Supporting Entrepreneurial Energy Discoveries (SEED) SBIR/STTR Exploratory Topic (Cohort 3)

PROJECT DESCRIPTIONS

Metalx Biocycle – El Paso, TX

Synthetic Biology Approach to Critical Metal Extraction from Waste Electronic Components to Ensure a Robust Supply of Critical Materials for Clean Energy - $500,000

Metalx Biocycle aims to enable the recycling of critical metals from electronic waste (e-waste) at a cost that is competitive against extraction via conventional mining. Most e-waste ends up in landfills where it causes serious environmental issues; and conventional extraction methods rely on inefficient, expensive, energy-intensive processes. The Metalx Biocycle team will leverage biological processes to efficiently extract, concentrate, and purify critical metals and rare earth elements from e-waste and low-grade mineral ores. They plan to develop a biological recovery platform that provides fossil fuel-free metal reclamation and minimizes environmental impact, ensuring a secure closed-loop life cycle for critical metals in the U.S.

pH Matter – Columbus, OH

Type V Vessel-Aided Electrochemical Compression for Ultra-High-Pressure Electrolysis- $500,000

pH Matter will use electrochemical compression within an electrolysis stack and contained in a Type V vessel to eliminate or reduce the amount of additional mechanical compression required to make high-pressure hydrogen (200-700 bar). Historically, mechanical stability, hydrogen crossover, or diffusion problems made such an approach very challenging. In addition to the Type V vessel, pH Matter will utilize their patented, hybrid liquid alkaline-anion exchange membrane electrolysis cell that has 30x less crossover than a state-of-the-art proton exchange membrane electrolyzer. Current hydrogen compression, storing, and dispensing costs add $2.70/kg to the cost of heavy-duty hydrogen fuel, which must cost between $3-4/kg to be competitive with fossil fuels. If successful, this approach could reduce the cost of 700 bar hydrogen fuel by $0.50-2.00/kg.

Stoicheia, Inc. – Skokie, IL

Discovery Platform for Low-Ir Anode Catalysts in PEM Electrolyzers - $495,528

Stoicheia aims to accelerate the discovery of proton exchange membrane electrolyzer (PEM) anode catalysts to reduce or eliminate the rare, expensive iridium oxide (IrO_x) that is currently the industry standard. Stoicheia's novel combinatorial process and Megalibrary platform enables the rapid synthesis and characterization of hundreds of thousands of unique materials in a single experiment. Stoicheia seeks to use this approach to accelerate the discovery of reduced IrO_X options. PEMs enable both water and CO_2 electrolysis to hydrogen and valuable hydrocarbons, respectively, at net-zero carbon. This enables the decarbonization of hard-to-abate sectors like chemicals, industrial heat, and heavy transportation. Low-cost catalyst alternatives are necessary to approach modest projections for electrolyzer deployment and enable corresponding decarbonization efforts in those sectors.

Osmoses – Cambridge, MA

Efficient Recovery of Dilute Helium Gas Using Molecular Sieve Membranes - $500,000

Domestic helium supplies are diminishing, while global demand is rising due to high-tech industries, medical diagnosis, chip manufacturing, and space exploration. Osmoses will develop of a novel family of ultra-permeable and ultra-selective polymer membranes that can efficiently capture dilute sources of this critical gas from feedstocks that are otherwise wasted. Osmoses will optimize its proprietary polymer synthesis procedure to reduce costs and enable rapid scale-up. The polymer will then be formed into an ultra-thin membrane film for helium recovery from natural gas streams, which in the US contain an estimated 306 billion cubic feet of recoverable helium and represent a significant opportunity. The Osmoses team will develop a techno-economic process model to minimize helium's production price as a function of helium feed composition.

