UIUC Biodiesel Initiative
Clean Energy Technology Fee Funding Application

APPLICATION INFORMATION

Project Leads

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PROJECT DESCRIPTION

- **Project goals**

The UIUC Biodiesel Initiative is a project of the student group Engineers Without Borders that seeks to collect Waste Vegetable Oil (WVO) from all university dining halls and convert it to biodiesel fuel that can be used by campus vehicles maintained by the UIUC Campus Garage and Carpool (operated under Facilities and Services). The team also hopes to use its expertise to aid other organizations in developing biodiesel projects of their own within the state of Illinois. As the project continues, the student team will organize outreach events such as demonstrations at the local children's museum and local workshops for "home-brewers".

The university dining halls currently produce about 400 gallons of WVO per week during the school year, which yields an approximately equal amount of biodiesel. The Campus Garage currently utilizes roughly 7,500 gallons of diesel each month. Once full production is achieved, the approximately 1,600 gallons of biodiesel produced a month will offset the petro-diesel consumption of the Campus Garage by approximately 20% for a total reduction of about 12,800 gallons per academic year.

- **Longevity/permanence of project on campus**

The Biodiesel Initiative currently has an indeterminate longevity. Biodiesel production should continue for many years to come, especially due to its ability to save the Campus Garage considerable fuel expenses (detailed below). The project team currently plans on expanding in two parallel paths – establishing and maintaining university operations, and offering students the opportunity to establish biodiesel projects in external communities. Based on the success of other volunteer-based EWB projects, the project team is confident that the operations can be maintained through a volunteer workforce. However, in order to guarantee the longevity of the project, the most updated cost analyses include the cost of any potential student labor needed to run the reaction.

- **Proposed location(s), including any concerns that may arise from the chosen site**

The biodiesel reactor will be located in a garage wash bay at the Campus Garage and Motor Pool, 1701 S. Oak St. in Champaign. This location had raised two concerns, adequate ventilation and spill containment. In order to address these concerns, the Campus Garage will undergo significant modifications as outlined by Facilities & Services, Environmental Compliance, and other regulatory agencies. The details of the modifications are currently being addressed. The main advantage of the chosen location is proximity of the reaction to the storage site. Producing the biodiesel near the storage location will save time and energy in transportation. The final

issue with the chosen location is the storage of the biodiesel post-production. The most probable solution is an above-ground storage tank; however the cost of this option is currently prohibitive.

- **Comparison to similar projects at other campuses, if possible**

CU Biodiesel at the University of Colorado at Boulder is a non-profit student organization dedicated to advancing the use and knowledge of biodiesel. Their efforts are focused on the University of Colorado at Boulder and the surrounding community. CU Biodiesel strives to educate the public and private sectors about the production and implementation of biodiesel and simultaneously promote its use as a valuable renewable resource. The CU Biodiesel team worked in various countries across the globe during the summer of 2006 to promote sustainability and energy independence. Their work in Columbia produced the "Synergy5" document ,which has been a primary resource for UIUC Biodiesel's operation. CU Biodiesel has also facilitated the transition of their university's buses to Biodiesel made from WVO – similar to the goals of UIUC Biodiesel. Thirteen diesel buses in the university fleet currently run on varying degrees of biodiesel blends. Other similar programs include the following: University of Idaho Biodiesel, University of Iowa (under the direction of Dr. John Gerpen).

BUDGET AND FUNDRAISING

- **Detailed Budget**

The Biodiesel Initiative seeks funding from the Student Sustainability Committee to further cover the capital costs of the reactor, safety equipment for each committee, and infrastructure costs for the renovation of the Campus Garage. Once construction is complete and the production process has been perfected, the Campus Garage will fund waste disposal costs and potentially student wages. The total proposed budget of the project is shown below. A more thorough, itemized budget is included in the Appendix.

Again, at this point student labor will be voluntary. However, the costs shown here to produce the biodiesel includes student labor estimated at $1.33 per gallon. Petroleum diesel currently costs approximately $2.31. This price is expected only to increase during the life of this project. Assuming that chemical costs and labor do not increase significantly, the estimated minimum savings for the garage is approximately $0.98 per gallon. Under current reactor designs and WVO usage, the Biodiesel Initiative plans to produce approximately 400 gallons of biodiesel per week. For an academic year of production, approximately eight months, this totals 12,800 gallons of biodiesel. Under the savings outlined above, the biodiesel produced through our project would save the Campus Garage approximately $12,544 per year.

