has offered free fuel testing services as well as educational discounts to be determined at the time of commitment. Figure 1 below provides a diagram of the Home Biodiesel processor.

Table 1: Biodiesel Processor Comparison Chart

Processor Model	**Biodiesel Solutions Fuelmeister II**	**Home Biodiesel Processor**	**Home Biodiesel Kits Freedom Fueler**
Biodiesel Output (gal/ batch)	40 gallons	80 gallons	40 gallons
Batch Processing Time	12 hours (not including wash time)	24 hours (including wash time)	18 hours (including wash time)
Operator Time	30 minutes	30 minutes	30 minutes
Price with Shipping	$4,245	$2,995	$4,190

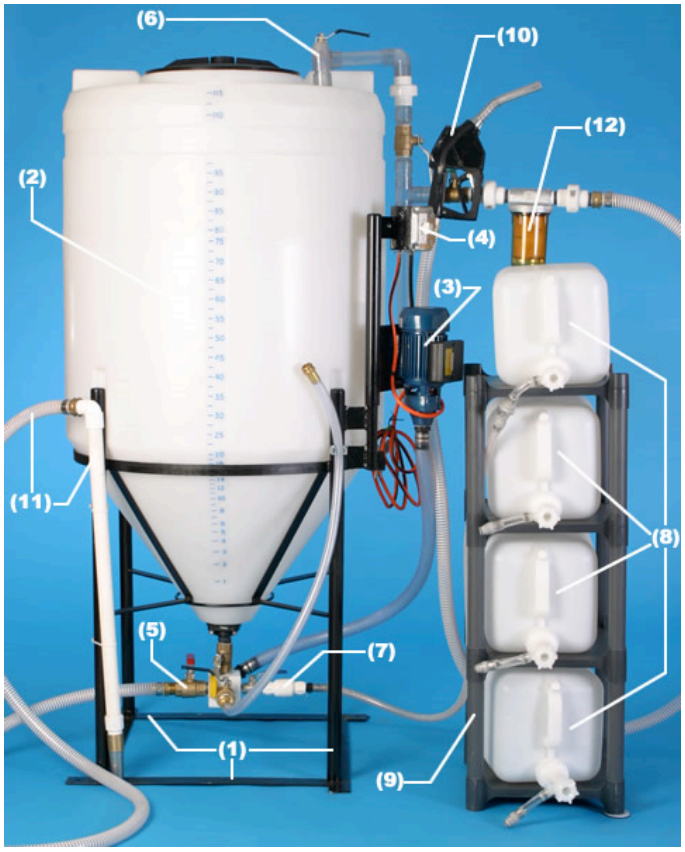


Figure 1: Home Biodiesel Processor (http://www.homebiodiesel.com). (1)metal frame (2)polyethylene reaction tank (3)electric pump (4)pump control panel (5)valve block (6)½ turn ball valves, 7 total (7)check valve (8)methanol carboys with quick disconnects (9)shelving unit for carboys (10)auto shutoff dispensing nozzle & hose (11)suction nozzle & hose (12)fuel & pre-water filter

Comparisons: Biodiesel vs. Petrodiesel

Emissions

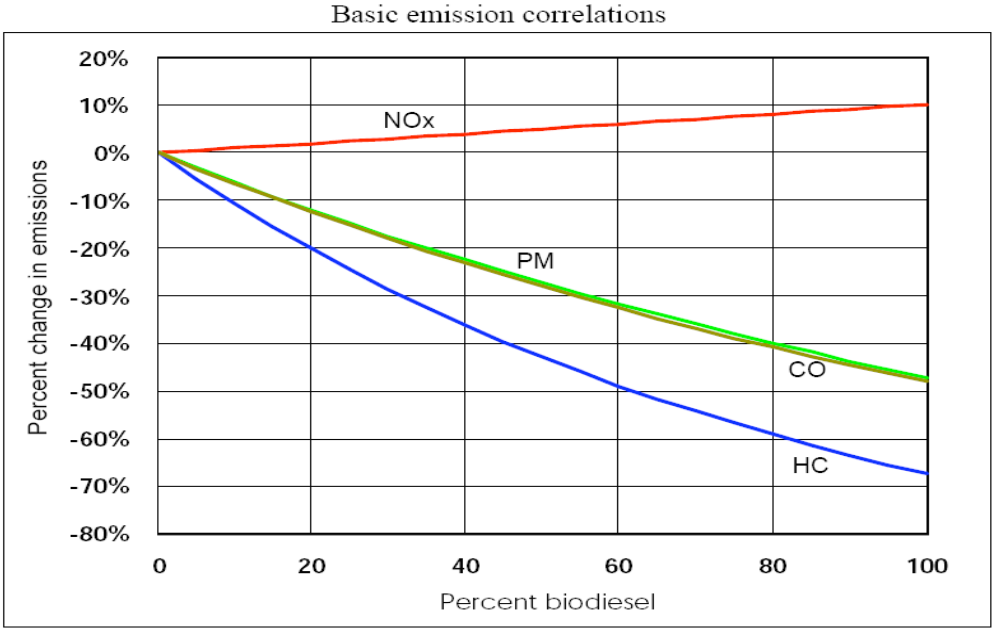
One major advantage of using biodiesel is the vastly lower emissions. The exact amount varies by the composition of the oil and the study performed. The resulting emissions from biodiesel of carbon monoxide (CO), particulate matter (PM), hydrocarbons (HC), sulfur oxides, and sulfates, which are all health hazards and harm the environment, are significantly less than petrodiesel. However, the amount of nitrous oxide (NO_x) emitted is about the same or may be slightly higher for biodiesel than for petrodiesel. Extended research and analysis of biodiesel by the Environmental Protection Agency (EPA) have shown these decreases in emissions[7]:

Table 2: Average Biodiesel Emissions Compared to Petrodiesel

Average Biodiesel Emission Compared to Petrodiesel		
Emission Type	B100	B20
Regulated		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NOx	+10%	+2%
Unregulated		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAHs)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

*Estimate from B100 result
**Average reduction across all compounds measured
***2-nitroflourine results were within test method variability

Figure 2: Basic Emissions Correlations



Though NO_x is also considered a greenhouse gas, the significant reduction in other gas emissions far outweighs the slight increase in NO_x emissions in burning biodiesel. Also, whereas burning petrodiesel releases new carbon into the atmosphere that had been stored underground, burning biodiesel simply recycles the carbon already in the atmosphere. Further, the use of a biodiesel blend of B20 reduces carbon dioxide (CO_2) emissions by 15% when compared to petrodiesel.[11] Interestingly, the smell of exhaust in vehicles running on biodiesel is similar to that of french fry grease or popcorn. This results in engines that smell similar to the back of McDonalds, as opposed to the potentially headache-causing fumes associated with petrodiesel.

