*Please submit this completed application and any relevant supporting documentation by the deadline listed on the SSC website to* [*Sustainability-Committee@Illinois.edu*](mailto:Sustainability-Committee@Illinois.edu)*. The Working Group Chairs will be in contact with you regarding any questions about the application. If you have any questions about the application process, please contact the Student Sustainability Committee at* [*http://sustainability-committee@illinois.edu.*](http://sustainability-committee@illinois.edu.)

**General Information**

Project Name: E2E Paradigm for Food Waste to Biofuel and Biomaterial

Total Amount Requested from SSC: $9500

Project Topic Areas:  Land & Water  Education  Energy

Transportation  Food & Waste

**Contact Information**

Applicant Name: Michael Stablein, Aersi Aierzhati

Unit/Department or RSO/Organization: Department of Agricultural and Biological Engineering

Email Address: stablei1@illinois.edu, aierzha2@illinois.edu

Phone Number: 8479871282, 2174176107

Project Team

|  |  |  |
| --- | --- | --- |
| *Name* | *Department/Organization* | *Email* |
| Michael Stablein | Agricultural and Biological Engineering | stablei1@illinois.edu |
| Aersi Aierzhati | Agricultural and Biological Engineering | aierzha2@illinois.edu |
| Patrick Dziura | Agricultural and Biological Engineering | pdziura2@illinois.edu |
| Jiawen Hu | Agricultural and Biological Engineering | jiawenh@illinois.edu |
| Vishaal Venkatesh | Chemical and Biological Engineering | vvnktsh2@illinois.edu |

Financial Contact’s Name: Tracy Wilkoff, Yuanhui Zhang

Faculty/Unit/Department: Yuanhui Zhang, Professor of Agricultural and Biological Engineering

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Phone: 217.333.3570

**Project Information**

*Provide a brief background of the project, its goals, and the desired outcomes.*

Our research team propose to expand the Environment-Enhancing Energy (E2E) research program to campus application, to augment management of wet biowaste, like food waste produced through the dining halls. More than 34 million tons of food waste was generated in the US in 2010 (EPA, 2010). According to Kelly Boeger, the Menu Management Dietician at the University of Illinois, 344,559 pounds of food goes unused by the cafeterias on campus which was worth $425,735 or 2.46 % of the overall budget as of 2015 (Hettinger, 2015). Moreover, this unnecessary spoilage creates additional cost and environmental burdens. On the other hand, this biomass presents an opportunity for UIUC to implement new resource recovery technologies to alleviate waste and increase student activities directly related to sustainability. Hydrothermal liquefaction (HTL) is a technology that utilizes elevated temperatures and pressure to convert wet biomasses to oil which can be used in motors or asphalts, potentiates greater sustainability by simultaneously remediating the food waste going to landfills and producing renewable energy.

*How will this project improve sustainability at UIUC?*

Our proposed approach would demonstrate the use of advanced strategies for waste management that can also add value directly to the campus, both in terms of economic and environmental benefits, while also engaging students through learning about sustainability research and education. After completion of a survey about our current campus food waste situation, we will publish our results on campus media so that students and university affiliates can learn about the sustainability project and the potential benefits. In this case, one of the campus products from this approach is high energy containing biofuel that can be presented as a drop-in fuel for university vehicles or asphalt binder to make roadways and sidewalks. The prospect of recycling our food waste already going to landfills and having adverse environmental effects to create high value products will be well presented to the campus. Our team could potentially work with other student organizations such as Algae Club on focusing the use of renewable bioresources for development of new campus activities. This would directly establish new interdisciplinary connections and further promote the Student Sustainability Committee contributions to a greater green infrastructure and visibility. Furthermore, it can function to educate community members on new technologies, sustainability practices, and encourage the technology application in other sectors. Of course, one of the project’s greatest impacts will be waste management as monetary and environmental costs incurred by sending food waste to landfills will be mitigated. Quantifying and realizing some of these fiscal returns is pivotal to development campus sustainability because of the long-term benefits for UIUC. Overall, this project will service the SSC by initiating new efforts to address a problem with food waste with innovative technologies to convert biowaste into biofuel, engage and educate community members from different backgrounds, and have potentially substantial economic and environmental benefit to our campus and society.

*Where will the project be located? Do you need special permissions to enact the project at this site? If so, please explain and attach a letter of support to your application.*

The project will be located at the facilities of Agricultural and Biological Engineering department of UIUC. No special permissions are required for it.

*Other than the project team, who will have a stake in the project? Please list other individuals, groups, or departments indirectly or directly affiliated to this project. This includes any funding entities (immediate, future, ongoing, etc.) and any entities that will be benefiting from this project.*

Currently, our project will be organized and carried out by the student team in the Agricultural and Biological Engineering Department under supervision of Professor Yuanhui Zhang. The Environment-Enhancing Energy Lab demonstration facility will serve as the primary work site for this project and have all needed HTL batch reactors. We will conduct lab-scale HTL in the first stage. Toward the end of Stage I we will plan for the pilot-scale HTL. A pilot-scale reactor, developed by SnapShot Energy, will be used for Phase II. Professor Zhang co-founded SnapShot Energy, and the pilot HTL reactor has been used before by our team members (Aersi Aierzhati) in another project. This team will have full accessibility to the reactor.