The total estimated budget is shown in Table 1 of the Appendix, and a detailed budget can be found in the Appendix.

- **If the Student Clean Energy Committee does not fund the full requested amount, will the project be able to move forward?**

At the onset of our project, the budget for the equipment and potential modifications to the space was significantly underestimated at approximately $20,000. Recent discussions with engineers at

the University's Facilities & Services (F&S) department have indicated that garage modifications alone may cost around $40,000. The UIUC Biodiesel Initiative has received approximately $22,000 in funding, which alone would be insufficient to even cover the cost of the capital equipment. The project has also applied for funding through the College of Engineering Design Council and other external sources, but no funding has been awarded. Therefore, the financial support of the Clean Energy Committee is indeed pivotal for the completion of this project.

- **List any grants or other sources of funding that have been obtained**

As previously mentioned, the UIUC Biodiesel Initiative has obtained $22,385 in funding through various grants, including $10,000 from the Clean Energy Technology fund last year. The current funds are outlined in Table 2 of the Appendix. Significant non-financial donations have come from other sources, including the Campus Garage, the Waste Management Research Center (WMRC), and private companies. The Campus Garage has agreed to donate the space for the reactor and to provide a truck for the team to transport WVO to the reactor site. The WMRC, F&S, and other campus entities have contributed significant technical support and time to the project. Private companies have supplied some materials to the project, such as used storage drums and lab equipment.

- **List any grants or other sources for which the project will apply**

The UIUC Biodiesel Initiative has applied for the Engineering Design Council Multi-Disciplinary Project Support grant to fund garage modifications, capital equipment, and solar panels for subsidizing some of the energy used in the reaction. The project team is also in the process of submitting applications for external grants through the local Rotary Club chapter and Keen, Inc.

TIMELINE

Spring 2006	Biodiesel Project organized. Location of space and use of product discussed.
Aug. 2006	UIUC Biodiesel Initiative becomes an active project, divides into committees, including Waste Vegetable Oil Acquisition, Testing and Integration, Reactor Design and Construction.
Fall 2006	Committee research begins to compile research and draw up a preliminary design for production steps.
Spring 2007	Committee work continues. Some funding secured.
Mar. 2007	Demonstrational "appleseed" reactor constructed for use in outreach. Committees and officers begin to compile a comprehensive "End of Year Report", detailing updated design information and the year's accomplishments.
Summer 2007	End of the Year Report completed.
Fall 2007	Committees reestablished to finalize design plans. The scope of garage

modifications finalized, and work begins on this construction (contingent on sufficient funding). Long lead-time items are ordered.

Dec. 2007 Modifications to the garage completed. Equipment and supplies purchases are completed (contingent on sufficient funding).

Jan. 2008 Begin construction of the reactor.

Mar. 2008 With reactor construction completed, production of biodiesel begins. Once proper testing indicates that the quality of the biodiesel is sufficient, integration into the Campus Motorpool begins.

Fall 2008 Future expansion projects are researched and installed, including projects in methanol recovery, workshops for local communities, regional workshops for other universities, etc.

ENERGY AND ENVIRONMENTAL IMPACT

- **The amount of energy it will generate:**

Plant-based biodiesel produces 119,216 Btu/gal according to an EPA biodiesel exhaust analysis. Assuming production of 12,800 gallons of biodiesel per year, the UIUC Biodiesel Initiative will be providing 1.5 billion Btu of renewable energy for University vehicles.

- **The negative impacts of the project**

Reactor designs have considered a number of options for the product cleansing process, which appears to be the biggest part of the project that may have negative environmental impacts. The plans for the use of a desiccant to cleanse the product have been rejected because of the uncertainty of the hazards associated with the by-products. At this point, our plans outline the use of a water misting wash system. Though we do not expect high water consumption, we will be unsure of the amount of water needed in this step of the process until the project is in its processing phase.