Performance

Range, power, payload, and performance are on par with petrodiesel. Biodiesel has a greater lubricity, resulting in longer engine life over the course of the vehicle's operating life. Biodiesel is about 5-8% less energy dense than petroleum diesel, but its greater lubricity and more complete combustion offset that somewhat, leading to an overall fuel efficiency about 2% less than petroleum diesel. For B20 the EPA reports a 0.9-2.1% reduction in miles per gallon efficiency than when using petrodiesel. For B100, the reduction is larger at a reduction of 4.6-10.6% miles per gallon[7]. Biodiesel is also often attributed with engines running much quieter, with less vibration, and starting up easier than when running on petrodiesel.

The use of pure biodiesel (B100) has a solvent effect that may release buildups accumulated on tank walls from previous diesel usage. Therefore, high blends of biodiesel tend to initially result in the release of deposits that may clog the filter until the petroleum deposits are eliminated. However, this is much less prevalent in lower blends such as B20[2]. Operation in cold weather can cause both petrodiesel and biodiesel to gel. This is considered in the production of regular petrodiesel and is the reason for the use of certain additives and taking other precautions. In using B20 no additional precautions beyond what is done for petrodiesel must be considered. However, B100 will gel faster than petrodiesel when operating in cold weather. Solutions to this are the same as solutions for using low-sulfur #2 petrodiesel in similar conditions. For example, it can be blended with #1 petrodiesel, fuel heaters can be used, and vehicles can be stored indoors[8].

Toxicity

Biodiesel is a much safer substance than petrodiesel. It is non-toxic and is four times more biodegradable than conventional diesel. Biodiesel also has a significantly higher flash point, the temperature at which it will ignite when exposed to a flame. This means that spills are much less of a safety and environmental concern, because the biodiesel will decompose in the ground like any other plant and will be far less flammable. This is in sharp contrast to conventional petrodiesel. It also means that many concerns are alleviated when raising the temperature of the fuel.[8]

Market Analysis

Current University Expenses

Currently, the University of Rochester purchases both diesel fuel and unleaded gasoline that is stored in large tanks at 612 Wilson Blvd. University Facilities purchases the fuel at going market prices, minus taxes. Then, Facilities sells the fuel to other University departments (such as Transportation) at a price that takes into account the expenses of

operating the tanks. This price ends up being comparable to, though sometimes lower than, the average price of diesel fuel in a given month at a retail gas station.

Table 3: Diesel Fuel Taxes in New York State

Diesel State Excise Taxes	Diesel State Other Taxes	Total State Diesel Taxes	Total State and Federal Diesel Taxes
8.0 cents/gal	33.6 cents/gal	41.6 cents/gal	66.0 cents/gal

Source: American Petroleum Institute

Table 4 shows the amount the University paid over the last 12 months for diesel fuel. On average over the last 12 months, the University paid $2.84 per gallon of diesel fuel. As shown in Table 5 and Figure 2, the price of diesel fuel has increased by about $1.00 per gallon over the last six years alone. Based on trends and analysis, it is likely that these prices will continue to increase, currently at a rate higher than inflation. While this study will focus on the costs over the last 12 months, these costs will only rise as does the price of diesel fuel. This will make the money saving opportunities afforded to the University by UR Biodiesel more attractive over time.

Currently, the University uses diesel fuel for several purposes. The University grounds crews use diesel fuel to run tractors and trucks. The other primary use of diesel fuel is for University busses. These are the busses used for various internal purposes at the University, but are *not* the Regional Transit System (RTS) busses that service the University. Over the last 12 months, the University has used 15,411 gallons of diesel fuel (Table 4). Based on the monthly price of fuel, University departments paid $44,009 for diesel fuel over the last 12 months.

Table 4: Gallons of Diesel Fuel Used at the University and Cost per Gallon in each month

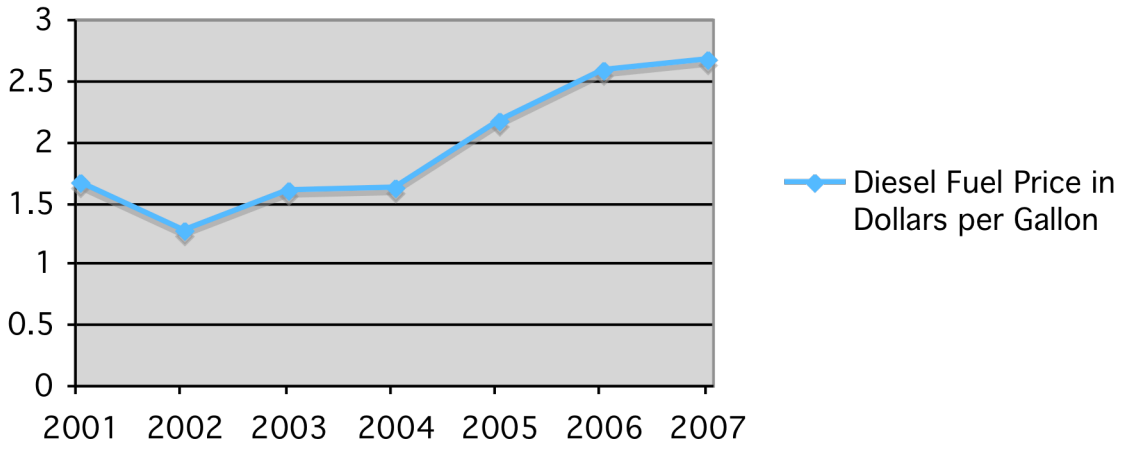
April 2006	**May 2006**	**June 2006**	**July 2006**	**August 2006**	**September 2006**	
1,275	1,017	1,186	1,240	1,137	1,271	
$3.00/gal	$3.12 /gal	$3.04 /gal	$3.07/gal	$3.00/gal	$3.04 /gal	
$3,825	$3,173	$3,685	$3,807	$3,411	$3,864	
October 2006	**November 2006**	**December 2006**	**January 2007**	**February 2007**	**March 2007**	**Total**
1,159	986	830	1,186	2,781	1,435	**15,411 gals**
$2.57	$2.64	$2.77	$2.58	$2.63	$2.78	**Avg.= $2.84**
$2,979	$2,603	$2,299	$3,060	$7,314	$3,989	**$44,009**

