OPEN 2021 Project Descriptions

Building Efficiency

University of Illinois at Urbana-Champaign - Champaign, IL

Green Light Emitting Diodes for the Ultimate Solid-State Lighting - $750,000

The University of Illinois at Urbana-Champaign (UIUC) will pursue direct-emitting novel green light emitting diodes (LEDs) that can enable accelerated solid-state lighting (SSL) adoption to reduce lighting-related energy needs and greenhouse gas emissions by approximately 25% compared with non-SSL. The transition to SSL could reduce U.S. energy needs and greenhouse gas emissions by an additional 55% by 2035 compared with non-SSL, accounting for 5% of the U.S. primary energy budget. High efficiency green LEDs enabled by cubic gallium nitride are used to eliminate polarization and reduce droop, making them significantly more efficient than traditional III-V based LED technology. UIUC's design could reduce manufacturing costs and facilitate widespread adoption of high efficient color-mixed SSL illumination by commercial and residential markets.

Distributed Energy Resources

Illinois Institute of Technology – Chicago, IL

Direct Conversion of Flue Gas to Value-Added Chemicals Using a Carbon-Neutral Process - $1,885,932

The Illinois Institute of Technology will design and construct a high-performance direct flue-gas-based electrocatalytic carbon dioxide (CO_2) reduction reaction unit to selectively reduce CO_2 to valuable products such as ethanol and propanol at high rates and low input energy. The production of ethanol and propanol using the team's scaled-up and distributed system has the potential to address a billion-dollar market while removing CO_2 from flue gas sources. The team's goals are to achieve net-zero CO_2 gas emission by using renewable energy, significantly reduce the cost of carbon (less than $40/ton CO_2), and save an additional ~900 kWh per ton of CO_2 by eliminating the CO_2 capture process.

Electrical Efficiency

Texas Tech University – Lubbock, TX

Semiconductor Neutron Detectors - $1,789,998

Based on Texas Tech University's recent development of hexagonal boron nitride (BN) semiconductor thermal neutron detectors with a record efficiency of 59%, Texas Tech will develop BN fast neutron detectors (FND) for energies up to tens of mega-electron volts. BN FND present unique advantages, including compact size, high gamma rejection ratio, low voltage operation, and low fabrication and maintenance costs. These neutron detectors can operate in high temperatures and harsh environments and detect thermal and fast neutrons simultaneously. The BN FND could be installed on the perimeter or in the core of a nuclear reactor to directly monitor reactor and fuel status. The technology also has the potential to replace the multiple Helium-3 gas tube-based neutron detectors currently deployed in geothermal and well logging tools. The BN FND's unprecedented performance at a reduced cost could also create new applications in nuclear energy, national security, nuclear waste monitoring and management, the health care industry, and material sciences.

Synteris – Baltimore, MD

Breaking the Board: Bringing Three-Dimensional Packaging and Thermal Management to Power Electronics - $2,746,501

Synteris is developing 3D-printable ceramic packaging for power electronic modules to improve their thermal management, power density, performance, and lifetime. Existing power modules contain flat ceramic substrates that serve as both the electrically insulating component and thermal conductor that transfer the large heat outputs of these devices. Synteris proposes an additive manufacturing process that would replace the traditional insulating metalized substrate, substrate attach, and baseplate/heat exchanger with an additively-manufactured ceramic packaging that acts as both an electrical insulator and heat exchanger for better thermal management. Synteris' technology would substantially improve the design, manufacturability, and function of power modules used in electric vehicles, aircraft, and other applications.

Cornell University – Ithaca, NY

Field-Focused Load-Leveled Dynamic Wireless Charging System for Electric Vehicles - $1,425,000

Cornell University seeks to develop a breakthrough wireless charging system for stationary and dynamic charging of electric vehicles (EVs), with significant improvements compared with state-of-the-art solutions. Specifically, the project will demonstrate a 50-kW capacitive wireless charging system with 150 kW/m^2 power transfer density and 95% efficiency, while meeting fringing-field safety standards and increasing grid reliability by minimizing power pulsations. By enabling effective stationary and dynamic wireless charging of EVs, this project has the potential to drastically reduce the need for expensive and bulky on-board batteries, enable unlimited range, and accelerate EV penetration. Successful deployment of the technology will lead to significant reductions in EV infrastructure costs and bring the U.S. closer to an electrified energy future.

IBM T.J. Watson Research Center – Yorktown Heights, NY

Systems Two-Phase Cooling - $2,629,666

IBM is developing an energy efficient two-phase cooling system for data centers to reduce cooling energy consumption and eliminate water usage. The system uses a dielectric coolant that absorbs heat as it changes phase from liquid to vapor. A condenser, cooled by a secondary loop, removes the heat from the vapor phase which condenses back to liquid to repeat the cycle. The extracted heat is transported to the outdoor ambient environment through a heat exchanger coupled to a "dry" cooler to reject the heat to the ambient air without using water. Cold plates reduce the temperature difference between the chip and coolant, enabling coolant temperatures above outdoor ambient. This design would reduce data center cooling energy usage by more than 90% compared with traditional air-cooling and offer an opportunity to save 19 billion kWh annually in the U.S.

Massachusetts Institute of Technology – Cambridge, MA

8'' GaN-on-Si Super Junction Devices for Next Generation Power Electronics - $ 4,521,601

The Massachusetts Institute of Technology will develop a new generation of power electronics based on vertical gallium nitride (GaN) superjunction diodes and transistors that can vastly exceed the performance of today's GaN power devices. The new superjunction structure will surpass the theoretical trade-off between on-resistance and breakdown voltage observed in conventional unipolar GaN, leading to more efficient and cheaper power converters. These new GaN power devices will enable the next generation of low-cost, fast, small, and reliable power electronics, which are key for efficient power conversion in data centers, solar farms, power grids, and electric vehicles.

Stanford University – Stanford, CA

Additive Manufacturing of Amorphous Metal Soft Magnetic Composites - $1,900,000

The Stanford team seeks to additively manufacture amorphous metal-oxide soft magnetic composites (SMC) with net-shapes, reduced cost, and reduced material waste. SMCs are key to increased energy density and efficiency of electric motors and enable miniaturized electric vehicle chargers, transformers, and power generators. Currently, SMC magnetic cores are expensive and time consuming to manufacture in the complex shapes required for next-generation devices using conventional press and sinter powder metallurgy. If successful, the team's efforts would result in magnetic cores with 10x lower core loss at frequencies of 500 kHz to 1 MHz at half the price.

