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: Development of more Environmentally Friendly Electric Alternatives for Rocket Fuel Pressurization using Additive Manufacturing.

Total Amount Requested from SSC: $33,500

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

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Contact Information

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Project Team

Name	Department	Email
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Luke Smith	Pump Electronics Project Manager	lukeis2@illinois.edu
David Riggio	Pump Housing Project Manager	driggio2@illinois.edu

Project Information

Please provide a brief background of the project, the goals, and the desired outcomes:

In liquid fueled rockets, the propellants have to be pumped into the engine at very high pressures. Typically, this is done by a turbopump driven by burning a small amount of propellant to spin a turbine. The purpose of this project is to develop electric

alternatives to traditionally gas turbine powered rocket fuel pressurizing pumps, thereby increasing efficiency and reducing fuel consumption. The pump development and testing process is broken up into 3 primary stages. The first stage produces a small half-size pump which is 3D-printed out of plastic. The second stage produces a full-size pump which will retrofit onto SSS's first liquid fuel engine and will only be tested on the ground. Note this liquid engine is currently being manufactured as a result of SSC funding. The third stage yields the two final pumps which will be used to power a rocket. The half-size and full-size retrofit will share the same converter and battery bank. The final pumps will need new, more powerful converters, battery bank, and motors

By designing our pumps to be driven by a battery bank and motor we can replace the typically less efficient gas turbine which normally drives rocket pumps. Additionally, we gain added control over the engine by altering the speed or torque of the driving motors. By completing this project we aim to demonstrate the efficacy of using an electric alternative to traditionally gas-power turbo pump systems.

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

Students are responsible for the entirety of the design, fabrication, testing, and implementation of the electric turbopump. We encourage everyone from freshman to graduate students to participate and learn the intricacies of practical engineering. In this way, the project provides a rigorous hands-on learning experience for the students involved and, after implementation, it will assist in providing a platform for students to launch research and experimental payloads.

Please provide a brief summary of the project timeline:

Half-size Pump

The half-size pump is currently in its final stages of development; however, we lack the funding for the electronics to power the pump. Once funded we can begin testing as soon as March 2018. Testing is expected to span 1-3 months after which we will begin developing the full-size retrofit pump.

Full-size Pump

Development of this pump is expected to be finished by February 2019 because we should have a more clear direction of design after our extensive testing of the previous pump. Manufacturing will take a few weeks during which we will be adapting the liquid engine testing apparatus to test the full-size pump. After another round of testing, which should last until October 2019, we should have enough experience to design and build flight-ready final pumps which will provide all the fuel and oxidizer to the rocket engine.

Final Pumps

Development of these final pumps will take longer than the previous pump because of the additional requirements that come with flight-qualifying hardware. A conservative estimate for completion of development is around March-April 2020. Manufacturing will take several weeks. Integration and testing

will last most likely until December 2021 due to dependencies on SSS's second liquid engine equipment. A conservative launch date would be summer 2022.

Additional comments

This project has the possibility of improving fuel efficiency of existing and emerging rockets by replacing gas turbine power generators of turbopumps with electric alternatives. This has the possibility of improving the overall efficiency of the rocket engine as well. This becomes increasingly important both as the frequency of rocket launches increases and as companies like Blue Origin and SpaceX move towards propellants with greenhouse gas combustion products.