Source: Jim Chodak, UR Facilities

Table 5/Figure 3: Price of Diesel Fuel since 2001 in the New York, Delaware, D.C, New Jersey, Pennsylvania Region

1/1/2001	1/7/2002	1/6/2003	1/4/2004	1/3/2005	1/1/2006	1/1/2007
1.669 cents/gal	1.281 cents/gal	1.591 cents/gal	1.63 cents/gal	2.163 cents/gal	2.59 cents/gal	2.681 cents/gal

Source: Department of Energy



University dining centers produce WVO as part of their daily meal preparation. This WVO is disposed of in large storage containers in various locations on each campus. The University pays a fee to a private contractor, Baker Commodities, to remove the WVO from the campuses (currently, Baker Commodities primarily uses the WVO for animal feed). The cost for removal from the River Campus is $220 per month, based on two pickups per month from both Douglass and Danforth Dining Centers. This cost over the course of 12 months totals $2,640. Dining Services also pays about $100 per month to have WVO removed from the Eastman campus. Finally, Baker charges $54 monthly to remove WVO from the Strong Hospital Campus. This brings the total cost of WVO removal to $4,488.

While the amount of WVO produced by the dining centers is variable, the amounts can be estimated based on data from Dining Services and Baker Commodities. Unfortunately, neither Baker Commodities nor Dining Services keeps a monthly record as to the number of gallons of WVO disposed. Instead, Baker keeps track of the number of pounds removed, and Dining Services keeps track of the number of pounds of oil purchased. In Table 6, we have estimated the monthly supply of WVO based on this information.

Table 6: WVO Supply

Source of WVO	**Pounds of WVO**	**Gallons of WVO**	**Cost of Disposal**
River Campus (Douglass and Danforth Docks)	8,500 pounds per year	1,260 gallons per year 105 gallons per month	$220 per month
Eastman Campus Dock	1,500 pounds per year	240 gallons per year 20 gallons per month	$100 per month
Strong Memorial Hospital Docks	10,000 pounds per year	1,500 gallons per year 125 gallons per month	$54 per month
Total	20,000 pounds per year	**3,000 gallons per year**	**$374 / month $4,488 per year**

Source: Dining Services, Mary Locke and Peter Castronovo

These numbers bring the total current annual costs to the University for diesel fuel and for WVO disposal to about $48,497. If the UR Biodiesel venture is established, this cost would be reduced as the amount of diesel fuel purchased is displaced by biodiesel made from our own WVO. Furthermore, given the increasing prices of diesel fuel (Table 5/Figure 2), the money that UR Biodiesel can save the University will only increase.

Costs of UR Biodiesel

The most significant cost of the project is the initial cost of the processor. The processor will cost about $3,000 (as described above). There are a number of other costs associated with the processor. For example, someone would have to operate it for several hours per week. This position will be filled by a paid student employee who will work approximately eight hours per week. Drums need to be purchased to store the WVO, to store waste products from the processor (such as glycerin), and for mixing and pumping the new biodiesel fuel. These drums can be purchased through University Facilities at somewhat discounted prices.

Another cost associated with the processor is the chemical additives that must be added to the WVO. These additives include lye and methanol. Costs for these chemicals are about $0.33 for lye and $0.40 for methanol per gallon of WVO processed. The methanol, however, can be recycled, as it is a byproduct of the reaction. An estimate of the actual cost per gallon of WVO processed is about $0.25 for methanol.

The physical process of transporting the WVO from its various disposal locations is currently handled by Baker Commodities. This would be a new cost and procedure that the University would have to incur. The easiest method is to load containers from a disposal location into an existing University vehicle. The University Courier Services department owns a truck with a lift-gate and contracts its services to University departments. UR Biodiesel will rent this truck and service once a week and simply perform a container exchange at each pickup location. The cost for this truck and service is $50 per hour.

Regulation is another issue that will be discussed in more detail below, but it comes with a cost. One rule regulates the disposal of glycerin. As glycerin is a byproduct of this process, it must be properly removed, which will cost around $100 per 55-gallon drum.

Tables 7 and 8 below estimate the up-front and long-term costs of UR Biodiesel. When reviewing these tables, note that some numbers are estimated based on available information.

Table 7: Estimated Up-Front Costs

Purchase of Processor	**Purchase of Storage Drums** (based on estimated cost of $50 per 55-gallon drum, 10 drums)	**Total Up-Front Costs**
$3,000	$500	**$3,500**

Source/Notes:
- Bascousa.com (for estimated drum and drum accessories prices)
- Details on the price of the processor can be found above

Table 8: Estimated Long-Term/Continuing Costs

Cost of Operation (employee salary)	Cost of Fuel Additives	Transportation of WVO	Removal of Glycerin	Total Long-Term/ Continuing Costs
$240/month $2,880/year	$145/month $1,740/year	$200/month $2,400/year	$550/year	**$7,570 / year**

Source/Notes:
- Cost of Operation determined by estimating an 8-hour per week time commitment at $7.50 per hour for operating the processor and for transporting the WVO.
- Cost of Fuel Additives determined based on ($0.25 per gallon of WVO for methanol and $0.33 per gallon of WVO for lye) $0.58 per gallon of WVO for additives. The approximate costs for the additives determined based on wholesale chemical information from Sigma Aldrich, Inc. and laboratory tests by UR Biodiesel. Bulk purchasing discounts may be available.
- Transportation of WVO based on $50 per hour lift-gate truck rental, one hour per week in WVO pickups (Bill Orel, UR Courier Services)
- Removal of Glycerin cost estimate provided by Marvin Stillman, Manager of Environmental Compliance, University Hazardous Waste Dept. Based on transesterification producing 10% glycerin per gallon of WVO used, and estimated by Marvin Stillman to be $100 / 55-gallon container of waste.

Market Conclusions

Based on the information above, UR Biodiesel will be economically beneficial in its first year of operation. A unique aspect of UR Biodiesel is that no profit is being generated, but rather the University will be cutting costs and saving money, thus positively impacting the bottom-line on the University's overall balance sheet. As shown in the table below, these effects will be realized almost immediately.

