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CHANGING WHAT'S POSSIBLE

PROPEL-1K—Pioneering Railroad, Oceanic and Plane ELectrification with 1K energy storage systems

PROJECT DESCRIPTIONS

Illinois Institute of Technology – Chicago, IL

1K Rechargeable Solid-State Li-Air Battery For Decarbonizing Aviation - $1,500,000

Illinois Institute of Technology (IIT) is developing a solid-state lithium-air battery that would overcome previous challenges with lithium-air technologies through several key innovations. IIT's approach features a composite polymer solid-state electrolyte with no liquid component, a cathode module with a highly active catalyst and oxygen uptake ability, advanced air flow, and a new cell architecture. The inexpensive battery materials in IIT's technology improve supply chain resilience, and the battery could have up to three to four times greater energy density than current lithium-ion batteries.

And Battery Aero – Palo Alto, CA

HERALD - High Energy Renewable Afx eLectroDes - $983,445

And Battery Aero and its collaborators are developing battery cells, stacks, and systems using fluorinated electrodes to usher in a new type of battery chemistry for aviation applications. The team will focus on enhancing energy density of the cell design through electrode materials optimization and electrolyte formulation. The proposed approach would also innovate battery pack design to reduce energy density penalty due to packaging.

Washington University in St. Louis – St. Louis, MO

Li-Air Redox Flow Battery Using Ionic Liquids - $1,499,985

Washington University in St. Louis (WashU) is developing a lithium-air (Li-Air) battery with ionic liquids to deliver efficient, reliable, and durable performance for high-energy and high-power applications. The proposed Li-Air flow battery would feature circulating ionic liquid saturated with oxygen to overcome critical challenges to Li-Air battery development, including achieving power rate capability and specific energy targets. The team will synthesize ionic liquids with high oxygen solubility, low viscosity, ultra-low volatility, and high ionic conductivity. Preliminary experimental results have demonstrated a tenfold increase in capacity using a circulating electrolyte.

Propel Aero – Ann Arbor, MI

High Energy Redox Engine - $1,117,000

Propel Aero is developing a "Redox Engine" with the potential to deliver a large reduction in greenhouse gas emissions for different modes of transportation. The Redox Engine would provide considerable power performance and deliver the energy density required to meet the demands of electric aircraft. The cost of electricity for the technology would be comparable to jet fuel. Given the low cost and high specific energy, the Redox Engine can address electrification of shipping and trains as well.

Georgia Tech Research Corporation – Atlanta, GA

Alkali Hydroxide Triple Phase Flow Batteries (3PFB) - $1,317,842

Georgia Tech Research Corporation is developing an alkali hydroxide triple phase flow battery (3PFB) to enable reversible operation of ultrahigh energy density battery chemistries. The approach takes inspiration from fuel injectors in internal combustion engines and from conventional flow batteries. The proposed design leverages innovative pumping and handling of molten alkali metal and hydroxide species to maximize the volume of reactants over inactive components and thus increase energy density.

University of Maryland – College Park, MD

High-Energy, Rechargeable, Low-Cost Batteries for Train and Ship Electrification - $1,483,595

The University of Maryland is developing rechargeable lithium carbon monofluoride cathode chemistry to meet the PROPEL1K Category B technical targets. This new chemistry builds on previous work at UMD on halogen conversion-intercalation chemistry but targets significantly higher energy through active material, electrolyte, and other cell chemistry modifications. The cell is assembled in the discharged state, significantly lowering cost relative to high-energy Li-metal cells that are built in the charged state (and hence require the use of Li-metal foils). The cell chemistry work will be combined with performance and cost modeling at several scales to demonstrate a path to meet the final system PROPEL1K targets.

Washington State University – Pullman, WA

Fully Electric Aviation Through Hydrogen Energy Recovery (FEATHER) - $803,945

Washington State University (WSU) is developing a modular energy system by combining ceramic fuel cell technology with an innovative way to package hydrogen in the liquid form. The approach uses a self-pressurizing heat recovery and hydrogen expander module coupled with a proton conducting ceramic fuel cell. The high-temperature system enables energy recovery and significant weight savings through omission of radiative heat exchangers used for cooling.

Johns Hopkins University – Baltimore, MD

High Density Energy Storage Using Cyclic Hydrogen Carriers - $625,000

Johns Hopkins University is developing a high-energy-density hydrogen carrier using methylcyclohexane to create a fuel cell (FC) system that holds higher mass-specific energy densities than conventional systems. The proposed hydrogen FC uses closed loop cyclic hydrogen carriers. The FC system can also be rapidly (~10 min) replenished via pumping.

Aurora Flight Sciences – Manassas, VA

Zero Emission, High Energy Density, High Efficiency Aluminum Air Energy Storage and Power Generation System - $1,499,375

Aurora Flight Sciences is developing an aluminum air energy storage and power generation system to provide a sustainable and environmentally friendly solution for powering heavy-duty transportation. The technology's novelty lies in its ability to facilitate aluminum combustion, resulting in the production of hydrogen that powers a solid-oxide fuel cell. The heat and electricity generated by this process are subsequently utilized for propulsion. The system utilizes a platform that separates energy and power, allowing for swappable energy boxes or pumpable fuel, that can be rapidly and seamlessly charged and discharged mechanically from the vehicle.

Wright Electric – Malta, NY

Modular Aluminum–Air Flow Battery System - $1,499,098

Wright Electric and Columbia University are developing an aluminum-air flow battery that has swappable aluminum anodes that allow for mechanical recharging. Aluminum air chemistry can achieve high energy density but historically has encountered issues with rechargeability and clogging from reaction products. To overcome these barriers, Wright Electric uses a 3D design instead of a 2D planar chemistry to improve the contact between anode and cathode. The system also circulates the electrolyte, preventing the accumulation of reaction products within the cell structure to remedy limitations of static aluminum-air batteries.

Precision Combustion – North Haven, CT

Electrochemical Microchip Paired with Energetic Fuels for MW-hr Electrified Propulsion (EMPoWEr) - $1,221,058

Precision Combustion is developing a unique hybrid fuel-cell battery system. The approach features an electrochemical wafer that uses liquid hydrogen as fuel to generate energy coupled with a high-power lithium-ion battery to enable peak-power operation. The progressive energy storage system hybridizes a highly efficient advanced electrochemical device and a small rechargeable battery and pairs them with a high-energy-density carbon-free fuel. The process intensified architecture has the potential to deliver significantly more power density than other systems in development.

Giner – Newton, MA

Polymer Electrolyte Fuel Cells Fueled By Power Paste - $1,500,000

Giner is packaging hydrogen in a paste to power fuel cells, eliminating the need for high-pressure hydrogen storage tanks. The power paste—a mix of magnesium and hydrogen stored in a cartridge—would trigger the release of hydrogen gas when water is added. The paste is not flammable or explosive. The team will also update the system's fuel cell to operate at lower humidity, making the approach more versatile and lower volume, improving the overall energy density of the design.