



**Biodiesel Learning Laboratory to Facilitate Campus
Sustainability Initiatives across SUNY**
[FINAL REPORT FOR SUNY SMALL SUSTAINABILITY FUND]

Lead campus The College at Brockport, State University of New York.

Project Director and
Principal Investigator Kyongsei Sohn, Ph.D.
School of Business Administration and Economics
SUNY, The College at Brockport
350 New Campus Dr.
Brockport, NY 14420
Phone: (585) 395-2623
Fax: (585) 395-2542
Email: ksohn@brockport.edu

Co-Principal Investigators Mustafa Canbolat, Ph.D., The College at Brockport, SUNY
John Gardner, Ph.D., The College at Brockport, SUNY



1. Title of project

Biodiesel Learning Laboratory to Facilitate Campus Sustainability Initiatives across SUNY

2. Abstract

This pilot project studies one of the challenges associated with high levels of food waste that contain used cooking oil. For example, at The College at Brockport, an amount close to 900 gallons of used canola and soy bean oil is collected for disposal per month during the period of regular session. The disposal of the used cooking oil presents environmental burdens requiring an oil recycling company to haul away the waste from the campus. The Brockport campus does not have an operating biodiesel production facility, and disposal of the waste is one of the environmental concerns presented across the SUNY campuses.

To investigate these concerns, a team of faculties and students in Rochester area collaborated for the development of an in-house biodiesel processing lab at Brockport campus. The project was successfully conducted at Brockport campus over the period of the spring 2014 to spring 2015, spanning three semesters. During the project period, this project led by a team of students from Brockport has participated in the college level research and development competition for the New York State Pollution Prevention Institute's 2014-2015 Student Earth Day Competition. The team's project was awarded with the first place from the competition.

The study/project provides some valuable information for future biodiesel processing lab project(s) for other SUNY campuses, and, also potentially for other colleges across the U.S. In this report, the scope of the information is focused and limited to providing basic safety and production manuals from this specific processor within this project, since building a biodiesel processing facility can vary widely according to particular regional environmental and local jurisdiction regulations.

For the summary, the investigators agree that the importance of the safety of the participants must be considered as the priority and such priority cannot be overemphasized when taking on a project of building an in-house biodiesel processing facility.

We proposed a three-part approach to develop and expand a SUNY system that will include students who are interested in campus sustainability programs. Our results can be extended onto other SUNY campuses, Brockport local community and other colleges across the nation.

Our approach is to:

- 1) Design and establish a biodiesel production facility on campus at Brockport through the work of student research assistants.

- 2) Develop manuals and the production specification details for future operations and expansion throughout SUNY campuses-the production process requires a period of "trials and errors" before it can become stable and consistent. Plan to frame next stage with development of further technical guidelines of expanded manual for error-prone production processes.
- 3) Develop a plan to apply and assist the production design and process for other interested SUNY campuses to establish on campus biodiesel facilities with their setups and productions.

3. The timeline and duration of the project

The biodiesel student learning lab project was implemented during January 2014, and the project was extended through June 2015 at the College at Brockport campus. The students driven research project outputs are attached as PDF files in this report. The following illustrates a brief time line for the entire project.

- a. September 2013 to June 2014: Basic research and development of the project. Biodiesel lab testing/experiment also in progress. Safety manual, business plan, safety education for all participants, and a processor (NWR model) specific manual completed.
- b. June 2014 to March 2015: The processing unit & other equipment purchase (NWR model) and implementation of the plan. Small scale production exercises initiated.
- c. April 2015 to June 2015: Actual processing and production of the biodiesel for Brockport campus. Compilation of the final report.