Chilldyne – Carlsbad, CA

Helical Turbulator for Robust Cold Plate - $773,990

Chilldyne will improve data center energy efficiency for future servers by developing a high-performance cold plate with a helical turbulator that increases the heat transfer rate by a factor of 3. This technology will result in less power consumed by data centers by eliminating the need for chillers. Chillers add 30% to the energy consumed by data centers, and most data centers use chillers. Chilldyne's technology will allow data centers with high-power processors to function anywhere with high cooling efficiency and chillerless operation. It applies to hyperscale, cloud, and co-location data centers, representing two-thirds of global electricity use for data centers.

Nokia of America Corporation – Murray Hill, NJ

Delivering Energy & Exergy Efficiency in the Converged 5G RAN/EDGE Compute Network - $2,106,380

Nokia is developing a highly efficient, resource-conserving thermal energy architecture that will simultaneously improve server cooling energy efficiency and deliver high-quality thermal energy that can be used directly for heating and cooling buildings. Nokia will pursue a low-cost, passive two-phase cooling philosophy from chip-to-room scale and re-architect the compute infrastructure as a valuable, practical, and cost-effective heat source. This design would contribute to the U.S.'s technological lead in developing and deploying advanced energy and information and communication technologies.

Generation

Los Alamos National Laboratory – Los Alamos, NM

Advanced Manufacturing of High-Entropy Alloys as Cost-effective Plasma Facing Components for Fusion Power Generation - $3,114,700

Los Alamos National Laboratory aims to use advanced and additive manufacturing techniques to develop novel tungsten-based high-entropy alloys with compositions and microstructures optimized for ideal performance in plasma-facing components (PFC). PFCs must maintain their thermomechanical properties and radiation resistance under the extreme conditions in fusion reactors. Atomistic simulations and high throughput additive processing/characterization will guide materials design and manufacture in this effort. Reliable PFCs will reduce maintenance downtime in fusion power plants and increase first-wall reliability during steady state and transient operation, making fusion power generation more cost-effective, economically predictable, and commercially attractive. Scale up will entail the use of additive manufacturing to fabricate more complex parts.

Massachusetts Institute of Technology – Cambridge, MA

Liquid Immersion Blanket: Robust Accountancy - $3,062,320

The Massachusetts Institute of Technology's Plasma Science and Fusion Center proposes its Liquid Immersion Blanket: Robust Accountancy (LIBRA) experiment to investigate the viability of a radically simple molten-salt (a lithium fluoride and beryllium fluoride mixture) approach to tritium (T) breeding for fusion power plants. Fusion must achieve unprecedented T-breeding ratios to enable rapid fusion deployment in support of sustainable global decarbonization. LIBRA seeks to demonstrate 70% lower-cost breeding-blanket technology (based on the liquid-immersion-blanket concept) than competing blanket concepts. LIBRA will offer a representative-scale T-breeding test stand that is compact and provides T containment and continuous T-extraction capability.

Princeton University – Princeton, NJ

Economical Proton-Boron11 Fusion - $1,499,953

Proton-boron11 (pB11) fusion is attractive because protons and Boron11 are readily available and non-radioactive. The fusion of proton and boron does not produce radioactivity-generating neutrons, just helium. This absence of radioactivity lessens engineering and waste-disposition challenges. Yet economical pB11 fusion remains physically challenging because pB11 fusion requires temperatures so high that losses due to radiation overshadow energy production. Princeton University aims to find fusion designs that could minimize these losses while maximizing fusion reactivity. By rotating the plasma vigorously, the heavier boron ions will be centrifugally confined far from the lighter protons. Then means are provided such that only the very energetic protons come into contact with the boron. Because essentially only the proton energy counts in the likelihood of a collision resulting in fusion, the boron ions and the electrons can be kept relatively cold, mitigating the radiative losses and perhaps enabling a pathway to economical pB11 fusion.

General Electric Gas Power – Greenville, SC

Lifted-Flame Combustion for High-Hydrogen Reheat Gas Turbines - $1,572,108

General Electric Gas Power (GEGP) propose to investigate a novel lifted-flame combustion approach for advanced gas turbine cycles using hydrogen and natural gas fuel blends. Gas Turbine Combined Cycle (GTCC) combustion technology is very mature in its present form, and further gains in efficiency are likely to be incremental without game-changing technical and operating cycle advances. This new technology could break the current, materials-limited upper bound efficiency barrier for gas turbines, create a new GTCC growth trajectory, and enable net GTCC plant efficiencies of 67% or greater on a wide range of fuel compositions while meeting strict emissions standards.

Makai Ocean Engineering – Waimanalo, HI

Remotely Installed Anchorages for Floating Offshore Wind and Other Offshore Renewables Cost Reduction - $849,951

The Makai Ocean Engineering (Makai) team will develop novel mooring and anchoring methods to reduce the costs of offshore renewable energy. Makai will focus on enabling grid-scale floating offshore wind turbines and marine hydrokinetic systems to be deployed in areas that would otherwise not be accessible or too expensive with current mooring and anchoring technologies. The team's unique approach to remotely installing micropiles on the seafloor will enable installation of an anchorage strong enough to secure these systems. This approach does not require large and costly equipment and vessels, dramatically reducing the initial installation costs. In addition to reducing costs, Makai's system will enable offshore renewable deployment where it would otherwise not be feasible.

Argonne National Laboratory – Lemont, IL

Non-neutron Transmutation of Used Nuclear Fuel - $3,000,000

Argonne National Laboratory will develop a transformational long-lived fission product (LLFP) transmutation technology using incident energetic non-neutron particles such as photons and protons. To achieve high transmutation performance, a multiple transmutation concept using a LLFP target and blanket arrangement is proposed. Using the proposed transformational technology, the team will design a conceptual national transmutation facility to transmute LLFPs recovered from used nuclear fuels (UNF) and evaluate the cost of transmuting LLFPs compared with other nuclear waste management options (e.g., direct disposal). Argonne's LLFP transmutation technology could substantially reduce the disposal impacts of UNF by eliminating the need for a geologic-time-scale repository. The technology will support the establishment of commercially viable, dispatchable, zero-carbon nuclear energy for the future clean energy market.

Eden GeoPower – Somerville, MA

Electro-Hydraulic Fracturing for Enhanced Geothermal Systems – $3,796,672

To improve Enhanced Geothermal Systems' (EGS) power generation efficiency, Eden GeoPower proposes "Electro-Hydraulic Fracturing" (E-HF), which uses high-voltage electricity and low-volume water injection to access a larger fracture network for heat recovery. The method consists of a new electromagnetic approach to enable monitoring and imaging existing fractures and the ability to create additional fractures in a highly targeted matter through the application of electrical current. This E-HF process will increase the heat transfer surface area, improving efficiency of EGS power plants by up to 500%. This technology can potentially save 270 billion gallons of water by limiting water use compared with traditional hydraulic fracturing and would provide access to untapped renewable geothermal energy.

