STUDENT SUSTAINABILITY COMMITTEE

Funding Application – Step 2

Please submit this completed application, the supplemental budget spreadsheet, and any relevant supporting documentation by the deadline indicated in your Step 1 notification letter to 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 SSC at Sustainability-Committee@Illinois.edu.

General Information

Project Name: Pilot Scale Demonstration of Plastic-to Fuel Technology to Produce Fuels for Campus Use.

Total Amount Requested from SSC: Total Project Cost

Project Topic Area(s): ☒Energy ☐Education ☒Food & Waste ☐Land ☐Water ☐Transportation

Contact Information

Project Lead

Applicant Name: Brajendra K (BK) Sharma
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Financial Contact *(Must be Full-time University of Illinois Staff Member)*

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Facilities Management Contact *(If Applicable)*

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Primary Project Team

Name	Department	Email
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Project Description

Please provide a brief background of the project, the goals, and the desired outcomes:
In previous studies we demonstrated the lab and pilot scale potential for producing crude oils through pyrolysis of waste plastics. On distillation, these plastic crude oils produce 80% fuel as gasoline and diesel and the remaining products as vacuum gas oil. In this project, we propose to demonstrate a continuous catalytic pyrolysis technology capable of producing predominantly one fuel; gasoline, diesel, or non-condensable gases (ethane, propane, and butane) from PE (#2 and #4), PP (#5), and PS (#6).

According to a 2012 EPA report, 251 million tons of municipal solid waste was generated in the US. After MSW recovery through recycling and composting, plastic was found to be the 2nd largest component (18%) behind food waste (21%) of the 164 million tons discarded in 2012. This means that huge quantities of plastics end up in landfills (29 million tons). The University of Illinois campus at Urbana Champaign generates about twelve tons of trash per day. Translating above numbers to UIUC campus MSW would mean that we are sending 1.39 tons of plastic to landfills every day. Through pyrolysis, this non-recyclable plastic waste stream on campus can be simultaneously diverted and converted into 175 gallons of fuel (assuming 60% conversion and 80% fuel yield) every day with possible use for campus vehicles. Implementation of this technology on campus will result in waste minimization, waste conversion to fuels/chemicals, decreased reliance on fossil fuels, the reduction of the carbon footprint of the material recovery facility, extension of landfill life (equivalent to 4380 tons/year), and a reduction in the GHG emissions. In a recent report by Argonne National Lab, it has been shown that plastic-to-fuel technology helps reduce up to 14 percent in greenhouse gas emissions, up to 58 percent in water consumption, and up to 96 percent in traditional energy use when compared to ULSD from conventional crude oil, using their highly regarded Greenhouse gases, Regulated Emissions and Energy use in Transportation (GREET®) model. Therefore, this project will not only contribute towards the total waste diversion goal set in the Illinois Climate Action Plan that requires 90% of solid waste to be diverted from landfills, but also towards the emissions reduction goal by reducing CO2.

The overarching goal of work that will be initiated under this project is to end landfilled plastic waste forever, by collecting, processing, and converting the plastic waste from the U of I waste transfer station MRF to a usable fuel that can be used in University vehicles. For this project, the focus is to demonstrate the continuous catalytic pyrolysis system for distributed production of most desirable fuels for use in the MRF/WM facilities. We propose to introduce this technology to students and involve them in conducting detailed process characterization with the aim of improving process yields and product quality. The specific objectives of this project are:

Year 1:

(i) Demonstrate the feasibility of converting waste plastic to fuels by installing a continuous catalytic pilot scale system capable of processing 200 lbs of waste plastic every day
(ii) Engage students to identify the parameters of the continuous pilot scale catalytic pyrolysis process for producing high yields of diesel compared to gasoline and NC gases

(iii) Support the education and training of students from various disciplines to study the effect of continuous operation on catalyst life

Year 2:

(iv) Involve students to study the impact of feedstock composition and quality on yield and quality of fuels
(v) Evaluate and compare diesel fuel produced with ULSD and demonstrate its potential as blend component in petroleum ULSD
(vi) Generate mass/energy balance data for the entire process
(vii) Create awareness in the larger community by participating in various outreach opportunities

How will the project improve the sustainability of the Illinois campus and how will the project go above and beyond campus standards?