4. Summary of the project

One of the challenges associated with the current food system remains in high levels of food waste (~1500 Kcal/per person/per day) that consume ~300 barrels of oil/year and over a quarter of total freshwater used (Hall et al., 2009) in preparation for the wasted amount. This presents significant environmental concerns. Among them, waste of cooking oil remains a major concern as this particular waste can be converted into biodiesel (Zhang et al., 2003a, b). This project sought to facilitate student research that supports biodiesel production on campus in order to reduce energy consumption. By converting waste of cooking oil into biodiesel that can be utilized in non-on road machines (especially mowers and tractors), this project addresses a part of those environmental concerns.

The project required a main processor, safety equipment for protection of participants (ex., protective goggles, masks & etc.) and emergency safety facility (emergency showers, eye wash, spill containments, active fire prevention systems, ventilation equipped space for the processor & etc.), holding tanks for raw waste oil and processed biodiesel, and etc.

The following presents most common considerations for planning and developing an in-house biodiesel processing facility for a campus.

- The safety of all participants, including students, faculty, and staff members, and, community residents near the facility is considered the most important consideration and priority.
- To ensure the safety of above mentioned, the processor should be located in a "safe place" – equipped with active fire prevention systems and properly ventilated facility equipped with emergency showers nearby, in addition to the spill containment that is built around the processor and oil transfer area.
- When dealing with the materials for the biodiesel processing, all participants are required to wear protective gears (i.e., goggles, gloves, and fire retardant garments, etc.). No skin exposure is recommended when the participants are nearby the processor.
- Each individual working for the project is required to pass minimum proficiency test for the hazardous materials before one begins working for the actual processing unit.
- The produced biodiesel is prone to solidifying in cold climate conditions. Thus, our facility operates during the spring semesters, and the produced biodiesel is used only during the summer months.
- The storage of the biodiesel poses a challenge for many institutions including college campuses. It requires a hazardous material storage building permit(s) for the local building code compliance. It is important to follow each local regulatory guideline(s) for compliance. It should be noted that the quality of the biodiesel is estimated to deteriorate over a period several months without adding and mixing stabilizer(s) for the produced fuel.
- The produced biodiesel can be used in only NON on-road equipment (such as in diesel lawnmowers), and NOT to be used for on-road vehicles. Using the biodiesel in on-road vehicles requires different permits and production quality control processes that are not studied or discussed in this report. If someone attempts to use the biodiesel in on-road vehicles from this pilot study, it will violate environmental regulations and may cause troubles and void the vehicle warranty.
- The recent fluctuations in diesel price have had an impact on the projection of the financial aspect of the project. In this report, we present the financial analysis at the time of the implementation of this project (Appendix 1).

5. Conclusion

The goal of this project was to create a student driven biodiesel processing laboratory, in support of the goal for reducing cooking-derived waste (spent cooking oil) on SUNY campuses including Brockport campus. This first-hand project experiences for the students as researchers and participants would provide stronger awareness and more realistic goals for the sustainability at different levels. The project had been originally conceived with a plan that included building a biodiesel processing facility in a separate garage on Brockport campus. However, the local building code requirements and consideration for safer storage and access of chemicals led the project to be adjusted, so that it could be carried out at the campus chemistry lab building.

The students and faculties who participated in the project can draw greater understanding and appreciation for the importance of the sustainability issues related to recycling and reuse of waste oil. Additional benefits of this project can be drawn from the levels of attention and awareness from other students, faculty and staff members on campus. Sustainability education naturally occurs with a level of recognition for benefits in waste reduction, and this project certainly facilitates such recognition.

In summary, this project has been serving as an educational exercise that can be extended at different local and regional levels. The SUNY campuses continue to share similar types of sustainability challenges that would most reliably be overcome with greater efforts in longitudinal engagements. While the PIs of the project recognize the shortcomings and challenges of the project, greater systematic levels of collaboration among educational institutions through various forms of communications and coordinations, including campus workshops, would be desirable and recommended as future and continued efforts. The researchers of the project look forward to further discussions and participations on research issues regarding biodiesel/sustainable recycling and reuse of waste oil.