Another point of concern for the project is glycerin, the main by-product of the biodiesel reaction. Glycerin has been used in a variety of applications, from an additive in antifreeze to soap. There is a concern that the glycerin created in our process will have residual methanol content, and therefore present a hazard environmentally. However, the project is currently working on establishing plans for methanol recovery to remove any residual methanol from the glycerin, as well as plans for selling or donating the glycerin as a product for applicable industries.

NO_x exhaust emissions of plant-based biodiesel increase 10% over those of petroleum diesel. While the increase in NO_x emissions is minor compared to the vast reductions in other pollution categories, there is research devoted to mitigating NO_x increases.CO_2

- **Other positive environmental impacts associated with the project:**

The pollution estimated for petroleum diesel is approximately 22.2 lbs of CO2 per gallon. Because biodiesel is a derivative of plant matter, the quantity of CO_2 exhaust emissions is approximately equal to the CO_2 intake of the its plant base. Thus, each gallon of biodiesel consumed effectively reduces CO_2 emissions by 100% over petroleum diesel. Using this information and the estimated production of 12,800 gallons per academic year, a net reduction 284,160 lbs of CO_2 emissions per year will result.

Possibly the most significant environmental impact associated with the project is one that cannot be quantified in energy savings or waste reduction, that is the education of fellow students and local communities about the benefits of sustainable living. We expect that the knowledge of the importance of waste reduction and the use of alternative energy, as exemplified in our project, will have a significant yet immeasurable impact on the mentality and future lifestyle choices of those affected by the project.

OUTREACH AND EDUCATION

- **Visibility of the project to the students**

Students will become aware of the project through various publicity efforts by the team including classroom announcements, newspaper articles, and possibly stickers on campus vehicles running on our biodiesel. Already, our project has been featured in *Daily Illini* articles, *The Green Observer*, and WCIA news. Our reactor will be one of the largest biodiesel reactors in the state. Being student-run, it will be ripe for media coverage. The UIUC Biodiesel Initiative, in conjunction with Engineers Without Borders, will support and host informational events such as demonstrations at the local children's museum and community workshops.

- **The role that students will play in the project**

The UIUC Biodiesel Initiative is entirely student-run. Aside from technical assistance from the Waste Management Research Center (WMRC) and some university faculty, the student team will perform all aspects reactor construction and biodiesel production.

- **The opportunities for involvement in classroom curriculum**

The team is compiling informational material that could be used for lectures in several university courses. The courses that we plan on pursuing for these opportunities are energy or environmentally related, and include:

- CEE 498: Sustainable Urban Engineering
- ABE 498: Renewable Energy Sources and Applications
- ENVS/NPRE 101: Introduction to Energy Sources

- **Additional information on methods the project will use to educate the students and the public about renewable energy technologies**

  - Field trips to the reactor and workshops for the university and local community will be arranged to educate the community on biodiesel.

  - The group will use the website to encourage other universities as well as community members to create their own biodiesel reactors. They are rather simple, but a lack of information inhibits new biodiesel projects from developing. The website will enable others to access information on the production and use of biodiesel with greater ease.

  - We will demonstrate biodiesel production and present the financial and environmental benefits of its use. Providing the appropriate information, demonstrations, and guidance our presentations should cultivate an expanding community of biodiesel producers.

  - The UIUC Biodiesel Initiative team members will hold workshops for local communities and neighboring universities in order to demonstrate the benefits of biodiesel fuel.

APPENDIX
Biodiesel Reactor Detailed Price List

Table 1 Total Proposed Budget - UIUC Biodiesel Initiative, Fall 2007

Estimated Budget	
WVO Acquisition	$3,321
Reactor	$24,600
Testing & Integration	$1,049
Chemicals	$1,419
Safety	$4,249
Subtotal	**$34,638**
Contingency/Misc. Funds	$2,000
Garage Modifications*	$40,000
PROJECT TOTAL:	**$76,638**

*Garage Modifications estimate yet to be finalized.