Table 9: Balance Sheet

Year	Start-Up Costs	Yearly Variable Costs	Gallons of Diesel Being Displaced by Biodiesel	Amount Saved from Eliminated Cost of Diesel	Amount Saved on WVO Disposal	Net Savings to University
2008	$3,500	$7,570	2,700 gallons	$7,688	$4,488	**$1,106**
2009	$0	$7,570	2,700 gallons	$7,911	$4,488	**$4,829**
2010	$0	$7,570	2,700 gallons	$8,154	$4,488	**$5,072**

Notes/Sources:
- Start up costs from Table 7.
- Yearly Variable Costs from Table 8.
- Gallons of Diesel Being Displaced by Biodiesel Calculated from 3,000 gallons of WVO per year (from Table 6) multiplied by 90% (90% of WVO converts to Biodiesel)
- Amount Saved from Eliminated Cost of Diesel Calculated by Gallons of Diesel being displaced multiplied by average cost of diesel to university, increasing at a conservative rate of 3% per year.
- Amount Saved on WVO Disposal calculated in Table 6 and remains constant

Other Economic Considerations

Thus far, the only costs mentioned have been those that the University currently pays and those that the University would have to pay under the UR Biodiesel plan. However, there are a number of other costs that are harder to quantify. For example, many in the global warming debate argue that a societal cost should be placed on CO_2 emissions. Specifically, each pound of CO_2 burned currently has an impact on society. If a cost was placed on each pound emitted, it could get very expensive. While this cost is not specifically included in the cost saved, it should still be considered.

Some lawmakers have proposed placing a tax on CO_2 equal to that societal cost. Recently, the US Supreme Court ruled that the Environmental Protection Agency (EPA) has the authority to regulate CO_2 emissions. This was in response to an EPA claim that it does not have that authority and that even if it did, it may choose not to regulate based on scientific uncertainty. While this does not make CO_2 a regulated pollutant, many see it is a first step toward regulation or taxation of CO_2. This potential cost may eventually have a very real effect on the price of gas, and the overall cost to the University. It would be superficial to estimate the amount of this tax, so we will not propose a dollar amount in projected savings from it. However, it is clear that if any type of a tax were imposed on CO_2 emissions, the carbon neutrality of biodiesel will severely limit the negative effects of that tax on the University.

Growth Potential

One of the most unique aspects of UR Biodiesel is its growth potential. Expansion of this plan is inevitable after the initial effects are successfully completed. The primary method of growth is by displacing current diesel fuel with biodiesel from WVO. In the first few years, financial constraints and a shortage of WVO will make it difficult to use biodiesel in all diesel engines on campus. However, many local businesses have already expressed interest in providing their WVO.

For example, the Distillery and Pellegrino's restaurants on Mount Hope Avenue (they have the same ownership) produce about 200 gallons of WVO per month (total). Continued outreach will inevitably produce more interested businesses, because these restaurants currently pay a fee to have their WVO removed. Potential nearby restaurants likely to have large quantities of WVO not included in the table below include Mount Hope Diner and The Elmwood Country Sweet. We will try to utilize the WVO from businesses that are part of the URoS program and work with University Auxiliary Services as they continue to expand it. UR Biodiesel would be offering to take their WVO, either for free or at a cost lower than they currently pay, while also offering good publicity for their business. When we spoke with the manager of The Distillery, he expressed great interest in providing his WVO, and stressed that he hoped The Distillery would be included in some method of advertisement as a supporter of the program.

The University's 10-year Strategic Plan calls for increasing the size of the student body by 25% (1,000 students). Inevitably, this will generate more WVO as the demand for food on campus increases. We have not included the potential increase in students into our calculations of the future WVO potential, however we anticipate the quantity of WVO for the University in the tables below to increase each year over the course of the next decade. Tables 10, 11 and 12 demonstrate the growth potential of UR Biodiesel by using off-campus sources of WVO.

Table 10: Supply of WVO from Potential Future Sources of WVO

Potential Future Sources of WVO	Estimated Monthly Supply of WVO
Pellegrino's/The Distillery	200 gallons / month
Wendy's Restaurant	250 gallons / month
Yummy Garden Chinese Food	300 gallons / month
University of Rochester	250 gallons / month (3,000 gallons/year)
Total	**1,000 gallons/month (12,000 gallons/year)**

Notes/Sources: • WVO supply from Pellegrino's and Distillery supplied by Larry, manager of The Distillery

Table 11: New Variable Costs Chart, with Growth Potential Included

Cost of Operation (employee salary)	Cost of Fuel Additives	Transportation of WVO	Removal of Glycerin and other waste byproducts	Total Long-Term/ Continuing Costs
$390/month $4,680/year	$580/month $6,960/year	$300/month $3,600/year	$2,182 / year	**$17,422 / year**

Notes/Sources: • Weekly hours would need to increase to 12 hours per week
• Cost of fuel additives still estimated at $0.58 per gallon of WVO, now multiplied by an additional 750 gallons per month (total 9,000 gallons from off-campus plus original 3,000 from on-campus = 12,000 gallons WVO total)
• Transportation of WVO cost is increased from four hours per month to six hours per month still billed at $50/hour
• Cost for removal of waste products still calculated at 10% of total WVO gallons, and $100 per 55-gallons of waste

The following table is an extended balance sheet from Table 9 (above). In this table, it is assumed that all of the discussed sources of WVO (Pellegrino's, The Distillery, Wendy's, and Yummy Garden) provide their WVO to the University, without a fee. Further, it is assumed that this begins in the year 2011. The table shows the new costs and savings associated with this growth.

Table 12: Balance Sheet with Growth Potential Included

Year	Start-Up Costs	Yearly Variable Costs	Gallons of Diesel Being Displaced by Biodiesel	Amount Saved from Eliminated Cost of Diesel	Amount Saved on WVO Disposal	Net Savings to University
2008	$3,500	$7,570	2,700 gallons	$7,688	$4,488	$1,106
2009	$0	$7,570	2,700 gallons	$7,911	$4,488	$4,829
2010	$0	$7,570	2,700 gallons	$8,154	$4,488	$5,072
2011	$1,000	$17,422	10,800 gallons	$33,480	$4,488	**$19,546**
2012	$0	$17,422	10,800 gallons	$34,484	$4,488	**$21,550**
2013	$0	$17,422	10,800 gallons	$35,519	$4,488	**$22,585**

Notes/Sources: • All Notes/Sources from Table 9 above (current balance sheet) apply
• New Start-Up Costs (year 2011) estimated based on potential costs associated with establishing partnership with local businesses, possibly including advertising, additional regulation and extra container purchases

Non-Economic Benefits

There are a number of benefits from this project that are of significant value to the University, though are not necessarily of financial value. The most significant of these benefits is the "green" image of the University that would be visibly displayed should this plan go forward. The prospect of a bus having a sign reading "This bus powered by the waste vegetable oil from University Dining Centers" is a very powerful statement. This concept significantly furthers the sustainability and green causes that are sweeping across colleges around the country. This plan would make the University a pioneer in the field.

