ARPA-E CHANGING WHAT'S POSSIBLE

CREATE—Creating Revolutionary Energy And Technology Endeavors

PROJECT DESCRIPTIONS

Texas Tech University – Lubbock, TX

Development of Cubic Boron Nitride (c-BN) Ultrawide Bandgap Semiconductors - $500,000

Texas Tech University will develop a novel method for producing electronic grade cubic boron nitride semiconductor wafers that could equip electronic devices to operate in extreme temperatures and conditions. The wafers—formed from microwave plasma chemical vapor deposition—would enable power devices that handle higher voltages and currents, furthering advancements in power distributions, electric transportation, nuclear energy, national security, health care, and material sciences.

Northeastern University – Boston, MA

Accelerating Electrocatalyst Innovation: High-Throughput Automated Microkinetic, Multiscale, and Techno-economic Modeling - $500,000

Northeastern University will develop a computer model that could identify new avenues for producing essential chemical ingredients using carbon dioxide, a waste product of fossil fuels. Computer modeling would save time and money compared with running experiments that often focus on a single reaction pathway, whereas computer models seamlessly detect promising pathways from thousands of options. The project's first steps will focus on producing propanol, a useful hydrocarbon found in cosmetics, cleaning, printing, motors, and other products.

Johns Hopkins University – Baltimore, MD

High-Entropy Glass-Ceramics for Nuclear Waste Immobilization - $500,000

Johns Hopkins University will develop a new class of materials called high-entropy glass-ceramics that could store more nuclear waste by percent weight than industry-standard glasses. The novel materials could significantly lower the infrastructure cost of nuclear waste disposal deep underground by reducing the volume of deep earth that must be excavated for every kilogram of waste.

North Carolina State University – Raleigh, NC

HVPE Grown GaN Conductive Substrates for Power Electronics - $476,190.

North Carolina State University will develop a method to fabricate electrically conductive thick gallium nitride crystals that could be used in the manufacturing of substrates for vertical gallium nitride semiconductors. North Carolina State University's pristine semiconductor substrates—composed of a material that can operate at higher temperatures and withstand higher voltages than silicon—would enable more efficient power delivery, bringing higher currents and voltages within reach in power electronics.

University of Notre Dame – Notre Dame, IN

GaN Core-shell Nanofin Vertical Transistor (CoNVerT): A New Direction for Power Electronics - $334,319

University of Notre Dame will develop a novel low-cost power transistor design that leverages the properties of the semiconductor gallium nitride for mid-range voltage applications and could disrupt the market for devices in electric vehicles, renewable energy grid integration, industrial power control, and grid resilience. The proposed design could lead to possible energy savings of one quadrillion British Thermal Units (BTU) per year, roughly equivalent to 1% of annual energy consumption in the U.S.

Marathon Fusion – San Francisco, CA

Advanced Metal Foil Pumps and Integrated Test Environment for the Fusion Fuel Cycle - $449,387

Marathon Fusion will develop a test stand to support the evaluation of metal foil pumps in nuclear fusion systems that could propel the novel technology into pilot plants within a decade. Metal foil pumps tested by the proposed device could drastically reduce tritium inventories and the cost of tritium processing, significantly improving the fuel cycle cost for fusion power.

Princeton University – Princeton, NJ

Highly Efficient Charged Particle Beam Injection into Magnetically Confined Plasmas - $499,866

Princeton University will develop a new method for particle beam injection that could boost the energy efficiency of plasma ignition to all-time highs. The proposed technology would avoid the major inefficiencies and operational complications associated with the beam neutralization process and strengthen the domestic energy sector through efficiently delivering plasma heating to fusion reactors.

Calion Technologies – Danville, CA

Zero-GWP Air Source Heat Pump Steam Generation Using Ionocalorics - $500,000

Calion Technologies will develop an air source heat pump steam generator that could seamlessly replace natural gas boilers for industrial processes and introduce heat pumps to a new swath of customers. Calion Technologies' unique device would harness ionocaloric heat pumping technology to generate steam at very high temperatures compared with current heat pumps and accelerate the decarbonization of industrial heating, which accounts for 9% U.S. greenhouse gas emissions.

Johns Hopkins University – Baltimore, MD

Enantioselective Electrosynthesis of Amino Acids - $500,000

Johns Hopkins University will develop a process using new electrocatalysts to make amino acids, the building blocks of proteins, that could accelerate the development of chemicals and food. The novel process would synthesize amino acids using chemical feedstocks that can be derived from merely air, water, and renewable electricity to substantially reduce carbon dioxide emissions in food and chemical production.

GaNify – State College, PA

50-kV/1-A Sub-Microsecond Power Switch for Gyrotron Modulation - $500,000

GaNify will develop a unique power switch for gyrotron modulators in nuclear fusion systems that could switch 50-kV/1-A in less than a microsecond without the need to stack multiple switches in series. Their design would significantly reduce the complexity and shorten the modulation voltage rise time, effectively pushing the voltage limit of solid-state power switches toward the high voltage regime.

Perseus Materials – Knoxville, TN

Variable Cross-sectional Casting: New Composite Fabrication Process for Wind Turbine Blades - $498,767

Perseus Materials will develop a new mode of composite manufacturing for wind turbine blades that could rapidly replace vacuum-assisted resin transfer molding as the dominant blade manufacturing process. Perseus's unique additive manufacturing method—known as variable cross-sectional molding—could significantly reduce labor costs, cycle times, and factory footprints for blade manufacturers at the same output levels.

WH-Power – College Park, MD

Low Cost All Temperature Zinc-pulp Battery for Stationary Storage - $500,000

WH-Power (WHP) will develop a high-entropy electrolyte and pulp-based zinc battery that could operate in temperature ranges from -80°C to 80°C and can be used for both residential and grid-scale energy storage applications. WHP's battery would be inherently safer and lower cost than existing batteries and could be produced from abundant materials that are readily available domestically.

Deep Isolation – Berkeley, CA

Sequential Advancement of Technology for Deep Borehole Disposal (SAVANT) - $441,674

Deep Isolation will test a range of canister designs in boreholes at the Deep Borehole Demonstration Center in Texas and assess US-based supplier capabilities in the hopes of identifying a universal canister design. Advancing a universal canister system from a conceptual development stage to a licensing stage would require full-scale test data, and help enable safe, scalable, and cost-effective disposal of the current stored used nuclear fuel as well as fuels from advanced nuclear reactors in development.

NK Labs – Cambridge, MA

Active-target Muon Source for Muon-catalyzed Fusion - $500,000

NK Labs will improve the efficiency of muon production to enable cost-effective muon-catalyzed fusion, a process that can operate at much lower temperatures than traditional approaches to fusion. NK Labs would improve the design of the target that gets bombarded with high-energy protons to generate particles called pions, which rapidly decay into muons that are then routed toward the fusion fuel to catalyze a fusion reaction. Instead of the standard sheet or rod-shaped targets, NK Labs will use machine-learning-based optimization methods to design improved targets which increase the efficiency and economics of muon-catalyzed fusion plants.

C-Crete Technologies – San Leandro, CA

High Performance Nanocomposite Kraft Papers to Improve Insulation and Lifetime of Large Power Transformers - $500,000

C-Crete Technologies will develop high-performance nanocomposite kraft papers to improve the insulation of large power transformers. C-Crete's advanced kraft paper would offer high thermal conductivity, high dielectric strength, low moisture content, and other features that translate to longer transformer lifetimes. This technology could potentially reduce the number of power outages associated with transformer failures, saving the U.S. economy tens of billions of dollars each year.

Pacific Industrial Development Corporation – Ann Arbor, MI

Biomimetic CO_2 to Fuel Enabled by Scalable Catalyst Development and Synthetic Electrochemistry - $500,000

Pacific Industrial Development Corporation (PIDC) will develop a novel synthetic pathway to create methane fuel from carbon dioxide (CO_2) at room temperature. Leveraging their expertise in inorganic materials synthesis and catalyst development, PIDC's CO_2-to-fuel conversion process could help drive down emissions and increase energy efficiency when implemented at scale at a target cost of $50 per kilogram.

Foundation Alloy Technology Explorations – Cambridge, MA

Enabling Resilient and Secure Domestic Supply Chains for Critical Reactor Components with Novel Materials and Additive Manufacturing - $449,100

Foundation Alloy Technology Explorations will develop a new class of alloys specifically engineered for powder metallurgy-based processing. These new alloys would be engineered at the atomic level for improved properties and for potential applications in critical reactor components. Foundation Alloy's integration of new material design with part production could enable rapid delivery times, lower costs, and more consistent part quality.

Eva Technology – Boston, MA

Nanoprotonic Devices for >240x Performance Analog AI Hardware - $500,000

Eva will develop novel devices to build analog processors that could drastically improve the energy efficiency of training complex artificial intelligence (AI) models. Eva's proposed technology—a new class of nanoprotonic programmable resistors—would reduce the programming voltage of the devices for integration compatibility with standard circuit drivers and overhaul the device structures with an encapsulant to enable monolithic integration. The resulting processors could outperform existing digital AI training hardware solutions by over 240 times.