STUDENT SUSTAINABILITY COMMITTEE

Funding Application – Step 1

Please submit this completed application and any relevant supporting documentation by the deadline listed on the SSC website 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: $132,300

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

Contact Information

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Project Team

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Name	Department/Organization	Email Address

Project Information

Please provide a brief background of the project, the goals, and the desired outcomes:
Earlier 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% gasoline and diesel and remaining as vacuum gas oil. In this project, we propose to demonstrate a continuous catalytic pyrolysis technology capable of producing predominantly one fuel either 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 and the University generates about twelve tons of trash per day. After MSW recovery through recycling and composting, plastic was 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). Translating these numbers to UIUC campus MSW would mean that we are sending 1.39 tons of plastic in trash to landfill everyday. 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) everyday with possible use for campus vehicles. Implementation of this technology on campus will results in waste minimization, waste conversion to fuels/chemicals, reducing 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 contribute towards CO2 reduction goals set in the Illinois Climate Action Plan.
The focus of this proposal is to demonstrate the continuous catalytic pyrolysis system for distributed production of most desirable fuels for use in the MRF/WM facilities. We plan 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 the research are:

i) Install a continuous catalytic pilot scale system to process 200 lbs/day of waste plastic.
ii) Identify the parameters of the continuous pilot scale catalytic pyrolysis process for producing high yields of one fuel out of gasoline, diesel, and NC gases.
iii) Study catalyst life on continuous operation.
iv) Study the impact of feedstock quality and composition on yield and quality of fuels.
v) Evaluate and compare various fuels thus produced with petroleum fuels and demonstrate their potential as blend component in petroleum fuels.
vi) Generate mass/energy balance data.

Please provide a brief summary of how students will be involved in the project:
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.
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.

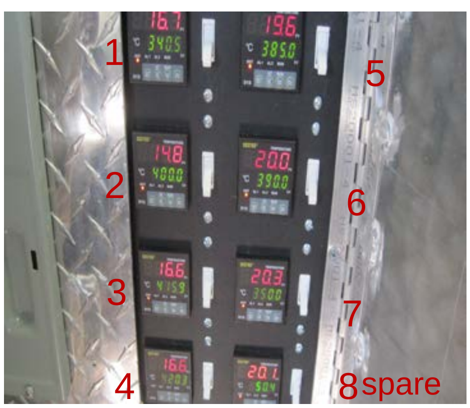
Please provide a brief summary of the project timeline:
This will be a two-year project for completing objectives 1-3 in the first year ($86,150) and remaining in 2nd year ($46,150). In brief, a continuous pilot scale system (200 lbs plastic/day) will be purchased and installed for demonstration. Catalytic process will allow reactor to run at lower temperature. Product yield, quality, and composition depends primarily not only on the nature of the plastic waste, but also on the process conditions. Therefore, dominant process variables, such as temperature, residence time, and catalyst will be identified for maximizing production of single fuel rather than producing crude oil. Operating conditions that provide the highest yields of individual fuel will be identified using a central composite with replicates design (CCRD) experimental approach to aid accelerated process development. The process will be repeated several times to allow production of repeatable fuel quality and quantity using the optimized conditions. In continuous catalytic process, an important aspect is catalyst life and recyclability, which will be studied. Further, we will study (a) feedstock composition effect starting with typical ratio of #2, 4, 5, and 6 present in MSW and then varying these 10-20%; (b) feed quality variable by the effect of typical impurities (e.g. food waste, moisture) present in the MSW plastic stream; and (c) and finally actual plastic sorted from MSW. This will help determine the type of pretreatment needed for the feedstock and level of impurities that can be tolerated in the process. Chemical characterization of final fuels from this process will determine, if any further processing would be needed to reduce the amount of olefins. Physico-chemical and fuel properties will be comprehensively tested on a stand-alone basis for comparison with petroleum fuels. Determinations will also be made if these fuels can be blended (and how much) with existing petroleum fuels. Finally, the feasibility of this technology will be determined by conducting cost/benefit analysis of the entire process including feedstock pretreatment, pyrolysis conversion, and any post-processing step for producing fuels meeting ASTM specifications.

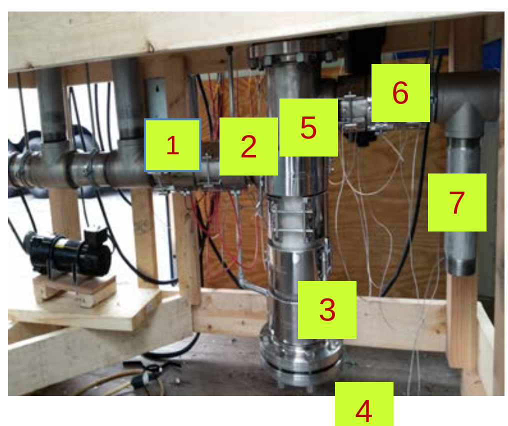
Additional comments
The project team have experience in pyrolysis process and fuels (PI), type of waste generated on campus (Co-PI), mass and energy balance (Co-PI), and fuel characterization (PI).

- This is a unique opportunity to reduce landfill disposal, reduce fossil fuel consumption, and provide a novel teaching and research platform in energy.
- The successful demonstration of this system would lead to implementation of 1-5 tons/day system capable of using all plastic waste generated on campus.
- We will take advantage of the sorting performed at the MRF to separate desirable plastic from the MSW.

PTF200 with mini-fractionator attached

PTF 200/300/500 Parts Identification





Temperature controllers and the zones they control