The 2015 iCAP (Illinois Climate Action Plan) set a goal of 90% solid waste diversion from landfills by 2020. Meeting the above laudable goal requires the campus to be creative in identifying where different fractions of MSW can be used. Although food waste, another major fraction of MSW, has a possible outlet to the Anaerobic Digestors available at UCSD, there seems to be no outlet for the 1.39 tons of plastic going to landfills every day. This project provides a unique opportunity in the University setting for diversion of this non-recyclable plastic fraction from landfills.

This distributed energy production model offers the opportunity to achieve greater efficiency through conversion in local areas in place of hauling the waste to a central facility. There is very little operational knowledge in the distributed energy production and utilization space, and we intend to fill this gap through this project. A successful demonstration at this scale has potential in the future to produce 175 gallons of diesel from 1.39 tons of plastic waste generated every day on this campus. The continuous plant will afford the opportunity to educate policy makers on campus, familiarize students with the technology, provide learning opportunities for students, lower the uncertainties surrounding this technology and provide a unique opportunity to bring together the various stakeholders on campus in the transition to a more informed and sustainable campus.

Furthermore, all this plastic comes from oil, so instead of handling, shipping, and landfilling the plastic off-site, it makes a lot of sense to convert it back to usable fuel on-site.

Where will the project be located? Will special permissions be required to enact the project on this site? If so, please explain and submit any relevant letters of support with the application.

The project will be located at the Illinois Sustainable Technology Center at 1 E. Hazelwood Drive. No special permission will be needed to enact the project on this site.

Other than the project team, who will have a stake in the project? Please list other individuals, groups, or departments affiliated directly or indirectly by the project. This includes any entity providing funding (immediate, future, ongoing, matching, in-kind, etc.)

and any entities that will be benefitting from this project. Please attach letters of commitment or support at the end of the application.
In keeping with the above objectives, key stakeholders include:

(i) U of I waste transfer station MRF: This project will help them to divert solid waste from landfills, thereby working towards iCAP goal.
(ii) iSEE: One of missions of the iSEE is to develop and implement strategies for a sustainable campus environment. Given that this project addresses this mission, the iSEE is one of the key stakeholders in this project.
(iii) The other key stakeholder is F & S. Our goal is to involve personnel from F & S and MRF in all aspects of the plant, installation, and testing. The goal would be to create awareness and lower uncertainty of the technology. In our experience, as key personnel in F & S become comfortable with the technology, they are more likely to consider it for future projects.
(iv) Student Groups: We are aware that there are several student groups on campus with an interest in promoting renewable energy on campus, such as the biodiesel student group. We will reach out to this and other interested student groups as we progress. We are also planning on offering paid internships to students in the Professional Science Master's Program offered through CABER.

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

(i) Paid internships or other type of hourly employment supporting the improved design, operation, and marketing of the pilot system
(ii) Outreach to student groups active in the renewable energy space, such as Biodiesel student group, IBRL, iSEE, Quad Day, Sustainability Week, Game Days, Marathons, etc.
(iii) Accessible facility as a resource for students to learn/advocate about this technology
(iv) Students will be able to conduct independent studies centered around the pilot plant. Examples of student roles would be access to data generated during pilot plant operation as input to follow-on analysis in courses offered on campus
(v) Students will assist in all tasks including installation and operation of the continuous plastic-to-oil system, to be located at pilot lab in ISTC; record data on system operation; and collect and analyze various liquid samples. Students will calculate and assemble feedstocks to process in the correct proportions for optimum operation and energy extraction.
(vi) There are many facets of this project that could serve as an R&D study or thesis project across several disciplines and departments. Potential domains include: Mechanical Engineering for system integration and operation; Chemical Engineering for fuel distillation and testing; Electrical Engineering for system controls and power management; Environmental Engineering for air emissions control and sampling

Financial Information

In addition to the below questions, please submit the supplemental budget spreadsheet available on the Student Sustainability Committee website. Submission of both documents by the submission deadline is required for consideration of your project.