There will also be other smaller benefits to the University. For example, the processor can be run by a student employee, providing new educational student employment options. It could also be an internship course that students can take for University credit. The processor can be further used as an educational tool in teaching University students and local elementary and secondary school students the importance of environmentally friendly activities. Similarly, students in engineering and the sciences can use the processor (and the WVO, the biodiesel and its byproducts) for experiments. Furthermore, once UR Biodiesel expands to the community, local businesses will benefit from our free removal of their WVO. This will save them money and improve their reputation as a contributor to the University's green campus initiative.

Competition

The University's contract with Baker Commodities is already a major source of competition. It would be easier for the University to maintain the status quo and continue its relationship with Baker. UR Biodiesel would make the termination of that contract, or at least a more cost-effective contract modification necessary.

Another source of competition comes from Gibbs Marine Group. Recently, Rochester Alternative Fuel, a subsidiary of Gibbs Marine Group, submitted a proposal to the University to purchase its WVO. Gibbs Marine Group operates large mechanized construction equipment, and was motivated to use the Dining Services' WVO to convert to biodiesel for their fleet. This would save them up to $1/gallon of their diesel consumption, as discussed in their proposal. Their offer was to purchase WVO at $0.03 per gallon. This proposal was stalled due to regulation and liability issues.

Additionally, companies that sell pre-blended B20 pose as further competition should the University choose to convert to biodiesel. However, based on current costs, this would cost the University more than it currently pays for diesel fuel.

Competitive Advantages of the UR Biodiesel Plan

UR Biodiesel is unique in that it offers an elimination of disposal costs for WVO while providing the benefit of using the end product biodiesel in University owned diesel powered equipment. This not only avoids expenditures for contracting a disposal service, but also saves money by offsetting diesel consumption with a much cheaper fuel. With an estimated 3,000 gallons of WVO produced per year at the University, the proposal by Gibbs Marine Group would equate to $90 paid to the University per year. Compared to the savings of more than $5,000 by the third year of UR Biodiesel's implementation, UR Biodiesel offers savings well above those that could be achieved by a deal with Gibbs Marine Group. UR Biodiesel also offers a unique promotional scheme that would attract attention to the University for its clean, energy efficient and sustainable transportation policies. Reducing waste disposal and petroleum consumption will be a step forward

towards gaining green campus and carbon neutral certifications. UR Biodiesel envisions that the green image of the UR can bring recognition from environmentally conscious groups in the form of grants, new student admissions and improved reputation

Implementation Plan

Organization

This biodiesel processor will be housed at 612 Wilson Boulevard, the current Facilities headquarters and the location of the University's diesel fuel tank. This will allow University buses, tractors and trucks to fill up conveniently. A student job will be created to perform the simple tests and titrations that are necessary for production of biodiesel. The student employee will keep records of the amount of lye and methanol needed to properly process certain volumes of waste vegetable oil. These records will give us the average amount of byproducts needed in order to more efficiently calculate costs in the future. In order to test the fuel, kits will be provided so that it will properly operate diesel machinery and not cause any major breakdown in engine components. These kits consist of a solution to which the fuel is added and if it is of inadequate quality, will describe what was wrong with it. The biodiesel will be blended in 55-gallon drums with petrodiesel in order to create a B20 blend to decrease its viscosity and in the winter months prevent extensive caking of the fuel.

Funding

Many grants, tax rebates and other incentives are available through the Federal Department of Energy and through the New York State Energy Research and Development Authority (NYSERDA). However, most of them require a far larger commitment than initial phases of UR Biodiesel call for. For example, once UR Biodiesel has expanded to include WVO from local sources and processes (or purchases) enough biodiesel to power the entire bus fleet, grants, rebates and incentives will be available to offset some of the initial costs.

In the meantime, UR Biodiesel will look for other sources of initial capital. Potential sources of capital include the related University departments, such as Facilities and Transportation, who have already expressed a great interest in the UR Biodiesel concept. The potential of this project to bring strong positive publicity to the campus make the Office of the President and various alumni funds likely sources willing to contribute to UR Biodiesel. Environmentally focused groups on campus, such as Grassroots and Engineers for a Sustainable World, may be interested in contributing as well. We may seek a grant from a local Rochester company, such as Xerox or Kodak, as an additional source of capital for the project.

Promotion of UR Biodiesel

Rochester's peer institutions, such as Cornell University and the University of Pennsylvania, have committed to eliminating their greenhouse gas emissions by a specified date in signing the Presidents Climate Commitment. An undergraduate group on the River Campus, Grassroots, recently sent a petition signed by over 1000 undergraduates in support of the University taking a more active role in the fight against global climate change. The purpose of the petition is to encourage President Joel Seligman, President of the University, to sign the Presidents Climate Commitment through significant student support. The commitment is for universities to completely

eliminate their net greenhouse gas emissions over an extended period of time and to have short-term goals with deadlines to accomplish this. Pressure from both within and outside the University makes it likely that the University will make such a commitment. Programs such as implementing the use of biodiesel would greatly add to the effort.

As green campus initiatives become more popular, the University will be seeking ways to convert to more environmentally sustainable policies. At the University's Sustainability Conference in April, 2007, many speakers preached that the time to take action and utilize current techniques for the production of sustainable energy is now. UR Biodiesel offers the University an easily implemented and cost-cutting opportunity to be more incorporated and associated with the green movement occurring around the world. Through the University's production and use of biodiesel from its own and local WVO, the University will generate significant public interest and in turn inspire students, faculty, other colleges and the local Rochester community to move toward sustainable lifestyles.