Oak Ridge National Laboratory – Oak Ridge, TN

Precipitation Strengthened Ni-based Alloys for Liquid Salt Containment and Transport in Energy Systems - $2,400,000

Oak Ridge National Laboratory aims to develop a superior precipitation-strengthened alloy with improved creep, irradiation, and corrosion resistance. The alloy will enable higher-temperature operation (750°C) in molten salt reactors (MSRs), fluoride-salt cooled high temperature reactors (FHRs), and concentrated solar power (CSP) systems. The team will evaluate creep, irradiation, and corrosion resistance in molten fluorides for several candidate alloys and down-select one for fabrication. The team will also develop casting, welding, and joining processes to fabricate components using this alloy and evaluate its properties in a flowing salt loop. This project will decrease risks associated with new alloy development and significantly accelerate the timeline for commercialization of the structural alloy for use in high-efficiency MSR, FHR, and CSP systems.

Polymath Research – Pleasanton, CA

Longer Wavelength Lasers for Inertial Fusion Energy with Laser-Plasma Instability Control: Machine Learning Optimum Spike Trains of Uneven Duration and Delay (STUD Pulses) - $2,012,032

Polymath Research will enable the use of longer-wavelength lasers for inertial fusion energy (IFE). To date, IFE has focused on the third harmonic of glass lasers because laser-plasma instabilities, which degrade the compression of fusion fuel, are reduced at their short wavelengths. The nonlinear optical process that shifts laser light from a fundamental wavelength to the shorter wavelength is inefficient, however. The second harmonic is more efficient, but using it has not been possible because its longer wavelengths increase laser-plasma instabilities (LPI). This project seeks to control LPI through using Spike Trains of Uneven duration and Delay (STUD) pulses, a sequence of precisely timed laser pulses designed to disrupt LPI growth and memory build up in the plasma due to persistent and undisrupted laser energy deposition. The team will use data from simulation models and high-repetition rate lasers to train a machine-learning algorithm to select optimal spike trains and define conditions where longer wavelength laser triggered LPI can be successfully tamed. These predictions will then be tested on a larger IFE facility.

Fervo Energy – Houston, TX

FervoFlex™: Long duration In-reservoir Energy Storage and Load-Following, Dispatchable Geothermal Generation - $4,500,000

Fervo Energy will demonstrate its proprietary field-scalable next-generation geothermal and long-duration storage technology, FervoFlex™. The FervoFlex™ technology effectively enables Fervo to operate their assets to achieve multi-day energy storage attributes in addition to the traditional benefits of clean, firm geothermal power. Fervo's horizontal well design connects subsurface wells with a set of hydraulically conductive fractures surrounded by impermeable rock. These fractures act as flow pathways, providing contact areas with the geothermal reservoir to enable sustained heat recovery, and the low-permeability rock prevents fluid leak-off. Charging and discharging cycles are performed by controlling the injection and production well flow rates and pressures to deliver flexible generation profiles in response to grid demands and time-shift energy at high round-trip efficiencies. The team will develop a fiber optics-based diagnostic platform to monitor and optimize dynamic subsurface processes that currently pose major barriers to flexibly operating geothermal facilities.

University of Tennessee, Knoxville – Knoxville, TN

Microfluidic Alpha Spectrometer for Materials Accountancy and Control in Liquid-Fueled Molten Salt Reactors - $2,418,576

The University of Tennessee, Knoxville, aims to develop a high-temperature, chemically resistant diamond-based microfluidic alpha spectrometer that will enable accurate online and/or at-line (the sample is removed and analyzed near the production process) measurement of alpha-emitting isotopes in liquid-fueled molten salt reactor (LF-MSR) fuel. The team will develop an optimal spectrometer design by using experimental and computational methods to evaluate the sensor architecture, packaging, and performance. The team also plans to develop on-site data processing algorithms that will provide rapid information via remote transmission to the end user as well as a commercial integration and maintenance strategy for LF-MSRs. This novel spectrometer is expected to improve material control and accountability for LF-MSR fuel salts and reduce the cost of meeting regulatory requirements.

Argonne National Laboratory – Lemont, IL

Advanced Facility Design and AI/ML Enabled Safeguards to Establish Secure, Economical Recycling of Fast Reactor Fuels - $3,600,000

Argonne National Laboratory (ANL) will develop crucial technologies to support the commercialization and licensing of pyroprocessing to enable the recovery and recycling of valuable nuclear materials from advanced reactor used nuclear fuel (UNF). Recycling valuable nuclear materials improves utilization of nuclear resources, generates less nuclear waste, and reduces the cost of fuel. ANL will develop a system to improve the safeguarding, security, and operations of UNF reprocessing plants. The system is composed of new advanced sensors that leverage machine learning-enabled algorithms to improve measurements and allow for the detection and diagnosis of off-normal events. The team will also create a digital twin for the reprocessing facility to demonstrate the system's performance. Once operational, this reactor fleet could disrupt the existing energy landscape and provide carbon-free electricity to the grid at competitive rates.

Grid

SixPoint Materials – Buellton, CA

Vertical GaN Photoconductive Semiconductor Switch for HVDC Breakers - $1,782,000

SixPoint Materials aims to develop a semiconductor switch that will enable low-cost, fast-acting, high-efficiency, high-voltage (HV) DC circuit breakers. The SixPoint team will develop and characterize the key material, a bulk thick crystal of semi-insulating gallium nitride (GaN); design the device structure; and fabricate a 100 kV photoconductive semiconductor switch (PCSS). One 100 kV GaN PCSS will potentially replace 56 semiconductor switches made with conventional silicon technology, vastly increasing efficiency and lowering the cost. This project will provide the key component to multi-terminal HVDC transmission systems and contribute to the expansion and accessibility of renewable energy resources.

Virginia Polytechnic Institute & State University – Blacksburg, VA

Substation in a Cable for Adaptable, Low-cost Electrical Distribution (SCALED) - $2,953,389

Virginia Polytechnic Institute & State University (Virginia Tech) will combine the functionality benefits of power electronics with the power density benefits of high-voltage cables to create a cohesive, all-in-one structure to replace bulky, inflexible power substations in today's electrical grid. This "substation within a cable" design uses a cascade of coaxial power conversion cells to gradually step-down voltage to levels required by the loads. Virginia Tech's module can achieve high power density and a form factor that enables seamless integration with the cable by mimicking a coaxial geometry design. This could eliminate the need for large and expensive power substations and enable simple integration of renewable energy sources, an electric vehicle fast-charging infrastructure, energy storage, and efficient direct current distribution lines.

Siemens Technology – Princeton, NJ

PICo-Design: Protection-Inverter Co-Design for 100% Renewable Power Systems - $4,000,000

Siemens Technology aims to develop innovative protection schemes for inverter-dominated power systems, enabling greater renewable integration in the electric grid. In addition to new control and protection (C&P) functions for inverters and protection devices, the team will also develop protection-inverter co-design tools that automatically analyze and optimize these C&P functions to achieve higher protection reliability. The protection schemes will be validated and demonstrated in hardware testbeds, as well as high-fidelity simulations with mixed generation. If successful, Siemens' protection schemes will enable reduced emissions and electricity prices and increased energy efficiency.