*Please indicate how this project will involve or impact students. What role will students play in the project?*

Our team is comprised of two PhD students and three undergraduate students. Under the supervision of Professor Yuanhui Zhang, a leading expert in the area of HTL of wet biowaste. The graduate students will lead the efforts during the project. This project involves some chemical laboratory tests organized by two graduate students, which will be a good opportunity for undergraduate student to learn and improve their experimental and analysis skills. After the project, an innovative food waste disposal approach will be reported and possibly published based on the information collected. We will also publish our results on campus media so that the other students can learn about the sustainability project. Aside from the three students listed, we expect there will be several undergraduate students will join the team for different tasks including food waste collection, conversion to biocrude, upgrading the biocrude, and campus presentations.

*Have you applied for funding with SSC previously? If so, for what project?*

No.

**Scope, Schedule, and Budget verification**

*What is the plan for project implementation? Describe the key steps of the project including the start date, target completion date, target date for submitting a final report, and any significant tasks or milestones in the table below. Please be as detailed as possible.*

Past projects like the Illinois Biodiesel Initiative (IBI), which used the dining hall oil to generate renewable biofuel at pilot scale (ISEE - IBI), help to bring awareness and application to sustainability on our campus. That team used innovative process and collection system and chemical treatment to recover energy in the form of biodiesel for the campus. Likewise, our team will use part of the campus food waste, focused on dining hall food going to a landfill, to validate the feasibility of larger scale use of HTL. Our team has previous experience with food waste and other feedstocks. Among different feedstocks, the food waste tested for HTL process and the biocrude oil yield and quality were relatively high (publication under revision). The project objectives would be the following (Phase I):

* Design survey on the total amount and specific types of food waste on campus to determine best feedstock for HTL operations
* Collect food waste from Ikenberry Dining Hall for laboratory composition and energy analysis
* Identify ideal reaction conditions to achieve highest biocrude oil yield and quality from food waste hydrothermal conversion.
* Separate and refine HTL produced biooil to meet biofuel standards
* Use refined oil for small scale sustainability project on campus
* Perform economic analysis for scaled and continuous use of HTL system on campus, suggesting value recovery from other waste biomasses

The project beginning in the start of spring 2018 semester will have four phases, each phase consisting of 1 month approximately. The target date for submitting a final report will be in June of 2018. The first phase will consist of analyzing the feedstock sources from the dining hall for their energy content at laboratory scale in batch reactions and potential economical returns. In doing so, our team will determine which source has the greatest conceivable benefit to campus, based on quantifying the available waste and value recovery using HTL. The second phase of this project will consist of converting the oil phase of the laboratory HTL process into a refined product for the sustainability project. During this phase, the biooil will undergo chemical treatment to refine the petroleum alternative into a usable product that can substitute a campus cost. This portion of the work is essential to validating food waste HTL processing, as our projects will specifically improve UIUC sustainability. The following weeks will be focused on performing a larger scale assessment for expanding the HTL scope of feedstocks for further energy recovery using waste at larger scale, as well as determine the potential impacts on campus with sizable amounts of food waste.

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| **PHASE** | **OBJECTIVES** | **EXPECTED RESULTS** | **DURATION** |
| 1 | Food Collection and survey | Food waste composition and quantities | 1 month collection and organization + analysis |
| 2 | Laboratory conversion of food waste to biocrude and analysis | Determine oil potential of specific food waste products | 1 month |
| 3 | Preparation and design and sustainability demonstration | Use biocrude product to make fuel or asphalt for small demonstration | 1 month |
| 4 | Economic analysis for scaled up and continued use of HTL system | Potentiate larger impacts for campus with scaled up production | 1 month |
| Final | Final report preparation | Closing of the project | 1 month |

*List all budget items for which funding is being requested. Include cost and total amount for each item requested. Please be as detailed as possible.*

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| **ITEM** | **COST** | **DESCRIPTION** |
| Laboratory Supplies | $ 3000 | * Swaglok Reactors Parts * Organic Solvents * Expendables (gloves, syringes, filter paper, etc.) |
| Operational Materials (lab analysis service) | $ 2000 | * Feedstock testing for energy potential (microanalysis/MCB lab) * HTL product analysis |
| Campus Impact Demonstration | $ 1000 | * Campus waste awareness flyers * Educational Poster with basic results * Materials for oil and asphalt samples |
| Publish Results | $ 1000 | * Undergraduate Research Symposium, Professional Presentation |
| Labor | $ 3000 | * Hourly students stipend for project related activities |
| **TOTAL** | **$ 10000** |  |

*If the project is implemented, will there be any ongoing funding required? What is the strategy for supporting the project in order to cover replacement, operation, or renewal costs? (Note: SSC provides funding on a case by case basis and should not be considered as an ongoing source of funding)*

Some of our activities will be co-supported by current laboratory infrastructure. By the end of phase I, we will have discussed the named collaborations in further detail with potential other project stakeholders. Moving ahead to phase II, these partners can contribute more significantly to a larger scale operation of food waste HTL or the resulting project. SSC can help to get the projected started through the initial funding stages, and once the project analysis has been conducted to determine economic viability in the long term, it can be funded with a different structure.

*Please include any other sources of funding that have been obtained or applied for, and please attach any relevant letters of support.*

N/A

*What is the plan for publicizing the project on campus? In addition to SSC, where will information about this project get reported?*

After this phase of the project and possibly including some early phase 2 results, an innovative food waste disposal approach will be reported and possibly published in a scientific journal based on the information or data collected. We will also share our results through campus media so that the other students can learn about the sustainability project.