Eagle Diesel: The Sustainability Business Lab
Problem Statement:

Three years ago The College at Brockport participated in a program titled the Sustainability Tracking, Assessment Rating System (STARS) in an attempt to better understand and map out Brockport’s efforts for long-term sustainable goals. The program helps higher institutions develop the framework needed for future sustainable goals, provide incentives for sustainable actions, and helps facilitate information flow in the development of best practices and data collection in order to help create a more diverse sustainable community on campus. STARS has four rankings: Bronze, Silver, Gold, and Platinum. In January 2012, STARS submitted their evaluation of the College at Brockport’s sustainable efforts and awarded the campus a Silver rating.

Following up on the results of the STARS report was the now retired Dave Turkow, who at that time was the Director of Environmental Health and Safety, Turkow took notice to a specific evaluation of the Student Sustainability Educators Program in which the campus scored a 0.00/5.00. The specific evaluation focused on whether the college or university provided and coordinated ongoing peer-to-peer sustainability outreach and education programs for degree-seeking students involving formal training and financial support from the school. Students noticed these sustainable efforts as well. In a collaborative effort between students of both the chemistry and business departments, the idea of a student run operation designed to produce biodiesel for campus vehicles was launched eventually in the fall semester of 2013. The project would enable the university to earn credits in transportation, as well as education. The idea was prompted to not only help the campus with promoting a greener initiative, but to also continue all around sustainable efforts at Brockport in hopes to receive a Gold or Platinum score from STARS in the near future. Lacking sustainability in the curriculum, and having a low level of student awareness, the
biodiesel project aimed to increase interest in sustainability in both the faculty and student bodies at Brockport.

This idea of a collaborative effort between students and eventually advisors became known as Eagle Diesel. The idea of biodiesel becoming a feasible option was apparent due to the large amount of raw material, the vegetable oil from dining services, right here on the Brockport campus. Dining Services on campus estimated they produce enough vegetable oil waste to provide us with 4,000 gallons worth of raw production material throughout a school year. If successful we will be capable of removing up to 3,500 gallons of petro diesel usage from the community which will result in cleaner air, less pollution, waste reduction, all around, and positive feedback loops for Brockport and the Campus. Our initiative will engage students with the campus community and will provide valuable marketing opportunities as well as developmental opportunities for the programs growth.

**Project Summary/Background:**

Through funding efforts by the NYSP2I and grants received by our advisors, we have been capable of producing an output this semester in a series of test batches that will be presented to the administration, including the Dean of the Business school and the Vice President of Financials for The College at Brockport.
As shown above in Image 1, the funding received from both NYSP2I and the grants awarded to our advisors, we have begun gathering the necessary materials to be successful in the lab. Among these purchases Eagle Diesel had to take some necessary steps to guarantee the safety of students in the lab, and also a constant flow of raw material from the school. Our team has a contract set up with Upstate Bio Diesel, located in Buffalo, to deliver the cooking oil from BASC (our dining facilities). We set up a delivery date and time once BASC’s containers get full, then Upstate Bio Diesel will deliver the oil to us on their regular pickup schedule. A member of the team will have to be at the garage receiving

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>PRICE PER ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 55 gallon lined steel drum, closed head OIL, DIESEL</td>
<td>2</td>
<td>$89.68</td>
</tr>
<tr>
<td>2) 5 gallon unlined steel drum, closed head GLYCEROL</td>
<td>1</td>
<td>$45.38</td>
</tr>
<tr>
<td>3) 5 gallon HDPE Tank w/spigot</td>
<td>1</td>
<td>$115.46</td>
</tr>
<tr>
<td>4) Long-sleeve smock</td>
<td>1</td>
<td>$101.75</td>
</tr>
<tr>
<td>5) Face Shield</td>
<td>1</td>
<td>$19.35</td>
</tr>
<tr>
<td>6) Neoprene gloves</td>
<td>3</td>
<td>$25.83</td>
</tr>
<tr>
<td>7) KOH 3kg per bottle</td>
<td>2</td>
<td>$89.68</td>
</tr>
<tr>
<td>8) Methanol 5 gallon poly/spout</td>
<td>7</td>
<td>$22.00</td>
</tr>
<tr>
<td>9) Drum Cradle</td>
<td>1</td>
<td>$134.19</td>
</tr>
<tr>
<td>10) Spill pallet (4 drum in-line) (26.25&quot; x 103.5&quot;)</td>
<td>3</td>
<td>$350.25</td>
</tr>
<tr>
<td>11) Bonding wire/clamp</td>
<td>2</td>
<td>$50.13</td>
</tr>
</tbody>
</table>