VEIR – Woburn, MA

High Current 10kV DC Superconducting Transmission Lines and Grid Architecture - $3,332,942

VEIR aims to enable the cost-effective transfer of bulk electric power (up to 400 MW) at a single voltage (10 kV) from generation to grid using superconducting overhead and underground power lines. The team proposes to integrate VEIR's existing distributed, evaporative liquid nitrogen cooling architecture for superconducting lines with new breakthroughs in two key areas: (1) high ampacity (maximum current), low-loss conductors and (2) ultra-low heat leak insulation systems. This proposed project will enable the development of high current 10 kV power lines, allowing significantly more power to be carried on shorter towers and in narrower rights-of-way compared with conventional technology. VEIR's superconducting lines will allow for faster integration of renewables and support more rapid electrification of end uses.

North Carolina State University – Raleigh, NC

Microgrid Control/Coordination Co-Design (MicroC3) - $4,828,980

North Carolina State University will develop, implement, and demonstrate a structured microgrid coordination/control co-design flow that yields the selection of the right equipment, integrated control, and a communication software and hardware architecture. The results will be validated in a simulated environment. NC State will also develop, implement, and demonstrate a modular resilient microgrid control integration platform. This hardware device has a robust, cyber-secure software platform and a library of microgrid control algorithms run on low-cost hardware devices that can be automatically customized by the microgrid coordination/control co-design flow. The team's approach to designing and operating microgrids will enable them to integrate and effectively manage renewable generation on the distribution system, while providing power to critical loads during and after extreme weather events, when the rest of the grid may be damaged.

Manufacturing Efficiency

Argonne National Laboratory – Lemont, IL

A Zero-emission Process for Direct Reduction of Iron by Hydrogen Plasma in a Rotary Kiln Reactor - $1,200,000

Argonne National Laboratory seeks to disrupt the steel industry by developing a potentially zero-carbon ironmaking process that eliminates the use of coke or natural gas and requires less energy than current processes. The team's process will use hydrogen plasma to reduce iron ore in a rotary kiln furnace, which will improve the thermodynamics and kinetics of iron ore reduction, potentially eliminate the need for iron ore pelletizing, and enable the process to run at a lower temperature. The team estimates that the combination hydrogen plasma-rotary kiln process can improve energy efficiency and potentially reduce CO_2 emissions in the steel industry by more than one billion tons per year. Energy consumption could be reduced by 45% compared with the blast furnace process and by approximately 15% compared with an H_2- direct reduced iron process.

Georgia Institute of Technology – Atlanta, GA

Surfactant-Free Multiphase Forming of Fiber Composite Products for Significant Reduction in Energy and CO_2 Emission - $2,161,071

The Georgia Institute of Technology (Georgia Tech) is developing a surfactant- free multiphase (MP) forming technology that could produce fiber composite products. Unlike traditional MP technologies that require surfactant to replace water with a high-density foam, this technology will eliminate the need for a surfactant. It will pre-disperse the fibers in a water-air mixture containing concentrated small air bubbles and feed the mixture by forced air injection into a headbox. An unstable foam would be generated, then rapidly pushed to a forming table. The proposed approach would significantly reduce the demand for drying, reducing the energy consumption and carbon dioxide emissions from producing fiber composites such as paper, tissue, cardboard, nonwovens, and new fiber-based products. The team will develop a next-generation paper manufacturing system that includes a novel microbubble generator integrated with next generation headbox that can scale up for commercial production.

General Electric Gas Power – Greenville, SC

Manufacturing High-Yield Investment Castings with Minimal Energy - $2,696,056

General Electric Gas Power (GEGP) is developing an investment casting technology that could fundamentally change production of high-value metal components for industrial gas turbines. GEGP proposes an innovative furnace design coupled with additive ceramic mold technologies to make single crystal blades and vanes. This energy-efficient technology would reduce cycle time and realize improved yields through lithographic printing of the core and shell of the casting—eliminating the thermal expansion mismatch in traditional investment casting—without requiring the use of complex machined wax and core dies. GEGP's technology could fashion high-value metal parts using 90% less energy than existing casting methods while reducing the production lead-time from more than a year to under three months.

Sublime Systems – Somerville, MA

Electrochemical Upcycling for Low-CO_2 Materials Production – $3,596,590

Sublime Systems will develop the first platform technology that uses electrochemistry to upcycle waste products and low-value minerals into valuable, carbon dioxide (CO_2)-neutral materials. The technology consists of an impurity-tolerant renewable electricity-powered electrochemical reactor that generates strong acids and bases that are chemically processed to separate, extract, and purify the elements contained in the input materials. The process can produce cements and several metals that can be used as CO_2-free alternatives to conventional materials. Sublime Systems' technology is the first integrated solution for using low-value minerals and wastes to produce valuable materials while preventing environmental contamination and decreasing greenhouse gas emissions. The proposed technology has the potential to eliminate >25 Mt/year CO_2 emissions in the U.S. market.

HighT-Tech – College Park, MD

Scalable Manufacturing of High-Entropy Alloy Catalysts for Ammonia Oxidation - $2,994,607

HighT-Tech seeks to create scalable manufacturing processes of high-entropy alloy (HEA) catalysts for ammonia oxidation with enhanced catalytic activity, selectivity, and stability. The HEA catalysts can potentially reduce the use of precious metals, enhance energy efficiency, and improve the economics and environmental impact of chemical industries. HighT-Tech's technology approach includes scalable high-temperature thermal shock manufacturing of uniformly mixed multi-metallic nanoparticle HEA catalysts; reduced precious metal contents by greater than 50% and reduced operating temperature; and enhanced selectivity to desired reaction products and extended catalyst lifetime. These processes could enable ~$3 million in savings in annual operating costs in a typical nitric acid plant and help to promote sustainability in U.S. energy and chemical industries and manufacturing.

Cornell University – Ithaca, NY

Advancing a Low Carbon Built Environment with Inherent Utilization of Waste Concrete and CO_2 via Integrated Electrochemical, Chemical, and Biological Routes (ADVENT) - $2,500,000

Cornell University will harness low-cost renewable electricity to produce cementitious materials using waste construction residues and carbon dioxide (CO_2) emissions to replace fossil fuel driven energy intensive processes and limit the construction industry's greenhouse gas footprint. The technology, known as ADVENT, would replace thermally intensive processes for producing construction materials with integrated electrochemical and chemical approaches that utilize CO_2 emissions and construction and demolition (C & D) materials. The proposed process could co-utilize CO_2 emissions and organic and inorganic constituents of C & D materials to coproduce calcium carbonate, hydrogen, and carbon materials for making construction materials. This unique, innovative approach could pave the way for distributed, on-demand synthesis of sustainable construction materials.