Enegis – Bend, OR

Ambient Seismic Imaging Technology for Low Cost and Effective Geothermal Resource Exploration, Development, and Management - $499,997

Enegis will use Ambient Seismic Imaging (ASI) to image permeability pathways and fluid flow in rock to advance geothermal development. Proper geothermal resource development must ensure project feasibility and integrity, improve targeting of permeability structures, and control induced seismicity. ASI overcomes the need for a controlled signal source (e.g., vibroseis) by using seismic emission tomography methods and passively listens to vibrations due to stress changes by fluid-rock interactions during the creation of permeability pathways. The team will adapt ASI to map the permeability architecture of the Newberry geothermal field in Oregon, focusing on measurement methods, network designs, and deployment campaigns to provide more robust characterization, thereby lowering risk and cost. ASI contrasts with status quo reflection seismology's use of induced earthquakes, which are suboptimal for imaging permeability structure and fluid flow.

Invizyne Technologies – Los Angeles, CA

Simplifying Reactor Setup for Cell-Free Biofuel Production - $496,177

Invizyne will develop efficient cell-free enzyme cascade reactions as an alternative, more commercially competitive approach to microbe-produced biofuels. Cell-free technology is still relatively new. However, Invizyne has already been successful in improving enzyme stability and process optimization to push down the cost curve of biofuels. The team seeks to address a barrier to market penetration for cell-free technologies by simplifying and reducing the cost of enzyme production. If successful, this approach could enable a cell-free enzyme system that produces isobutanol at below $3 per gallon gasoline equivalent.

Captura – Pasadena, CA

Development of Thin Film Composite Hollow Fiber Membranes for Direct Ocean Capture - $500,000

Captura will demonstrate efficient CO_2 stripping from oceanwater using low-cost thin film composite hollow fiber membranes. The team will use ultra-low-cost hollow fiber membranes, traditionally used in water filtration applications, as a structural support, and modify their outer layers with highly CO_2 permeable polydimethylsiloxane layers to selectively strip CO_2 from oceanwater. Captura will also employ a computational model-assisted design and rapidly prototype new gas liquid contactor designs that use counter-flow and cross-flow design for efficient CO_2 stripping from oceanwater. The team estimates a >10x cost reduction in the capital expenditure for the CO_2 stripping unit.

Impact Cooling – Fort Collins, CO

High Density Cooling System for Ultra-Low PUE Data Centers - $500,000

Impact Cooling will develop a novel data center cooling solution that can cool server equipment efficiently using only air. Data centers are predicted to consume 8% of global electricity by 2030; approximately one-third of that energy is used for cooling server equipment rather than actual computations. State-of-the-art data center cooling has come from better separation of hot and cold air. State-of-the-art air-cooled data centers use air at ambient atmospheric pressure to cool the server equipment. Impact Cooling's patented air jet impingement cooling technology can achieve dramatically improved heat transfer at minimal energy cost. By leveraging elevated working pressures rather than being limited to ambient conditions, Impact Cooling's solution can achieve a remarkable cooling coefficient of performance exceeding 20, even in hot, humid environments.

Zephyr Innovations – Somerville, MA

Air Conditioning via Liquid Desiccant Dehumidification - $499,611

Zephyr is developing an alternative to the standard, vapor-compression (VC) driven air conditioner that uses no synthetic refrigerants. Zephyr's solution employs evaporative cooling preceded by efficient liquid desiccant dehumidification. The key challenge in any desiccant-based dehumidification system is the removal of moisture from the desiccant so it can be reused. This is typically done by heating the desiccant to boil off water. Zephyr's differentiator is its desiccant regeneration system which avoids direct desiccant heating and doubles dehumidification and cooling efficiency over today's most efficient VC systems.

AtmosZero – Fort Collins, CO

Heat Pump to Decarbonize Industrial Heat – $500,000

AtmosZero, in partnership with Colorado State University, seeks to develop a modular high-temperature heat pump system with the potential to significantly reduce carbon emissions from on-site heat generation in the U.S. industrial sector. Approximately 75% of all on-site energy consumption in the U.S. manufacturing sector is used to generate heat, which means industrial process heat must be decarbonized to substantially reduce U.S. emissions. The team will use a combination of strategic approaches, including: heat recuperation strategies, optimized heat exchanger selection and sizing, and high-efficiency, high-temperature compressors to achieve the desired heat pump performance. Preliminary analysis indicates the AtmosZero system will be competitive with today's fossil fuel fired systems, reducing heat costs by leveraging the declining costs of zero-carbon electricity sources.