Table 2 Current Project Funding

Source	**Grant Amount**
Clean Energy Technology Fee	$10,000
Engineering Design Council	$7,885
Environmental Council	$2,000
V. Dale Cozad Business Plan Competition	$2,500
TOTAL AWARDED	**$22,385**

Committee Budgets

Waste Vegetable Oil Acquisition Committee Proposed Budget

ITEM	QTY	UNIT COST	ITEM COST
WVO Collector (55 gal drum)	20	$125	$2500
Portable High Speed Pump (>15 gpm)	1	$320	$320
Truckbed Polyethylene Tank	1	$198	$198
Tie Downs	1	$23	$23
Stick Heater	1	$250	$250
Industrial Strength Funnel w/ Filter	1	$30	$30
Estimated WVO Cost:			**$3,321**

Reactor Committee Proposed Budget

ITEM	QTY	UNIT COST	ITEM COST
600 Gallon SS Tank	1	9,500	9,500
100 Gallon SS Tank	1	3,500	3,500
Main Pump	1	900	900
Methanol Pump	1	400	400
Piping	1	3,000	3,000
Valves	1	2,000	2,000
Drum Pump	1	300	300
Boiler	1	2,000	2,000
Bag Filter Housing	1	2,000	2,000
Assorted Wash Components	1	1,000	1,000
Estimated Reactor Cost:			**$24,600**

Testing and Integration Committee Proposed Budget

ITEM	QTY	UNIT COST	ITEM COST
Cloud Point	1	$103	$103
Centrifuge	1	$436	$436
Specific Gravity	1	$27	$27
Acid Number	1	$330	$330
Viscometer	1	$153	$153
Estimated T&I Cost:			**$1,049**

Chemical Proposed Budget*

ITEM	QTY	UNIT COST	ITEM COST
Methanol (55 gallon drum)*	5	$275.00	$1,375.00
Sodium Hydroxide (35 gallon drums)*	1	$44.00	$44.00
Estimated Chemical Cost:			**$1,419.00**

*These estimates are based on five weeks of full scale reactions.

Safety Proposed Budget

ITEM	QTY	UNIT COST	ITEM COST
Overpack Mobile Spill Response	1	$325	$325
Truckbed Spill Kit	1	$359	$359
Red Alert Drain Protector x3	3	$55.00	$165
Flammable Storage Closet	1	$1,200	$1,200
Fire Extinguishers	3	$26	$78
Eye Wash	1	$260	$260
Chemical Shower	1	$600	$600
Spill Pallets	4	$225	$900
Fire Blankets	2	$42	$84
Industrial Fan/Blower	1	$140	$140
Lab Apron	5	$7.50	$38
Goggles, Gloves	12 ea.	---	$100
Estimated Safety Cost:			**$4,249**

Cost Analysis Plan
UIUC Biodiesel Initiative
Estimates as of October 2007

Labor Cost:		**Hours**	**People**	**Wage**	**$/week**	**$/month**
	Collection of WVO	4	2	9	72.00	288.00
	Reactor	4	2	9	72.00	288.00
	Testing	3	2	9	54.00	216.00
	Totals	11	6	27	$198.00	**$792.00**
Input Costs		**Units/week**	**Price/unit**	**$/week**	**$/month**	
	Methanol (gallons)	60	2.5	150.00	600.00	
	KOH (kg)	15.12	1.52	22.98	91.93	
	Totals			$172.98	**$691.93**	
Waste Disposal		**gal/week**	**Drums/week**	**$/wk**	**$/month**	
	Glycerin	80	1.45	110.55	442.18	
	Filters	15	0.27	4.09	16.36	
	Totals	95	1.72	$114.64	**$458.54**	
Transportation		**Miles/wk**	**Mpg**	**$/gal**	**$/week**	**$/month**
	Driving Truck	15	10	4	$6	**$24**
Energy		**kwh/mo.**	**$/kwh**	**$/month**		
	To run the reactor	30	0.11	3.3		
	To run the tests	60	0.11	6.6		
	Totals	90	$0.22	**$9.90**		
Chemicals for Testing		**Product #.**	**Quantity**	**Unit/mo.**	**Price**	**$/month**
	KOH	319376-2L	2L	1	24.1	24.1
	Phenolphthalein	P9750-100G	100g	1	21.9	21.9
	Acetone	179124-2L	2L	2	43	86
	Totals			4	89	**$132.00**
Safety		**$/year**	**$/month**			
	Reactor Gloves	90	7.50			
	WVOA	42	3.50			
	Testing	7	0.58			
	Goggles	100	8.33			
	Aprons	30	2.50			
	Totals	$269.00	**$22.42**			
Total Costs		**Per month**	**Cost/gal**			
	Costs	**$2130.79**	**$1.33**			