Resource Efficiency

National Renewable Energy Laboratory – Golden, CO

Incorporating Record-Breaking Catalysts in Electrospun Bipolar Membranes for Low-Cost Carbon Capture via Salt Splitting - $3,337,668

Acid and base pairs are important components of solutions for direct air capture (DAC) and direct ocean capture (DOC) of carbon dioxide (CO_2). The National Renewable Energy Laboratory team seeks to reduce the cost of acid and base production in an advanced electrodialysis system to drive salt (e.g., sodium chloride) splitting electrochemically. The project aims to improve the performance and durability of bipolar membranes—critical components of electrodialysis devices—using three-dimensional interfaces and new catalysts that speed up the process of pulling apart water molecules. Driving electrodialysis with carbon-free electricity for DAC/DOC enables the scalable capture of CO_2 from the environment and could reduce the upfront investment and operating costs of DAC and DOC.

Foro Energy – Houston, TX

Eliminating Methane Emissions from Abandoned Oil and Gas Wells - $3,750,000

Foro Energy will design, build, and demonstrate a transformational platform to efficiently plug leaking abandoned oil and gas wells, significantly reducing and preventing methane emissions. As part of the multi-functional, fit for purpose, integrated system, Foro will use a downhole high power laser tool to create the required geometric access to set a bismuth alloy plug to seal leaking wells. The technology will reduce methane emissions from abandoned wells while developing a more cost-effective and efficient solution to promote national security and U.S. technical leadership.

University of California, Los Angeles – Los Angeles, CA

AMENDER: Seawater Mediated Electrochemical Carbon Dioxide Removal – $1,000,000

The University of California, Los Angeles (UCLA) is developing a novel electrochemical process to mineralize carbon dioxide (CO_2) using seawater. This approach leverages the ocean-atmosphere equilibrium of CO_2 and abundance of divalent alkaline cations in seawater. UCLA will develop new highly conductive and durable electrodes as well as electroactive flow-through reactors to induce seawater's alkalization at high yields. This process will be able to mineralize CO_2 at a gross energy intensity of <2.5 kWh per kg of CO_2 while producing low-pressure hydrogen as a co-product. The produced minerals sequester CO_2 permanently in dissolved or solid forms, removing it from the atmosphere, and result in a levelized cost of removal of <$100 per tonne of CO_2 mineralized.

University of Houston – Houston, TX

Miniaturized Pulsed Power Systems for Mission Critical Applications (Mini-PulPS) - $965,028

The University of Houston will develop gallium nitride-based Miniaturized Pulsed Power System (or Mini-PulPS) architectures to improve the power density (10x reduction in capacitor size) and life of converters (>1000 hours of operation above 175ºC) used in pulsed power supplies. The project will also build a battery-operated handheld nuclear magnetic resonance device for lab use or to perform mobile magnetic resonance imaging (MRI) measurements. The University of Houston's new technologies will improve the power converter system efficiency and reliability across pulsed power applications, as well as reduce the risks of equipment or formation failures. The miniaturized size of the system will also disruptively reduce the cost of downhole well-logging tools used in fossil and geothermal energy applications for the characterization of sub-surface formations and fluids. The technology will also lead to transformational healthcare applications of MRI in the near term.

Palo Alto Research Center – Palo Alto, CA

CACTUS: CO_2 Aerogel Capture Towards Utilization and Sequestration - $2,090,000

Palo Alto Research Center (PARC) seeks to develop a novel solid sorbent material, termed CO_2 Aerogel Capture Towards Utilization and Sequestration (CACTUS), for direct air capture (DAC) of carbon dioxide. CACTUS will yield substantial improvements over incumbent sorbent material and carbon-capture process cost, significantly improving the economic viability of DAC using the moisture-swing adsorption (MSA) mechanism. Because MSA uses changes in humidity to switch the sorbent from capturing CO_2 to releasing concentrated CO_2 for sequestration or reuse, it is 4–10x more energy efficient than conventional thermal processes. CACTUS will potentially enable capture of 1 Gt CO_2/yr at $100/tonne CO_2 with embodied emissions <5%, helping secure the U.S. economic, energy, and climate future.

Rio Tinto Services – Tamarack, MN

Assessment of the CO_2 Mineralization Properties of Mineral Formations – $2,222,203

Rio Tinto Services will develop carbon sequestration processes to mineralize CO_2 and store stable carbonates within CO_2-reactive subsurface geologic formations. While past research has focused on subsurface saline aquifers for carbon storage, Rio Tinto aims to demonstrate that using other-geologic media, such as mafic-ultramafic rock, is an emerging strategy for long-term carbon storage. The broad approach to carbon sequestration in mafic-ultramafic geologic media could provide a significant increase in long-term domestic carbon storage capacity and reduce greenhouse gas emissions.

University of Illinois at Urbana-Champaign – Champaign, IL

Ultra-Efficient and Ultra-Rapid Electro-Thermal Pulse Deicing, Defrosting, and Desnowing for Renewable Energy and Electrified Aircraft Systems - $3,000,000

The University of Illinois team seeks to remove ice/snow/frost accretion on mobile and stationary electrified systems in an ultra-fast manner and with lower energy consumption when compared with current methods. Pulsed interfacial heating through thin film heating is integrated with controlled surface wettability to achieve interfacial defrosting without bulk melting. The team aims to melt only an ultra-thin layer of ice/snow/frost while the remaining ice/snow/frost is removed with the aid of gravity or shear forces (e.g., wind). They intend to apply their technology to photovoltaics, heat pump heat exchangers, wind turbines, and electrified aircraft that are particularly affected by ice/show/frost aggregation phenomena.

Storage

National Renewable Energy Laboratory – Golden, CO

Repurposing Infrastructure for Gravity Storage using Underground Potential energy (RIGS UP) - $2,700,000

The National Renewable Energy Laboratory seeks to convert inactive oil and gas wells into energy storage devices called Gravity Wells to create an energy storage solution that meets our nation's energy needs while vastly decreasing system costs. This approach could give a second life to ~$4 trillion of inactive upstream oil and gas infrastructure while also sealing hundreds of thousands of idle oil and gas wells currently emitting methane. The devices' mechanical, distributed, and underground nature ensure reliability and scalability. These advantages will allow the technology to provide the nation's lowest cost, most flexible, and most greenhouse gas-abating energy storage.