**Image 1**: List order after receiving funds
to receive the cooking oil and distributing it into the designated 55 gallon drum and/or directly it into the processor. We do not need any equipment to pump the oil, but will have pumps and hoses in the event that we decide to use alternative methods. Their truck pumps raw, used vegetable oil it out of their container and into our storage vessels, drums/tank or the processor directly. Upstate Bio Diesel will only deliver once the BASC tank is near full and they respond within 24 hours of our request to collect the oil. This, to some extent, allows us to create a production schedule, however, we would prefer to have larger storage capacity in the future. With further investment, we would be able to store oil for future production and thus would have easier production scheduling, and greater output. The problem with the project is a lack of faculty involvement - depending solely on students and advisors, the project and production will be determined by their schedules. We will work with BASC to develop a more accurate and productive schedule based on historic usage data and calls for pickup.

With the items purchased listed in image 1 and the secured flow of raw material from our school, we have enabled our lab to be a very convenient space with safety equipment on hand at all times. Our process began with having the necessary students available in the lab to assist as our chemistry advisor who instructs the students and leads the process. The professor had to also be and the advisor for the overall course (as the startup program was inducted into the curriculum) and place everyone into a 1 to 3 credit course in order to help the school avoid liability in case a student was harmed - doubly, this provided student incentive and fostered further engagement and commitment. Next, we begin the production our process utilizing with our NWR Independence Biodiesel Processor, which creates 80 gallons of biodiesel per batch, we purchased this system with previous grant money. Production flows are based on lab scale production, and are mapped out as follows:
The processor must be primed with 13-16 gallons of oil poured into the large processor tank.

1. Fill suction hose with oil by holding top of open tube over oil level and open black and red valves. Close red valve when hose is full.
2. Place suction wand in oil to be transferred and connect hose to suction wand by collapsing metal cam locks.
3. Open yellow valve (processor valve).
4. Open black valve (tank valve).
5. Start pump motor, making sure oil is pumping into tank.
6. Close black valve to ½ position, and open red valve ½ position.
7. Once a flow has stabilized open red valve to full open, and close black valve.
8. Fill tank to 80 gallon mark.
9. Turn pump off and close red valve.

After now initiating the system, the process of creating biodiesel is estimated by a combined 48 hours including prep and production time of our processor. In previous attempts before this semester, we have successfully produced biodiesel at full lab scale using our previous formula that included Sulfuric Acid as a catalyst. Through careful consideration, our students and advisors have found a way to cut our own costs by not including the Sulfuric Acid due to small test batches we have performed to give us the confidence to exclude this chemical.

Due to the NYSP2I funding, we have been able to secure valuable storage and safety materials that will help the stability of our project through the next steps and in the future. Our problem at hand now has been the successful use of the chemical process in
the processor that excludes the Sulfuric Acid. In order to do so, our team of students and advisors have planned and kept academic journals detailing their process of performing \( \frac{1}{4} \), \( \frac{1}{2} \), and a full batch of biodiesel in this order. The results have been given for our \( \frac{1}{4} \) batch of biodiesel and the formula has been successful. We believe our scale up production for the campus can be ensured through further funding and developing a learning curve. These notes currently being written down by our students and lead chemistry advisor can help us lead to new innovations in the process of preparing the processor eliminating time. The issue at hand for our project has never been, will the biodiesel work in the campus vehicles, rather, the issue has been engaging the higher ups on administration to witness the successful production of our project and get on board.

**Relationship to Sustainability:**

Our student operated project, structured in the manner of a startup company, has allowed students and faculty from all disciplines to work together in towards a unified and valuable goal. Through research, marketing, networking, good business, and scientific analysis and procedure, our team has developed a plethora of lessons learned and resources that will enable students for years to come to replicate this process. Eagle Diesel has only scratched the surface of what is possible, and is still very much in an infant stage, but will grow and become a testament to the economic value of sustainable solutions on campus, and the overwhelming value of student projects that provide real world experience in this field.