The campus movement for sustainable energy is supported by many student-run environmental groups. Campus groups including Grassroots, Engineers for a Sustainable World, and UR Sustainability are pressing for change. UR Biodiesel's plan is a good first step toward that end by utilizing resources that we currently pay for the disposal of. UR Biodiesel is a good first step toward setting an example of sustainability.

In concert with setting an example for students to be conscious of energy consumption, this project will also provide the opportunity for many to learn about the conversion process of WVO into biodiesel. The use of the processor in laboratory settings for students to understand how to make this fuel will expose many to the easy steps for production of this fuel and its current utilization as an alternative source to power diesel machinery. This will further build the University's reputation in relation to renewable energy education.

In addition to the public recognition gained by the University and our inspiration in the community to become sustainable, we will in another way bolster the local economy. As expansion of our company continues, the University will be fostering relationships with local businesses in order to switch our dealings and profit-making opportunities to smaller companies in the immediate area.

Regulatory Controls

Our research has revealed a number of regulations that UR Biodiesel will be subject to. The Spill Prevention Control and Coutermeasures regulation will have to be filed. UR Biodiesel can comply with this regulation with an engineer's certification and documents describing the tank size, locations, safety measures, and plans for containment of a spill. Through contact with Marvin Stillman of the University Hazardous Waste Management department and Mark Cavanaugh, the University Fire Marshall, we will ensure that we are in compliance will all necessary regulations. Other regulations that we will be subject to include storage space for the fuel at 612 Wilson Boulevard, the type of drum necessary for blending, storage, and production, and fire code regulations. Proper safety regulations must also be followed in handling the lye and methanol. Due to the fact that biodiesel has a higher flashpoint than normal petrodiesel fuel, fire codes will treat it as a combustible liquid with little regulations other than containment. We have and will continue to work closely with members of facilities that are knowledgeable in these areas.

All of these people suggest that, with time, proper documentation, certifications and regulation compliance, the success of this project is realistic.

Timeline for Implementation

May 2007-August 2007:

- Obtaining official approval from the University Department of Hazardous Waste and the University Fire Marshall to ensure that we will be practicing safe procedures while complying with all applicable regulation. This will likely be the most complex approval to receive, as an engineer's certification and the Fire Marshall's certification are both necessary. Further, our plan for the disposal of glycerin must be approved by the Department of Hazardous Waste.
- Obtain final approval from Dining Services. Submit final WVO pickup plan to the department, and work with them on a renegotiation or termination of the Baker Commodities contract.
- Work to achieve the necessary capital as discussed in the "Funding" section above.
- Obtain official approval and endorsement from University Transportation and University Facilities. This includes working with any necessary private contractors (buses), confirming the location of the processor in 612 Wilson Blvd. and finalizing plans to create a student job to run the processor.
- Work to obtain support and approval in the Office of the President of the University
- Work with University Purchasing to establish a plan for the flow of money related to UR Biodiesel. This may either be by establishing a ledger for UR Biodiesel or by including UR Biodiesel as a part of another department (such as Facilities). Should the latter option be utilized, a detailed plan on increasing the funding to that department from other related departments must be established.

August-September 2007:

- Request the weekly services of University Courier Services and submit the detailed pickup and drop-off schedule of the WVO containers from their disposal locations and 612 Wilson Blvd. (the location of the processor).
- Contact the supplier of the processor, and purchase it.
- Contact the chemical supplier and order monthly shipments of methanol and Sodium Hydroxide. Attempt to negotiate long-term, bulk ordering discounts.
- Work with Facilities to purchase the drums and containers necessary; attempt to negotiate a discount because of long-standing relationships with Facilities.
- Work with Facilities to determine which diesel engines will be filled with new biodiesel blend.
- Hire student employees to work processor and finalize schedules and contracts.

October 2007:
- Begin implementation of the UR Biodiesel plan. Begin pickups of WVO with Courier Services, delivery of chemical additives, using transesterification process, and phase in use of biodiesel in predetermined engines.
- Observe and record success of the initial phase-in. Make adjustments to plan as necessary.

November-Dec. 2007:
- Work with Office of Communications to implement a publicity campaign demonstrating the benefits of the program, focusing on decreased emissions, sustainability, and renewable energy.
- Work with administration and encourage their participation in the publicity campaign. Make campus community aware of program. Invite leaders of other colleges, local community members, and local businesses to ceremony to 'officially' kick-off the UR Biodiesel program.

January 2009 and on:
- Begin gathering support from local businesses to obtain their WVO. Work with Office of Communications to ensure local businesses enjoy appropriate advertising upon use of their WVO. Work with Courier Services to expand use of pickup and delivery service.
- Work with Facilities to expand the diesel engines on campus using the B20 blend.

Conclusion

In summary, we propose a process that converts WVO from both University dining centers and from off-campus sources into a biodiesel fuel blend. A B20 blend would be usable in any existing University diesel engine. We propose that the University offset the purchase of diesel fuel by using biodiesel, thus significantly cutting costs to the University. This plan can save $1,000 in the first year of implementation, and can save as much as $23,000 by the sixth year of operation. It is anticipated that this number will continue to grow, especially as the price of fuel continues to rise.

Not only will UR Biodiesel yield financial savings for the University, but it will also produce a variety of other desirable benefits that will be realized from the project. For example, this project will create a new and unique student job, which will provide students with an additional place to work. UR Biodiesel will also expose many students, faculty and community members to the use of renewable, sustainable and clean energy in everyday life. We plan to have University busses advertising their use of WVO from University dining centers for fuel to show others that sustainability is an easy, progressive option that can save money and help to save the environment. Further, our plan promotes the green campus initiative and will raise University awareness and promote environmental health. The plan will make the University a pioneer in renewable energy and sustainability, which will likely bolster the University's reputation.

Due to the significant cost savings and other desirable benefits as described above, we strongly recommend that the University accept and initiate this project in accordance with the timeline above.