The final reports and other outputs of the students' research of this project will be available through Digital Commons at Brockport shortly after the submission of this report to the SUNY Research Foundation.

6. Project Participants

Three Co-PIs - each of the three are Brockport faculty members:
Kyongsei Sohn, Ph.D. (Project Director and Principal Investigator)
School of Business Administration and Economics
The College at Brockport, SUNY
350 New Campus Drive
Brockport, NY 14420
Phone: (585) 395-2623
Fax: (585) 395-2542

Email: ksohn@brockport.edu

Mustafa Canbolat, Ph.D. (Co-Principal Investigator)
 School of Business Administration and Economics
 The College at Brockport, SUNY
 Email: mcanbola@brockport.edu

John T Gardner, Ph.D. (Co-Principal Investigator)
 School of Business Administration and Economics
 The College at Brockport, SUNY
 Email: jgardner@brockport.edu

Student Participants (13):

(Some of the students graduated and others joined the project later)

Skyelar Habberfield, Student, The College at Brockport, SUNY
 Zachariah Piron, Student, The College at Brockport, SUNY
 Alexander Theuman, Graduate Student, The College at Brockport, SUNY
 Anthony Lenzi, Student, The College at Brockport, SUNY
 Kelly Holder, Student, The College at Brockport, SUNY
 Andrew Bailey, Student, The College at Brockport, SUNY
 Ken Johnston, Student, The College at Brockport, SUNY
 Paul LaPlante, Student, The College at Brockport, SUNY
 Kristen Mooney, Student, The College at Brockport, SUNY
 Brian Jones, Student, The College at Brockport, SUNY
 Jay Lambrix, Student, The College at Brockport, SUNY
 Peter Cabral, Student, The College at Brockport, SUNY
 Charles Flanagan, Student, The College at Brockport, SUNY

Collaborators (8):

Stephen Godleski, Ph.D., Professor and Chair, Department of Chemistry, The College at Brockport, SUNY
 Thomas Trabold, Ph.D., RIT Golisano Institute for Sustainability
 David Fister, MS., RIT Senior Staff Engineer
 Jamie Adams, SUNY at Oswego
 Daniel Bruton, Graduate Student, RIT
 David Frank, Graduate Student, RIT
 Dave Turkow, Facilities and Planning, The College at Brockport, SUNY
 Sarah Klein, Facilities and Planning, The College at Brockport, SUNY

7. Future research

The biodiesel derived from the waste cooking oil is a relatively carbon neutral fuel, when managed optimally. The plants, either soy bean or canola in our example, take carbons from the air and store them in the bodies until released again into the atmosphere. Also when the biodiesel burns, it burns cleaner than regular diesel by producing less harmful residuals (Lapuerta et al., 2009). Processing of the used cooking oil into the biodiesel does take certain amount of electricity, chemicals and methanol. In reality though, this process takes relatively small amount of energy, relative to the volume of the fuel that is being generated.

Given the recent fallen fossil fuel prices, the biodiesel can appear to be economically less practical or attractive than the regular diesel fuel, compared to the period when the project was initially conceived. The investigators understand that sustainability initiatives are driven by or led by economic reasons. But this project stands as an educational exercise and tool from which students and academic community can learn and continue to ask pertinent questions to minimize negative environmental effects while achieving better solutions to sustainability equilibrium.

A small contribution of the processing manuals developed by this project is the culmination of the educational exercise, specifically tailored to the context of local Brockport environmental regulations. While their general applications would not be desirable or recommended to other communities or regions, they may still serve as reference positions from which others will develop and improve the similar types of endeavors in sustainability.

Appendix 1. Eagle Diesel Student Presentation Slides

Appendix 2. Eagle Diesel: Biodiesel Safety Manual

Appendix 3. A business plan for Eagle Biodiesel at Brockport

Appendix 4. A processor (NWR Model) manual at Brockport

Appendix 5. Safety Hazards Regarding Biodiesel Production

References

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