California Institute of Technology – Pasadena, CA

A Hybrid Electrochemical and Catalytic Compression System for Direct Generation of High-Pressure Hydrogen at 700 Bar - $2,200,000

Low-cost, high-pressure hydrogen (H_2) will play a critical role in future long-duration grid storage for deep decarbonization and improved grid resilience. The California Institute of Technology seeks to develop a hybrid electrochemical/catalytic approach for direct generation of high-pressure H_2. The proposed system has the potential to reach <$2/kg of H_2 produced and compressed at 700 bar using renewable energy sources. The proposed catalytic compression is estimated to require lower capital expenditures and operating expenses and has much better scalability than incumbent technologies. The team estimates a cost of $0.19/kg- H_2 for compression to 700 bar, representing a >80% reduction compared with state of the art.

Columbia University – New York, NY

Lithium-Ion Bobbin Cells for Grid Scale Energy Storage - $1,498,553

Columbia University aims to adopt a bobbin cell format for lithium-ion (Li-ion) batteries. The bobbin cell consists of one cylinder of cathode surrounded by one cylinder of anode material. This design involves increasing the thickness of electrode materials that store energy beyond the dimensions achievable today to reduce the overall cost per kilowatt hour (kWh) of energy stored. The team will explore the use of existing commodity Li-ion battery materials in cell packaging used by billions of alkaline cells based on their model study. By combining existing materials with longer duration form factors, like the bobbin cell, Columbia University will accelerate the cost curves for Li-ion grid scale storage cells from Bloomberg New Energy Finance’s forecasted time of~$50/kWh in 2035 to 2025. These cells will be suitable for daily, long duration grid storage applications.

Transportation Energy Conversion

Precision Combustion – North Haven, CT

Additively Manufactured Electrochemical-Chip Based Scalable Solid Oxide Fuel Cells - $ 1,540,224

Precision Combustion, Inc. (PCI) will demonstrate a fundamentally new solid oxide fuel cell (SOFC) architecture that permits a power dense, lightweight design ideal for transportation applications. The team’s novel approach will include a scalable, electrochemical chip-based SOFC. PCI will combine the unique SOFC architecture with their ultra-compact reforming technology to achieve fast start-up and long-term durability. Addressing the shortcomings of conventional SOFCs for transportation, which include large mass and volume, long startup times, and high cost, will enable low cost, efficient, and sustainable electric power for transportation applications when utilized with net-zero carbon footprint fuels.

The Ohio State University – Columbus, Ohio

Vehicle Traction Electric Machines Enabled by Novel Composite Magnetic Powder Material and Electrophoretic Deposition Insulation Material- $2,405,076

The Ohio State University team will transform the design and manufacturing processes of electric machines for electrified vehicles (EVs) through two innovative magnetic and insulation materials: a novel composite magnetic powder (CMP) material and ceramic electrophoretic deposition (EPD) insulation. The team at will develop the CMP material to have high bulk resistivity, permeability, saturation flux density, and low coercivity for the electric machine cores. Their approach removes the need for laminated cores and will not generate any scrap metal in the core manufacturing process. The EPD insulation is 10 times more thermally conductive than the traditional material. Combined, the new materials and manufacturing methods are expected to improve torque density by 40-70% and reduce manufacturing costs.

Carnegie Mellon University – Pittsburgh, PA

Ionomer-Free Electrodes for Ultrahigh Power Density Fuel Cells - $3,220,310

The Carnegie Mellon team seeks to develop novel ionomer-free electrodes to enable transformative improvements in polymer electrolyte membrane (PEM) fuel cell technology. The project will combine functionalized mixed conductors with advanced ultra-high activity catalysts to move proton conduction functionality to the support surface and remove ionomer from the electrode. This would eliminate the ionomer, which conducts ions, but also poisons catalyst sites and obstructs oxygen transport. Removing the ionomer is also key to accessing the ultra-high oxygen reduction reaction activity of emerging nanostructured platinum-alloy catalysts in PEM fuel cells. The resulting ultra-high-power density would revolutionize PEM fuel cell technology, enabling the deployment of low-cost, high-efficiency fuel cells for light-duty and heavy-duty vehicles.

Transportation Fuels

University of Washington – Seattle, WA

Harvesting Infrared Light to Improve Photosynthetic Biomass Production - $1,347,122

The University of Washington seeks to develop new photosynthetic systems that use sunlight from previously under-utilized or inaccessible portions of the solar spectrum to produce chemical fuel. The team will use the *de novo*-protein design (a computational approach to design proteins from scratch, rather than using a known protein structure) to modify photosynthetic light harvesting machinery for a broader spectrum, allowing more energy to be translated from light to chemical energy. If successful, this project would enable biofuel and bioproduct generation from near-infrared light in cyanobacteria, algae, and plants, showing that it is feasible to reengineer the light-harvesting and charge-separation reactions that are the foundation of natural photosynthesis.

National Renewable Energy Laboratory – Golden, CO

ReSOURCE: The Carbon Negative Biorefinery of the Future - $3,508,800

The National Renewable Energy Laboratory aims to develop the first carbon negative biorefinery that funnels multiple organic waste feedstocks into a chemically consistent stream of volatile fatty acids (VFAs) that are upgraded to carbon negative products. The ReSOURCE (Recirculating System for Optimal Use of Refuse with Control and Efficiency) process operates via arrested anaerobic digestion, and it accumulates and selectively isolates VFAs. The VFA products serve as robust platform chemicals to subsequently produce sustainable aviation fuel, lubricants, and cleaning surfactant substitutes.

University of California, Berkeley – Berkeley, CA

Integrated System for Electromicrobial Production of Butanol from Air-Captured CO_2 - $1,953,397

The University of California, Berkeley, aims to develop a scalable, integrated process to directly capture and convert CO_2 from ambient air into butanol, a platform molecule for jet fuels. The system takes three main inputs: ambient air, water, and a sustainable energy source, and produces butanol with high selectivity. The proposed process is projected to have a 35% lower global warming potential and a twelvefold reduction in land use compared with a biotechnological process relying on corn-derived glucose.

University of California, Santa Barbara – Santa Barbara, CA

Quantifying the Potential and Risks of Large-Scale Macroalgae Cultivation and Purposeful Sequestration as a Viable CO_2 Reduction (CDR) Strategy- $2,897,686

The University of California, Santa Barbara-led team will investigate the impacts of removing up to 0.1 Gt CO_2/yr from the atmosphere and surface oceans through cultivating and sinking fast-growing macroalgae that would capture carbon and sequester it for more than 100 years at sea. Macroalgae do not require arable land, fresh water, or added fertilizers, and high production can be achieved in the offshore areas of the U.S. Exclusive Economic Zone. The team will quantify the long-term biogeochemical fates of fixed carbon in macroalgae, assess the sequestration time scales of macroalgal carbon, estimate their environmental impacts on the ocean interior, and evaluate the benefits and risks of these introduced perturbations to natural earth systems.