Sources:

1. http://www.ybiofuels.org/bio_fuels/history_diesel.html

2. http://www.biodiesel.org/

3. http://www.ehs.unr.edu/Default.aspx?tabid=354

4. http://web.mit.edu/newsoffice/2007/biodiesel.html

5. http://www.news.cornell.edu/stories/Jan07/sustainability.biofuel.html

6. http://www.cogeneration.net/transesterification.htm

7. "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions" http://www.epa.gov/otaq/models/analysis/biodsl/p02001.pdf

8. http://www.utahbiodiesel.org/biodiesel_making.html

9. http://www.biodieselcommunity.org/index.php

10. http://www.homebiodiesel.org

11. http://www.eere.energy.gov/afdc/altfuel/bio_benefits.html

Daniel Fink

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OBJECTIVE

Internship position in Chemical Engineering expanding upon and utilizing:

- Exposure to current practices in creating and producing alternative fuels gained through academic and research experiences.
- Practical experience in field of chemical engineering developed through coursework and independent research.
- Organizational and leadership skills developed through various collegiate and community service activities.
- Ability to use Mathematica, Microsoft Word, Excel, Powerpoint, Firefox, and Internet Explorer.

EDUCATION

UNIVERSITY OF ROCHESTER — Rochester, NY
Bachelor of Science Chemical Engineering — Anticipated May 2009

- Overall GPA 3.62/4.0, GPA within Chemical Engineering 3.73/4.0
- Collegiate Activities: American Institute of Chemical Engineers, University of Rochester Chapter, Member; Outdoors Club, Member; Engineers for a Sustainable World member, University of Rochester Chapter.

SHAWNEE HIGH SCHOOL — MEDFORD, NJ
High School Diploma — June 2005

- Burlington County Supervisors and Principals Association Award for Highest Cumulative GPA, 2003
- Certified EMT in the state of New Jersey, service and respond to 911 calls throughout the community
- Extra-curricular Activities: Science League: Highest score in chemistry; Debate Team: Debated schools throughout region on a variety of topics including Nuclear Warfare.

CHEMICAL ENGINEERING AND LIBERAL ARTS COURSEWORK

Chemistry for Green Engineering, Fluid Dynamics, Chemistry, Physics, Organic Chemistry, Calculus, Chemical Processes Analysis, Biology, Introduction to Comparative Politics, Introduction to International Relations, Writing, Saxophone, and Business Law.

CHEMICAL ENGINEERING RESEARCH EXPERIENCE

UNIVERSITY OF ROCHESTER, Chemical Engineering Department, Professor Ben Ebenhack — Rochester, NY
Research Assistant — **2006-2007**

Alternative fuel research for AHEAD Energy, a corporation used to organize and provide modern energy facilities to third world nations. Researched various alternative fuel options for Mozambique energy policy including the use of coconut oil as a biofuel.

UNIVERSITY OF ROCHESTER — Rochester, NY
Engineers for a Sustainable World — September 2006- present

Organizing and coordinating a wind turbine site testing and installation as well as writing grants to raise money to put a methane digester on a local farm to gather energy. Working to furnish a biodiesel production facility on campus using waste vegetable oil.

LEADERSHIP AND COMMUNITY SERVICE EXPERIENCE

PEOPLE TO PEOPLE — EUROPE
Student Ambassador — **Summer 2001**

- Traveled to Europe for three and a half weeks touring England, France, Greece, and Italy to promote the better understanding of world cultures.

MULTIPLE SCLEROSIS BIKE RIDE — Philadelphia, PA to Ocean City, NJ
Participant — **2001-2005**

- Biked 75 miles raising $1,000 for Multiple Sclerosis Research through sponsorship of friends, family, and local organizations.

HABITAT FOR HUMANITY
Camden, NJ
Participant
Summer 2004

- Helped build home in partnership with Habitat for Humanity, a housing organization which builds affordable housing in partnership with people in need.

David C. Borrelli

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OBJECTIVE

Summer position in the field of Chemical Engineering utilizing and expanding upon:

- Knowledge of and experience using chemical engineering, chemistry, and physics laboratory techniques and procedures
- Experience with: microscope, filtration devices, centrifuge, spectrophotometer, vapor phase osmometer
- Excellent verbal and written communication skills developed through academic and industry settings
- Computer skills using C++, Word, Excel, PowerPoint, Windows XP, MAC OS X, Mozilla FireFox

CHEMICAL ENGINEERING AND SECONDARY EDUCATION

UNIVERSITY OF ROCHESTER Rochester, NY

Bachelor of Science in Chemical Engineering; minors in Physics and Mathematics

Anticipated May 2009

- Overall GPA 4.0 out of 4.0
- Dean's List, 3 of 3 semesters
- Genesee Scholarship for Academic Excellence
- Iota Book Award, Iota Chapter of Phi Beta Kappa
- Men's Crew Team, 09/2005 -1/07
- Teaching Assistant: Calculus II, Spring 2007
- Grassroots
- Engineers for a Sustainable World
- American Institute of Chemical Engineers, Rochester Chapter, Professional Liasion

WEBSTER SCHROEDER HIGH SCHOOL Webster, NY

High School Diploma with Honors **June 2005**

- Class rank: 2/339; Cumulative GPA: 98.226
- SAT Math: 790; SAT Verbal: 770
- Advanced Placement Courses: Biology, Chemistry, Physics B, Physics C-Mechanics, Physics C-Electricity and Magnetism, Calculus B/C, U.S. History, English Literature, English Language, Statistics, Macroeconomics, Microeconomics, World History. Earned a score of 5 out of 5 on all AP tests
- Activities: Math League, Chess Club, Model United Nations, Science Olympiad
- Bausch & Lomb Honorary Science Award, Vincent Lombardi Lodge # 2270 Inc. Scholarship, Sam Walton Community Scholarship, Rotary Interact Scholarship, New York State Board of Regents Scholarship for Academic Excellence, National Merit Commended Student, National Honor Society, AP National Scholar, American Chemical Society Chemistry Achievement Award.

CHEMICAL ENGINEERING COURSEWORK

Organic Chemistry I & II, Organic Chemistry Lab, Honors Calculus I & II, Honors Physics (Waves and Modern Physics), Green Engineering, Honors Electricity and Magnetism, Principles of Biology, Ethics, Personal Identity and Immortality (writing course), Inorganic Chemistry, Honors Linear Algebra and Differential Equations, Chemical Process Analysis, Honors Multidimensional Calculus, Quantum Mechanics, Fluid Dynamics, Probability for Chemical Engineers, Fundamentals of Computing.

CHEMICAL ENGINEERING EMPLOYMENT

UNIVERSITY OF ROCHESTER, CHEMICAL ENGINEERING DEPARTMENT

Research Assistant in Dr. Yates's Lab

Summer 2006-present

- Conducted research in synthesizing inorganic molecules for composite fuel cell membranes
- Presented research at Eisenberg Symposium in October, 2006

UNIVERSITY OF ROCHESTER, CHEMICAL ENGINEERING DEPARTMENT
Rochester, NY

Research Assistant in Dr. Anthamatten's Lab 2005-2006

- Assisted with research in using vapor phase osmometer to study properties of polymers.

ROCHESTER INSTITUTE OF TECHNOLOGY, MUNSELL COLOR SCIENCE LABORATORY

Lab Assistant Intern Summer 2004

- Took spectral reflectance measurements in lab using spectrophotometers

CHRIS BABCOCK

161 Crittenden Blvd • Rochester, NY 14620 • 585-738-6361• cb003m@mail.rochester.edu

QUALIFICATIONS

- Strong interest and education in renewable energy, natural resource/environmental conservation and sustainability
- Experience with team leadership, time management, effective communication through detailed presentations
- Strong skills with problem solving, analytical and computational methods, engineering science
- Excellence in independent research and scientific report writing
- Proficiency with MS Word, Excel, PowerPoint, MatLab, CAD, and several Internet tools

ENGINEERING AND LIBERAL ARTS EDUCATION

UNIVERSITY OF ROCHESTER ROCHESTER, NY
Bachelor of Sciences, Biomedical Engineering **anticipated May 2007**

- Concentration in Mechanical Engineering
- Dean's List 5 semesters
- Cumulative GPA of 3.42
- Take Five Scholar's Award: One year scholarship to pursue interest in renewable energy and sustainability. Program included a semester abroad at the University of Christchurch, New Zealand.

UNDERGRADUATE COURSES

Sustainability/Energy/Resource Management: Environmental Resources and Sustainability, Energy Resources and Utilization, Sustainable Transportation Design, Green Engineering, Independent Study in Chemical Engineering: Life Cycle Analysis of Biofuels, Forests and People, Forestry in New Zealand

Engineering/Math/Physics: Biomedical Computation and Statistics, Thermodynamics, Intro to Fluid Dynamics, Intro to Solid Mechanics, Cell and Tissue Engineering, Intro to Mechanical Design, Biomedical Engineering Signals and Measurements, Biomedical Engineering Senior Design Project, Circuits for Scientists/Engineers, Fundamentals of Biomechanics, Quantitative Physiology, Biomechanics Lab Lecture with MatLab, Intro to Digital Music, Mechanics, Electricity and Magnetism, Multidimensional Calculus, Linear Algebra with Differential Equations, Calculus I and II

General Science: Intro to Environmental Science, Mammalian Physiology, Mammalian Anatomy, Principles of Biology I and II, General Chemistry I and II

EXPERIENCE

CHEMICAL ENGINEERING INDEPENDENT STUDY, ROCHESTER, NY
January 2007- Present
Preparing a life cycle analysis of ethanol derived from local apples and processed apple waste. Study involves intensive independent research, meeting with and surveying apple growers and processors, and calculating energy balances and cost inputs.

BIOMEDICAL ENGINEERING DESIGN PROJECT, ROCHESTER, NY
November 2005 – May 2006
Developed portable head acceleration measuring device and analytical software for ARCCA Inc (Penns Park, PA). Served as manager of the design team's budget and primary liaison with electronic parts and analog measuring device wholesalers. Also, integral part of the design, production and testing of the device.

IMMUNOLOGY LABORATORY UR MEDICAL CENTER, ROCHESTER, NY
Technical Assistant, November 2004 – January 2005
Helped researchers under Dr. Dennis McCance investigate human papillomavirus by preparing bacterial plasmids and media for experiments. Also lab equipment manager.

CELL AND GENE THERAPY LABORATORY, DEPT. OF NEUROLOGY, UR MEDICAL CENTER, ROCHESTER, NY
Technical Assistant, April – August 2004
Cell and tissue culture and histological procedures for Dr. Steve Goldman. Also lab animal manager, computer data entry and genome databank creation.

EXTRACURRICULAR ACTIVITIES

- Hiked the Appalachian Trail in entirety from Georgia to Maine, 2175 miles, in five months
- WWOOF New Zealand volunteer, micro-hydroelectric unit installation, earth building, trail construction, forestry, wildlife conservation
- Engineers for a Sustainable World member

ERIC WEISSMANN

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eric.weissmann@rochester.edu

EDUCATION

UNIVERSITY OF ROCHESTER — ROCHESTER, NY
Bachelor of Arts Degree — **Anticipated May 2010**

- Overall GPA of 3.71
- Dean's List
- Rochester Early Business Scholar: one of seven freshmen admitted into honors business program that includes admission to the Simon Graduate School of Business after graduation
- Some Courses Include: American Politics, Business and Politics, Principles of Economics, Microeconomics, Calculus I and II, Green Engineering (a chemical engineering course designed to examine the energy debate from technical and economic perspectives)

WALT WHITMAN HIGH SCHOOL — BETHESDA, MD
High School Diploma — **May 2006**

- Some Courses Include: AP Comparative Politics, AP American Politics, AP World History, AP Environmental Science, AP English Language, AP English Literature, Honors Calculus

ELECTED LEADERSHIP POSITIONS

- President of Freshman Class, University of Rochester
- President of Senior, Sophomore, Freshman classes, Walt Whitman High School (2002-2006)
- Treasurer of Student Government Association, Walt Whitman High School (2005)
- Executive and Communications Vice President, Executive Board, United Synagogue Youth, Beth El Congregation in Bethesda, Maryland (2003-2005)

HONORS AND AWARDS

- Nominated for Award for Freshman Leadership, University of Rochester; decision pending
- University of Rochester Paychex Leadership Institute, nominated and accepted (2007)
- Kochavim Award for Jewish Teen Leadership, awarded by Jewish Experiences for Teens (2006)
- Kodak Award for Outstanding Academic Achievement and Leadership, selected by Walt Whitman High School teachers (2005)
- Represented Walt Whitman High School in statewide Hugh O'Brian Youth Leadership Conference (2004)
- Outstanding Service and Dedication Award, awarded by Kiwanis Club International (2004)
- Member of choral program at Walt Whitman High School, 2002-2006
- Roles in musical productions at Walt Whitman High School, 2002-2006

EMPLOYMENT

- Administrative Assistant, Realtor Anne Cavanagh, Summer 2005, 2006
- Teaching Assistant, Beth El Religious School, 2002-2004
- Clerk, Anderson Kill & Olick, Summer 2003