Our project has forced students to develop supply chains, give detailed presentations in the request of financial support, test scientific method and procedures, develop and test new methods, assess environmental impacts and outcomes, develop
safety and regulatory understanding of chemical production, source raw materials and
equipment, and develop detailed business strategy, and all in the name of science. Eagle
Diesel has been a powerful learning experience entirely integrated into the curriculum giving
students of all disciplines great opportunity to create sustainable change.

Successfully we have created lab scale biodiesel and a sound business plan for
scale up. We have proved the effectiveness of a student company model, and have
developed a detailed set of plans. We have also opened communication between faculty,
administration, and the student body. We have identified an economic solution to a dirty
problem that will place sustainability in a place of great importance, and have great
environmental benefits.

The environmental outcomes of our project are largely significant, offsetting up to
3,500 gallons of petro-diesel will dramatically reduce the campuses transportation footprint.

<table>
<thead>
<tr>
<th>CO2 EMISSIONS DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2 Emissions per Gallon of non-biodeisel</td>
</tr>
<tr>
<td>CO2 Emissions from B20 biodiesel</td>
</tr>
<tr>
<td>Amount of Diesel consumption we can save at full scale:</td>
</tr>
<tr>
<td>Total CO2 Emissions saved</td>
</tr>
</tbody>
</table>

15,680 lbs of CO2 Emissions not entering the air in Brockport

Image 2: Our CO2 numbers calculated of potential emissions saving

This CO2 footprint left by diesel fuel production can easily be erased and provide a healthier
community and reduce the overall impact on the environment. We believe our project is the
first step. Economically speaking, we can cut the cost to a quarter of existing budget by
using student produced biodiesel. The current price of diesel fuel on the market in the New
England region is approximately $2.35. But we believe through our production costs and volunteer hours we can produce and sell our biodiesel to the college at a low cost of $1.70, saving $0.65 per gallon. Projects like ours will close open system loops, and benefit many. By making sustainability exciting in the form of a company structured project, people have taken notice, and the education level and awareness of sustainability has increased greatly on campus as a result. Projects like Eagle Diesel create lasting and long term benefit for those involved.

**Materials and Methods:**

The roles of a lot of students has been widespread since the start of Eagle Diesel. We range from recruiting, finances with our advisor, widespread advertising, scheduling and of course the handling and production of our product.

*Recruiting:* As far as importance to the sustainability of the program, recruiting is absolutely number one. Because of our program being entirely student-run, we rely on membership to carry out our day-today tasks, and also to plan for the future. It's gravely important that every semester, the Marketing Department of Eagle Diesel has their focus on recruiting for future semesters. It is this department’s job to find people to step into associate and executive spots when they are open so that the company doesn’t have to deal with any lag.

*Advertising:* Advertising is how companies build awareness of their brand. We’re using advertising to do the same thing on our campus. One of the Marketing Department’s larger goals is for everyone at The College at Brockport to know exactly what you’re talking about when you mention Eagle Diesel. Ideally, students in high schools will know who we are as well and will factor our existence into their ultimate college decision. A big benefit of our existence within the Brockport campus is that we both gain from each other. Eagle Diesel
relies on the campus to provide a location as well as waste vegetable oil and our chemical inputs, and they rely on us to decrease their fuel costs and improve their brand image.

Through various informative sites such as the digital commons, Brockport on-campus advertising, and the school’s radio we have been lucky enough to freely share our brand and recruit students interested in making a difference. All students and advisors participated in order to maintain the projects sustainability and our ability to potentially expand. The more we can get our name in the community, the more people are going to care about the program. This will help with recruiting as much as it will help with satisfying our ultimate goal of people using our example to do other cool things. Eagle Diesel will participate in as many events and growth opportunities as possible in the future. A recent example of this is our Scholar’s Day presentation in the spring of 2014, which we were able to get Rochester media to attend. Doing things like that in the future is going to be a large part of what makes us an integral part of the college and community as a whole. Looking forward, our network links will need to touch a much larger scale in the administration of The College at Brockport. Since 2 years ago, our project has expanded a multiple of times into greater and greater possibilities for the campus and our project, and will continue to expand in upcoming years.