Have you applied for funding from SSC before? If so, for what project?
Yes, for a project on Rotary Gasification for Waste to Energy in Spring 2016. Because of high cost of project ($409,000), we were not successful in receiving the grant.

If this 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?

Please note that SSC provides funding on a case by case basis annually and should not be considered as an ongoing source of funding.
The facility will be maintained and operated by personnel from the Illinois Sustainable Technology Center.
Recurrent funding will be sought from ISTC clients for testing their feedstock and will come from additional grant requests.

Please include any other sources of funding that have been obtained or applied for. Please attach any relevant letters of support as needed in a separate document.
ISTC in-kind support for Operating Costs (Personnel, feedstocks, publicity and communication. Other costs) - $10,000

Environmental, Economic, and Awareness Impacts

In addition to the below questions, please indicate specific measurable impacts as applicable on the supplemental budget spreadsheet.

Which aspects of sustainability does your project address, and how? Does the project fit within any of the iCAP goals? If so, how does the project go beyond the university status quo standards and policies.

The iCAP set a goal for total waste diversion, which means 90% of solid waste generated on campus should be diverted from landfills by 2020. This project will help achieve this iCAP goal along with contributing to other goals, such as: reduction in transportation emissions, providing immersive sustainability learning opportunities to students, and indirectly, to water conservation.

In order for a product or material to be truly described as sustainable it must be environmentally, economically and socially sustainable. Plastic makes an immense contribution to environmental sustainability through its energy saving potential and intrinsic recyclability and energy recovery options.

Plastics-to-Oil (PTO), goes beyond the iCAP goal of Waste Diversion from landfills. PTO takes it a step further; not only does it divert the plastic from the landfill, the waste plastic will also be converted into a useable fuel product that can be used to power campus vehicles. If PTO were to be implemented on Campus, Plastics could be considered and reclassified as Zero Waste.

How will the environmental impacts of your project be measured in the near and long term? What specific monitoring and evaluation processes will you be using to track outcomes and progress?

Environmental impacts will be measured by past year waste plastic material going to plastic recycling and landfills. The throughput of waste plastic going to the PTO reactor and the desired output fuel exiting the reactor will be measured by mass balance to determine productivity and efficiencies. CO2 emission reductions will be determined using ANL GREET model.

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

We will have a comprehensive outreach, and publicity plan to promote the project. These can be divided in to the following categories:

- Outreach to campus policy makers and operational personnel
- Outreach to general campus community through Sustainability Seminar Series, Lab tours and open houses, news releases through Daily Illini, the News Gazette etc. to spread the word in addition to featuring it on the web pages of the ISTC, PRI, iSEE and in PRI newsletter, iSEE newsletter, local media outlets.
- Outreach to student groups active in the alternative fuel and sustainability space by participating in the annual iCAP meetings, Quad days, Sustainability week.

• Publicize Funding of Project by SSC by having a plaque by the equipment acknowledging SSC support for project. This will also be highlighted in fact sheets and media focused news.

What are your specific, measurable outreach goals? How will these be measured?

(i) We will track the number of visitors to the plant.
(ii) We will track media and news outlet coverage.
(iii) We will track posters, publications, and presentations related to project.
(iv) We will track number of cross-campus collaboration generated as a result of this project by communicating with other departments on campus, where students from those departments could benefit from becoming part in this project.
(v) We will track the information disseminated to the Cities of Champaign-Urbana, the surrounding counties.
(vi) We will track grade and middle school visits about the technology.

Do you have any additional comments or relevant information to aid in evaluation of this application?

The project team have experience in pyrolysis process and fuels (PI), type of waste generated on campus (Co-PI), mass and energy balance (Co-PI), and fuel characterization (PI).

• This is a unique opportunity to reduce landfill disposal and fossil fuel consumption.
• This project will provide a novel teaching and research platform in alternative fuels.
• The successful demonstration of this system would open up the dialogue for implementation of 1-5 tons/day system capable of using all plastic waste generated on campus and in surrounding neighborhoods.
• We propose to take advantage of the sorting performed at the MRF to separate desirable plastic from the MSW for conversion using this technology.