Perlumi Chemicals – Berkeley, CA

Novel Biological Carbon Fixation Pathway to Increase Plant Yield - $1,487,064

Rubisco, the carbon-fixing enzyme central to the Calvin-Benson-Bassham cycle, is rather inefficient, limiting how much CO_2 a plant can convert into sugars per unit time. Perlumi Chemicals will develop a novel biological carbon fixation pathway with a more efficient carboxylase to better utilize CO_2. The team will improve pathway enzymes using directed evolution, and implement the novel pathway in a living system on the way to demonstrating yield improvements in plants.

Columbia University – New York, NY

High Capacity Electrolyzers Based on Ultrathin Proton-Conducting Oxide Membranes - $3,375,712

Columbia University seeks to lower the production cost of carbon-free, “green hydrogen” through the development of a low-temperature electrolyzer that uses proton-conducting oxide membranes (POM) with the potential to achieve step-change increases in current density and efficiency compared to today’s commercial polymer electrolyte membrane (PEM) electrolyzers. The project’s approach of decreasing POM thickness by 2-4 orders of magnitude, and subsequently decreasing its resistance by roughly an order of magnitude, would enable efficient low-temperature water electrolysis at current densities higher than those used by conventional PEM electrolyzers. The production of carbon-free “green hydrogen” from low-temperature (< 100 °C) water electrolysis is a highly attractive approach to enabling large-scale decarbonization across a variety of end-use sectors.

Massachusetts Institute of Technology – Cambridge, MA

Nitrogen Fertilizer: New Strategies for Low-energy, Low-emission Production and Use - $2,256,346

Bioenergy crops require nitrogen (N) fertilizer for high biomass yields. The incumbent fertilizer technology, Haber-Bosch, requires high temperature and pressure and cannot be scaled down economically; this reaction alone is responsible for up to 3% of global GHG emissions. The Massachusetts Institute of Technology’s approach uses biological N fixation performed by the plant or associated bacteria with current and future sources of synthetic N. Each of the approach’s components provides N to the crops at different times and impacts energy, yield, and emissions. If successful, these advances will eliminate Haber-Bosch-derived N from agriculture.

North Carolina State University – Raleigh, NC

Intensified Alkenyl Benzenes Production via Modular Redox Dehydrogenation - $1,862,109

North Carolina State University will develop transformative, autothermal Redox-Dehydrogenation (RDH) technology to flexibly produce a variety of alkenyl benzenes in modular packed beds with integrated air separation and greatly simplified product separation. Alkenyl benzenes such as styrene and divinylbenzene are important building blocks for rubber, plastics, and resin production. Current industrial production of these chemicals is generally based on energy intensive, catalytic dehydrogenation processes. This project aims to demonstrate the feasibility and attractiveness of the RDH technology and its ability to reduce energy consumption, operating costs, energy, and carbon dioxide emissions for styrene and other alkenyl benzenes.

Dimensional Energy – Ithaca, NY

3D-Printed Ceramic Thermocatalytic CO_2 Reactor with High Carbon Conversion and Energy Efficiencies - $3,100,104

Dimensional Energy will use additive manufacturing systems to 3D print ceramic components for innovative chemical reactors that can run on low-carbon electricity sources. The ceramic chemical reactors will have enhanced properties and design features that could not be produced using conventional manufacturing processes. Dimensional Energy's innovative reactors convert carbon dioxide into a feedstock chemical that can be further processed into synthetic jet fuel, thereby providing low-carbon sustainable aviation fuel to the aviation sector that accounts for nearly 3% of global annual emissions.

University of California, Berkeley – Berkeley, CA

Mesh Network of Soil Sensors for Greenhouse Gas Monitoring of Biofuel Agriculture - $2,148,991

For biofuel crops, large nitrous oxide (N_2O) emissions following fertilization and irrigation can significantly reduce the product's net climate benefit. The high spatial and temporal variability typical of N_2O emissions make it difficult to quantify at the field or landscape scale, and current practices generally require high capital investment and years of training for data collection and interpretation, making them inherently unscalable. The University of California, Berkeley, will develop a SmartStake technology consisting of low-cost consumable wireless sensor arrays to measure N_2O concentrations and emissions drivers (ammonium, nitrate, oxygen, moisture, temperature, pH, and denitrification enzymes). Results will provide a new paradigm for quantifying, monitoring, and managing for lower N_2O emissions from biofuel agriculture.

Northeastern University – Boston, MA

High-Performance and Miniaturized Greenhouse Gas Sensor for Drone-based Remote Sensing - $2,141,022

Conventional N_2O sensing methodologies for agricultural lands are often characterized by low sampling rate and resolution, due to the intrinsic technical challenges associated with lab-based gas sensing systems. Northeastern University will leverage commercial and industrial drones to demonstrate high resolution (temporal and spatial) remote N_2O monitoring suitable for large agricultural lands. The team will address the undesirable size, weight, and power of state-of-the-art N_2O sensors for drone-based sensing operation. They will develop a high-performance (accuracy ~1 ppb with a sampling rate >20 Hz), low-power (1 W), and ultra-miniaturized (palm-sized, <400 g) infrared spectroscopy based N_2O gas sensor. The proposed system will improve drone flight time by 50% and provide the temporal and spatial resolution required to monitor N_2O hot-spotting.

Transportation Network

Pacific Northwest National Laboratory – Richland, WA

Autonomous Intelligent Assistant (AutonomIA): Resilient and Energy-Efficient City-wide Transportation Operations - $4,242,075

The Pacific Northwest National Laboratory team will combine artificial intelligence with multiscale simulation and real-time control to create a traffic management system, AutonomIA, that reduces congestion, improves energy efficiency, and reduces CO_2 emissions across regional transportation systems. The system includes four innovative components: (1) real-time and context-aware transportation state estimation, (2) scalable and computationally efficient traffic forecast, (3) predictive control, and (4) hierarchical reinforcement learning. AutonomIA's traffic forecasting and real-time management approach will leverage emerging connected and automated vehicles, sensing, and signaling technologies within a unified learning, simulation, and control paradigm to improve system-wide situational awareness, energy efficiency and reduce emissions.

Transportation Storage

University of Houston – Houston, TX

Lithium- and Transition Metal-Free High-Energy Fast-Charging Batteries - $3,400,000

The University of Houston seeks to create a class of battery that uses magnesium anodes instead of lithium and organic materials in place of transition metal-based cathodes. Early work has shown very fast reaction kinetics, and power capabilities in excess of 5kW/Kg have been demonstrated. The battery would provide a transportation energy storage solution that could be charged very fast and have a comparable energy density with the state-of-the-art lithium ion. Additionally, given growing market pressures in lithium and transition metals, this alternative could enhance the nation's energy supply chain security. The project team seeks to advance the technology on multiple fronts including electrode material and electrolyte optimization, cycle life extension, practical cell design, and scaling-up material production and cell fabrication.

University of Michigan – Ann Arbor, MI

Battery Separator for Completely Stopping Dendrite - $950,000

The University of Michigan team aims to develop a new type of battery separator that can effectively prevent rather than block the formation of dendrites. These dendrites can cause battery failure and pose a safety hazard due to internal short-circuit. The new separator will be synthesized through a wet process followed by phase alignment. The resulting dendrite-suppression capability could be the equivalent of several orders of magnitude better than existing separators or solid-state electrolytes. If successful, this mechanism could make high-capacity lithium (Li) metal batteries viable, significantly increase the reliable operational window of current Li-ion batteries, and ensure safe operation of Li-ion batteries even when manufacturing defects are present. The improved batteries would have a wide range of vehicle applications.

University of Maryland – College Park, MD

Fast-Charging, Solid-State, Roll-to-Roll Processed Li Metal Batteries Enabled by Intercalated Ions in Cellulose Molecular Channels - $2,600,000

The University of Maryland (UMD) team seeks to fabricate fast-charging batteries in which the electrolyte comprises a cellulose fiber-based ion conductor. The cellulose-based ion conductor overcomes the gap from current solid-state electrolytes to solid-state batteries because they use natural materials, are easy to process, and are compatible with conventional coating processes. UMD's approach could enable high conductivity at room temperature, high energy density, and roll-to-roll manufacturing of nano-paper batteries with low cost. UMD's cellulose-based batteries will be capable of empowering electric vehicles (EV) with high energy and fast charge, promoting U.S. leadership in the EV market.

Transportation Vehicles

Copernic Catalysts – Cambridge, MA

Improved Catalyst Design for GHG Reduction via Bulk Chemicals - $3,579,694

Copernic Catalysts will design novel chemical catalysts to reduce the energy use and carbon footprint of bulk chemical reactions. Bulk chemicals—such as ammonia, ethylene, and methanol—are produced at very large scales, often up to hundreds of millions of tons annually, and are responsible for nearly one gigaton of greenhouse gas (GHG) emissions every year. Copernic Catalysts will focus on creating a faster trajectory for developing more energy-/carbon-efficient processes for the bulk chemicals industry, while also allowing for the development of more cost-competitive zero-carbon chemicals and fuels. This transformational work has the potential to develop processes for alternative fuels that would increase U.S. energy independence, reduce GHG emissions, and improve the efficiency of the domestic chemicals industry.

Pratt & Whitney – East Hartford, CT

Hydrogen Steam Injected Intercooled Turbine Engine (HySIITE) - $3,822,026

Pratt & Whitney will design a novel, high-efficiency hydrogen-power turbomachine for commercial aviation. The Hydrogen Steam Injected Intercooled Turbine Engine (HySIITE) concept is intended to eliminate carbon emissions and significantly reduce nitrous oxide (NOx) inflight emissions for commercial single-aisle aircraft. The HySIITE engine will burn hydrogen in a Brayton (thermodynamic) cycle engine and use steam injection to dramatically reduce NOx. Via an innovative semi-closed system architecture, HySIITE aims to achieve thermal efficiency greater than fuel cells and reduce total operating cost compared with "drop in" sustainable aviation fuels.

HRL Laboratories – Malibu, CA

Surface Laser Architected Magnets (SLAM) - $ 2,661,888

HRL Laboratories will develop novel magnets that improve the operating energy density of the state-of-the-art magnets for increased electric motor efficiency. Surface Laser Architected Magnets (SLAM) is a new magnet architecture that mitigates thermally induced demagnetization while reducing the use of expensive heavy rare earth elements. These magnets will increase motor efficiency, and thereby accelerate the adoption of electric ground and air vehicles, reduce energy demands and greenhouse gases, and reduce the need for non-domestic rare-earth elements.

University of Delaware – Newark, DE

Energy Efficient Manufacturing of Lightweight Composite Architected Structures for Transportation Vehicles - $2,500,000

The University of Delaware team seeks to develop a new composite forming route, Composite Architected Materials Processing (CAMP), to offer a rapid economic fabrication process of composite architected structures to achieve high volume cost effective, lightweight, and energy-efficient vehicle structural components. CAMP includes key innovations in composite formation, Localized In-plane Thermal Automation (LITA), and feedstock materials – low-cost, high performance, highly conformable and steerable fiber materials. These innovations coupled with computational geometry optimization will enable the weight-efficient design of composite architected structures for air and ground transportation vehicles. If developed, CAMP would greatly reduce the energy intensity of carbon fiber composites manufacturing, drive down the total cost, and reduce structural weight.

Hinetics – Champaign, IL

Cryogen-fRee Ultra-high fIeld Superconducting Electric (CRUISE) Motor - $5,761,467

Hinetics will develop and demonstrate a high-power density electric machine to enable electrified aircraft propulsion systems up to 10 MW and beyond. Hinetics' technology uses a superconducting machine design that eliminates the need for cryogenic auxiliary systems yet maintains low total mass. The concept features a sub-20 K Stirling-cycle cooler integrated with a low-loss rotor, magnetic fields on an order of magnitude higher than conventional machines, and a novel coil suspension and torque transfer system with tensioned fibers that cut the cryogenic heat-load by a factor of 10 to eliminate the need for external coolers. This design could enable a 10 MW, 3000 RPM aircraft propulsion motor weighing less than 250 kilograms that rejects up to 10 times less total heat to the ambient environment (>99% efficiency).

Parallel Systems – Culver City, CA

Zero-Emissions Railway Freight - $4,438,897

Parallel Systems will develop a system of autonomous, battery-powered rail cars with an advanced test program. Current technology limits the economic feasibility and efficiency of intermodal rail services to long-haul, high-volume corridors. Parallel Systems created a new vehicle system to change this and enable smaller, cleaner terminals, opening the way for new, clean freight transportation. The vehicles will be tested with Transportation Technology Center, a subsidiary of the American Association of Railroads. The potential system operations and energy performance will be analyzed across multiple study corridors with the National Renewable Energy Laboratory and the University of Illinois, Urbana-Champaign (RailTEC), leveraging the ALTRIOS software. If successful, the team's system will offer an alternative to short-haul freight transportation, reducing greenhouse gas emissions and highway congestion.

University of California, Berkeley – Berkeley, CA

Ultra Light-weight Bidirectional DC-DC Converters for Electric Aircraft - $1,195,345

The University of California, Berkeley (UC Berkeley) will develop ultra-light-weight and efficient DC-DC power converters for electric aircraft. UC Berkeley's design could enable a 12x reduction in weight and a 3-5x reduction in power loss as compared to what is possible today. Through innovations in power electronics research and thermal management, the team will develop key technologies crucial to maintaining U.S. leadership in electric flight. UC Berkeley's proposed technology has the potential to greatly reduce overall greenhouse gas emissions while reducing noise pollution at airports across the country.