Molten Industries – Stanford, CA

Biogas to Renewable Fuels via Thermal Reforming – $499,866

Molten Industries is using a new reactor technology to enable the direct conversion of biogas into sustainable aviation fuels and renewable diesel. Molten Industries' thermal reforming reactor powered by renewable electricity enables high energy efficiency at significant gas throughputs. If successful, this project will open a new route to upgrade biogas to fuels to increase U.S. sustainable fuel production.

Artimus Robotics – Boulder, CO

Low-Cost Electronics for Pressure-Agnostic Actuators Driving Bio-inspired Vehicles for Deep Sea Mining - $200,000

Artimus Robotics aims to enable environmentally conscious deep-sea mining of rare earth elements and precious metals using next-generation bio-inspired unmanned underwater vehicles (UUVs). The team will focus on developing inexpensive electronics for its hydraulically amplified self-healing electrostatic (HASEL) actuators, which enable 'soft' autonomous vehicles that can facilitate environmentally conscious mineral collection methods to access the deep ocean. More than 50% of the total UUV cost is attributed to the motors and associated drive systems. Replacing such a system with a HASEL-based system would reduce the cost by 50x, enabling greater access to the billions of tons of critical minerals in polymetallic nodules on the ocean floor. UUVs based on the new technologies have applications in other initiatives including carbon dioxide monitoring and mitigation and ocean agriculture for biomass production.

GaNify LLC – State College, PA

High-Performance and Manufacturable Medium Voltage Power Diodes – $500,000

GaNify seeks to develop 10-kV/10-A power diode prototypes for medium-voltage power electronics systems. Medium-voltage power switches are needed for a range of power electronics. GaNify's medium-voltage power diodes are based on a novel charge-balanced GaN super-heterojunction technology, which has already demonstrated ~2X higher effective electric field, scalability to over 10 kV, and ~3X lower on-resistance over the existing wide bandgap semiconductor technology. The team will study scalability, manufacturability, and reliability of this technology and seek to develop engineering prototypes to be used in the next stage of research and development. The outcome of this project will inform future directions of medium-voltage power electronics technology.

Inlyte Energy – Berkeley, CA

The Salt and Iron Path to Renewables Integration - $500,000

Inlyte Energy will engineer robust cyclability of the sodium metal halide (NaMx) battery's iron chemistry for next-generation grid storage. The NaMx iron chemistry's raw storage materials are table salt and iron, two of Earth's most abundant and low-cost materials. The NaMx battery displays excellent safety, high efficiency, and a long life. Limited research on the sodium/iron chloride battery chemistry has shown variable cycling performance, the number of charge/discharge cycles it can complete before losing performance. Inlyte Energy will perform a systematic study, using a sodium/iron chloride cell, using electrochemical measurements and materials characterization to isolate the factors that allow for long cyclability and engage in a parallel effort in scaling NaMx battery manufacturing for the grid.

Verne, Inc. – San Francisco, CA

Decoupling High-Density Hydrogen from the Liquid Hydrogen Infrastructure: Catalyst-Filled Heat Exchangers for Modular Cryo-Compressors - $ 499,684

Verne is developing a cryo-compressor technology platform that will convert gaseous hydrogen (GH_2) at low pressures (e.g., 20 bar) and ambient temperature (e.g., 300K) to cryo-compressed hydrogen (CcH_2) at 60–80K and 300–500 bar. CcH_2 is thermodynamically optimal for high-density, low-cost storage in achieving an economical hydrogen infrastructure. This platform will provide hydrogen with liquid-like densities using half the energy intensity and at smaller scales relative to liquefaction. If successful, this work will validate cryo-compressors as a way to decentralize high-density hydrogen and accelerate deployment and utilization of electrolysis and the broader hydrogen infrastructure of the U.S. and globally.

Media and Process Technology – Pittsburgh, PA

Supercritical Fluid Based Wet Substrate Dewatering without Evaporation- $500,000

Media and Process Technology (MPT) proposed a process to convert high-energy evaporative drying into low-energy filtration with the potential to reduce energy consumption in wet substrate dewatering by up to 90%. The team will demonstrate the technical feasibility and energy and cost savings potential of a non-evaporative substrate drying process based upon supercritical CO_2 ($scCO_2$) extraction combined with downstream ceramic membrane filtration. In addition, MPT will conduct ceramic membrane permeation study for low cost $scCO_2$ recovery and recycle for the proposed drying process as well as other industrial $scCO_2$ extraction processes. The proposed concept has lower capital costs than conventional $scCO_2$ extraction.

Sylvatex – San Francisco, CA

Breakthrough Process to Manufacture Very Low-cost LFP Cathode for Li-ion Batteries - $500,000

Sylvatex will use a low-cost, high-yield, and simplified continuous approach to synthesize lithium iron phosphate iron (LFP) based cathode materials for lithium-ion batteries (LIBs) where the reactants flow and mix continuously. Sylvatex's proprietary nanomaterial platform has already demonstrated a significant breakthrough in synthesizing cathode materials for LIBs. This project will demonstrate the feasibility of producing LFP-based materials with a controlled continuous approach which could reduce energy consumption by 80%, waste by 60%, and cost by 60% relative to the incumbent commercial process. The performance of the cathode materials will be validated in two common LIB design types.

Advanced Ionics, Inc. – Milwaukee, WI

Simplified Steam Electrolysis: Hydrogen for Hard-to-Abate Industries - $500,000

Advanced Ionics (AI) aims to advance its high-efficiency low-cost hydrogen electrolyzer technology to gigawatt-scale production within the next decade. If successful, AI's system will enable and catalyze decarbonization in refining, ammonia production, chemicals production, steel, glass, methanol, and other high-consumption industries that currently rely on steam methane reforming (SMR) for hydrogen production. Today, electrolyzers suffer from low efficiencies and high capital cost, causing the price of hydrogen from electrolysis to be many times that of conventional SMR. AI's technology will integrate with existing industrial processes and utilize abundant, low-grade process and waste heat, achieving price points that are otherwise challenging for other electrolyzer technologies.

Heimdal – Kailua-Kona, HI

Improving Ocean CO_2 Capture with Bipolar Membrane Electrodialysis of Seawater - $498,208

Oceans are responsible for ~25% of all CO_2 capture, but increased acidification decreases CO_2 uptake. Heimdal aims to remove excess acidity introduced by CO_2 and return mineral hydroxides to the oceans, enabling additional CO_2 uptake from the atmosphere. Renewably generated electricity will drive bipolar membrane electrodialysis with seawater or concentrated brine as an input and produce acid and base by-products, introducing the latter back into the oceans to increase alkalinity. Heimdal's goal is to make the electrochemical cell lifetime costs 10x cheaper than currently available commercial systems to achieve target CO_2 sequestration costs of $100/ton.

Gencores – Somerville, MA

Digital and Cost-Efficient Production of Hybrid Polymethacrylimide Foam Cores for Radical Lightweighting of Light-duty Vehicles - $494,015

Gencores, Inc. enables technology for ultra-light vehicles to decarbonize transportation. Herein they demonstrate a scalable and digital production of low-cost and high-performance hybrid Polymethacrylimide (PMI) foam cores for sandwich composite constructions. Sandwich composites feature a foam core wrapped in fiber-reinforced skins and offer a 40-75% weight reduction potential compared with traditional metal alternatives. Current PMI foam cores are costly and time-consuming to produce in complex shapes. Gencores' hybrid material and digital manufacturing technology will reduce the production cost of complex PMI foam components by up to 75%, unlocking the production of complex structural composites designs for cost-driven marketplaces.