**Results, Evaluation, and Demonstration**

As our project began we faced many problems 2 years ago. Getting the raw materials, contracts, funding, recruiting, etc. If there was a problem you had in mind, we probably had it. Since then, the determination of our previous and current students with collaboration of professors we were able to receive funding from grants such as the NYSP2I. With money no longer an issue, the team felt confident. As of now we have a lab set up in the chemistry
department working on a full scale production of biodiesel to prove to the administration our potential to make an enormous environmental impact for the campus.

Since the start of the year, we’ve excluded Sulfuric Acid from our production and have revamped our chemical process. Shown below is our current process.

Image 4: Steps in our production

As production begins and raw production materials needed, we’ve had to estimate scheduling issues to secure times to order our chemicals so we never have to wait to produce our biodiesel. We’ve determined that there will be enough inventory on hand to sustain the operation for one month which will be 5-10 batches depending on our progress. Items should be reordered at least two weeks before they run out. So orders would be put in every two weeks for a month’s worth of supplies. This allows a two week processing and delivery period in case an issue should appear it would not affect the operation. The operation will not be paused to wait for inputs to arrive. When items need to be reordered we
will contact the school to place the order of the items needed as well as the quantity needed.

Scheduling for students and professors were included as well. Students will submit their schedule to the chief operations officer who will then produce a weekly schedule based on classes. Schedule will be sent to all students in case if they have any non-class commitments such as work. We will require a safety officer who will be in charge of making sure everything is done in a safe manner. Since the process contains chemicals that are dangerous, such as methanol which is highly flammable, safety will be paramount. There will be 2-3 people on shift at a time. One should be a safety officer. A safety officer is a role and is classified as a student that has passed the quiz and properly trained on the dangers. The other would be the chemist who works on the process. The safety officer watches and makes sure everything is done in a safe manner; their role also includes managing batch information, gathering inventory and production data, enforcing proper procedures, and ensuring a clean safe work environment with proper materials and equipment on hand at all times. Students may shift roles by explicitly announcing and consenting to switch roles. There should also be 1-2 students as backups. These innovations of safety and monitoring allows us to maintain approval by our professors and the administration of Brockport.

With our planned steps and chemical requirements ordered by funds granted by NYSP2I we’ve only just scratched the surface. As a successful ¼ has been produced as of late, we plan to upscale to a ½ and then a full. These results will be demonstrated and shown in jarred samples on Earth Day for the Student Competition this year.
Conclusions:

Based off the results we have been given, our continued project sustainability by student involvement and professors, our estimates of future potential, and the backing of the soon to be retired President Halstead during last year’s Scholar’s Day presentation, we at Eagle Diesel feel extremely confident. More and more innovative solutions will arise soon as our current 35 page business plan is compiled to present to the Vice President of Financials here at campus with positive results to continue the production next year. Our goal has been focused on improving our success and approval in order to maintain access of a successful laboratory for students to engage in with each other and professors. This improvement will lead to the trust of a yearlong production of biodiesel to then test the product in the summer vehicles that usually run on diesel fuels. In that experiment, our production of biodiesel will be poured into the diesel fuel tank creating B5 (5% biodiesel 95% petro-diesel fuel), B10 and then eventually B20.

Our belief is that after results of the lab’s current success are presented to the administration, we can receive the go ahead to hold a permanent position to produce our biodiesel. At the same time, we have been pushing for the biodiesel lab to be included in the catalog for classes here at Brockport to take since the project’s variety of majors is what really sets us apart. Last year we were close in adding Biodiesel Lab as an official class, but no cigar. After the recent funding and results on a lab scale, we hope this will lead to future approval.

In essence we are doing a service, and providing a highly economical and sustainable product for the campus. Eagle Diesel's objective is to encourage student and professor engagement that would dual-serve as professional experience and educational credit opportunity. Upon success of our company, our team plans to encourage a SUNY wide sustainability initiative by encouraging use of our business plan and student model.
With time, we believe not only will the operation succeed to produce an economic and environmentally safe product for Brockport, but perhaps SUNY and state wide. By giving students the opportunity to operate in a startup oriented environment, cross disciplinary learning and work enables us to solve creative and complex problems for the greater good - that is the true goal of Eagle Diesel.
Bibliography:

