OPEN 2015 PROJECT SELECTIONS

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EFFICIENCY

Buildings

Data Analytics for Virtual Energy Audits and Value Capture Assessments of Buildings

Case Western Reserve University | Cleveland, OH | $1,433,281

Case Western Reserve University will develop open-source software to collect data for virtual building energy audits, energy-efficiency assessments, and improvement advisories. Analysis of multiple data streams will identify correlations among different variables, diagnose building and equipment efficiency, and prescribe the highest return on investment solutions. The software could enable cost-effective audits for smaller commercial buildings and help spur energy improvements.

High-Efficiency, Low-Cost Laser-Based Solid State Lighting

University of California, Santa Barbara | Santa Barbara, CA | $2,372,724

The University of California, Santa Barbara will develop a laser-based, solid-state lighting module that could be a low-cost alternative to light emitting diode (LED)-based devices currently on the market. Laser efficiency increases, whereas LED efficiency decreases, with increasing current density, which would result in improving energy efficiency by a factor of two. This design could reduce lighting-related electricity use, and cut costs by roughly 20x compared to current LED technology.

Retrofit System for Single Pane Window Efficiency

The Mackinac Technology Company | Grand Rapids, MI | $2,500,000

The Mackinac Technology Company will develop a novel, cost effective, retrofit window insulation system that will significantly reduce heating energy losses. The window system will utilize a durable conducting oxide window film that is highly transparent to visible light (>90%), but reflects ultraviolet and thermal-infrared energies to reduce heat loss in winter. This window retrofit technology could save nearly one quad of energy if fully implemented across the United States.

**Projects have been selected for negotiation of awards; final award amounts may vary.*

Paintable Heat-Reflective Coatings for Low-Cost Energy Efficient Windows

University of Colorado Boulder | Boulder, CO | $3,955,218

The team led by University of Colorado Boulder will develop an inexpensive, polymer-based energy-saving material that can be applied to windows. The coating can self-assemble into a photonic crystal that will reflect near-infrared wavelengths but pass visible light, thus reducing solar heat gain for most windows, thereby reducing building cooling requirements. The paintable nature of this technology means that deployment can be faster, less expensive, and wide-spread.

Industrial Processes and Waste Heat

Revolutionary Process for Low-Cost Titanium

Boston Electrometallurgical Corporation | Natick, MA | $2,279,027

Boston Electrometallurgical Corporation will develop a molten oxide electrolysis process for titanium extraction. The team projects that they can replace the state-of-the-art, multistep Kroll process with a single one-step process that resembles today's aluminum production techniques. If successful, titanium ingots could be produced at cost parity with stainless steel, opening the doorway to titanium industrial heat recovery and naval applications and increasing its adoption in commercial aircraft. This shift could result in energy savings in the respective sectors of 4 Quads and 0.7 Quads per year in the US alone.

Directional Solvent Extraction – A Low Temperature, Non-Membrane Water Desalination Process using Waste Heat

Electric Power Research Institute, Inc. | Palo Alto, CA | $1,500,000

The team led by Electric Power Research Institute, Inc. will develop a desalination system based on the concept of directional solvent extraction that uses low-grade waste heat to power the desalination process. If successful, the system could provide a low-energy means of water desalination.

Ultra-Low Energy Magnesium Recycling for New Light-Weight Vehicles

INFINIUM, Inc. | Natick, MA | $2,850,000

INFINIUM, Inc. will develop a process for Magnesium (Mg) recycling. This process could significantly reduce energy and cost required to convert low-grade Mg scrap metal into high purity Mg and Mg alloys. The result would be a key enabling technology to promote increased use of these materials in reducing vehicle weight by up to 50%.

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New High Temperature, Corrosion-Resistant Cast Alloy For Operation in Industrial Gaseous Environments

Oak Ridge National Laboratory | Oak Ridge, TN | $3,900,000

Researchers at Oak Ridge National Laboratory will develop new cast alumina-forming alloys (AFAs), along with associated casting and welding processes for component fabrication. These innovations would allow various industrial and chemical processing systems and gas turbines to operate at higher temperatures, to improve efficiencies, and to reduce downtimes, thus providing cost and energy reductions for a wide range of energy-intensive applications.

High Speed Diode and Rectenna for Waste Heat to Electricity Harvesting

RedWave Energy, Inc. | Glen Ellyn, IL | $3,381,448

RedWave Energy, Inc. will develop a rectenna-based device that can convert waste heat to electricity. The technology will incorporate special metamaterial structures, multiple nano-antennas, compensation circuit structures, and proprietary rectifiers. The proposed device will be demonstrated in large-area arrays, fabricated using nanoimprint lithography, thus enabling cost-effective roll-to-roll fabrication.

High Efficiency Wafer-Scale Thermionic Energy Converters

Stanford University | Stanford, CA | $3,636,000

The team led by Stanford University will develop an efficient thermionic energy converter that can be manufactured via advanced microfabrication processes. These devices could enable direct heat to electricity conversion at scalable system sizes and a levelized cost not accessible by current technologies. The team’s design could yield drastic improvements in the efficiency of thermal energy conversion for combined heat and power for residential use, as well as distributed solar thermal power, and heat scavenging.

Reactor Engine

Gas Technology Institute | Des Plaines, IL | $3,000,000

Gas Technology Institute will modify an internal combustion engine for efficient distributed chemical production by installing an oxydehydrogenation catalyst into the combustion chamber. The engine reactor platform takes advantage of mass production for economic advantage and therefore offers a unique alternative to conventional, one-off chemical reactors that achieve economy by their massive scale. The high pressure/temperature regime of reactants within the engine chamber could easily be used for many types of chemical reactions and produce products at higher rates than the current state-of-the-art.

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Data Management and Communication

Low Power Consumption, Ultra-High Speed VCSELs for Optical Communication

Princeton Optronics | Trenton, NJ | $1,120,000

Princeton Optronics will develop a sub-millimeter scale laser integrated on a chip known as a Vertical Cavity Surface Emitting Laser (VCSEL) for use in data transmission. The team's laser is anticipated to have reduced resistance and capacitance, enabling higher speed and lower energy loss. Creating VCSELs with a 10x improvement in speed and a 10x reduction in energy consumption per bit is an enabling technology for widespread implementation of optical communication to reduce energy consumption in data centers.

High Efficiency Quantum-Dot Photonic Integrated Circuit Technology Epitaxially Grown on Silicon

University of California, Santa Barbara | Santa Barbara, CA | $1,935,325

Researchers at the University of California, Santa Barbara will apply a unique approach to building an on-chip quantum-dot laser through epitaxial growth on patterned Silicon. Such technology could be a key enabler for widespread adoption of photonic integrated circuits that hold the promise of large reductions in data center energy use.

ELECTRICITY GENERATION AND DISTRIBUTION

Wind, Solar, Tidal and Distributed Generation

EHD Innovative Low-Cost Offshore Wind Energy

Accio Energy, Inc. | Ann Arbor, MI | $4,500,000

Accio Energy, Inc. will develop and demonstrate an Electrohydrodynamic (EHD) turbine-less wind energy system that harvests energy through physical separation of charge. The technology uses the wind to separate a mist of positively charged water droplets from excess electrons that form a high voltage direct current source. The team's innovative approach could create an entirely new option for low-cost offshore wind.

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50 MW Segmented Ultralight Morphing Rotors for Wind Energy

University of Virginia | Charlottesville, VA | $3,569,580

The team led by the University of Virginia will design a 50 Megawatt (MW) wind turbine featuring downwind morphing to reduce blade loads and allow ultralight segmented blades. They will also build and field test an aeroelastically-scaled version to demonstrate this novel technology. The 50 MW turbine design could enable a 10x increase in power compared to today's largest production turbines. The 200-meter long blades can be fabricated in five to seven segments, and assembled at the point of use. The hurricane-resistant design can enable low-cost, off-shore wind energy for the United States.

Ultrahigh Efficiency Photovoltaics at Ultralow Costs

National Renewable Energy Laboratory | Golden, CO | $5,160,000

Researchers at National Renewable Energy Laboratory will develop an HVPE (hydride vapor phase epitaxy) deposition process for producing high quality, photovoltaic cells with the potential to achieve up to a 30% efficiency target. This manufacturing technology has the potential to be an order of magnitude lower cost than current state-of-the-art technologies, thus enabling larger scale deployment of efficient solar cells.

Tidal Power: Deployment and Retrieval System for Cross-flow Hydrokinetic Turbines

Ocean Renewable Power Company | Portland, ME | $2,248,223

Ocean Renewable Power Company (ORPC) will develop an innovative deployment and retrieval capability that will significantly reduce costs for cross-flow design marine hydrokinetic systems, in which a turbine generates power from tides and/or rivers. The turbine blades will employ active pitch control to allow for thrust generation in deployment/retrieval mode and higher efficiency in power generation mode. If successful, this project could reduce the cost of the installation process in which ORPC's turbine could be placed in the water near shore, self-propel to the deployment location, and hold itself in place on the seafloor through redirected downward thrust.

Efficient Knock Suppression in Spark Ignited Engines

Cummins Corporate Research & Technology | Columbus, IN | $2,073,235

Cummins will develop a natural gas-fueled internal combustion engine for distributed electricity generation with the goal of achieving 55% brake thermal efficiency while maintaining low emissions. By using wet compression, the team expects to enable significant knock suppression in spark ignited engines that could lead to further efficiency improvements, for example, by allowing very high compression ratios. In the future, these engines may utilize other alternative, low-carbon fuels being developed for grid scale energy generation and storage.

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Grid Scale Storage

Electrochemical Ammonia Synthesis for Grid Scale Energy Storage

Ceramatec, Inc. | Salt Lake City, UT | $2,350,000

Ceramatec, Inc., along with its team members, will develop a modular electrochemical process for a power-to-liquid fuel system based on ammonia. A new synthesis approach will combine chemical and electrochemical steps to facilitate the high-energy step of breaking the molecular nitrogen bond. The proposed method could enable distributed ammonia production for energy storage, alternative fuels and agriculture, decrease energy input by more than 20%, and substantially simplify the process.

High Efficiency Alkaline Water Electrolyzers for Grid Scale Energy Storage

Dioxide Materials, Inc. | Boca Raton, FL | $2,000,000

Dioxide Materials, Inc. will develop an alkaline water electrolyzer for an improved power-to-gas system, which is used to store energy in the hydrogen chemical bond. High conductivity membranes that can function under alkaline conditions could lead to a 10x lower electrolyzer stack cost because they allow higher current densities and enable systems that do not require platinum catalysts.

Hydration-Free Conductive Membranes Based on Two Dimensional Materials

Oak Ridge National Laboratory | Oak Ridge, TN | $2,800,000

The team led by Oak Ridge National Laboratory will design 2-D proton-selective membranes for use in storage technologies, such as flow batteries or electrolyzers for liquid-fuel storage. Current proton-selective membranes (e.g., Nafion) require hydration, but the proposed materials would be the first low-temperature membranes that conduct protons without the need for hydration. These membranes could have the potential to lower costs by removing system components and complexity.

Low Cost, Safe, and Efficient All Solid State Sodium Batteries for Grid-scale Energy Storage and Other Applications

Iowa State University | Ames, IA | $2,949,872

Iowa State University seeks to create a Sodium (Na)-based battery that will have a high energy content and can be easily recycled. Commercially available Na-based batteries operate at elevated temperatures. The proposed Na battery operates at room temperature, uses a benign

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and scalable solid-stack design for a long cycle life and expects to achieve a 20% improvement in energy density over state-of-the-art lithium-ion cells.

Power Electronics

Charge-Balanced SiC FETs for Breakthrough Power Conversion

General Electric Company, GE Global Research | Niskayuna, NY | $2,561,606

Researchers at GE Global Research will develop high-voltage, solid-state Silicon Carbide (SiC) Field-Effect Transistor (FET) charge-balanced devices, also known as “Superjunctions”. Through high frequency, high voltage, and low resistance operation, these devices could achieve up to 10x reduction in power conversion losses compared to existing Silicon-based technologies.

Plasma-based AC-DC Transformer for HVDC Transmission

Tibbar Technologies | Los Alamos, NM | $3,500,000

Tibbar Technologies will develop an AC-DC transformer that uses no capacitors or semiconductor switches. The device will rely on helical coils that induce output current and voltage through electrodes at the ends of plasma. The resulting devices have the potential to be half the cost and yield power densities 10x higher than state-of-the-art transformers, potentially providing an innovative new enabling technology for HVDC transmission.

Power Grid System Performance

High Performance Power-grid Optimization (HIPPO) for Flexible and Reliable Resource Commitment Against Uncertainties

Pacific Northwest National Laboratory | Richland, WA | $3,120,249

Researchers at Pacific Northwest National Laboratory will develop fast, accurate, large-scale software that can be used for grid optimization. The software will be based on modeling and algorithm improvements to the underlying mathematical foundation, and the team will use parallelization and high performance computing to increase the accuracy and speed of the software. This faster and more accurate software will allow utilities to enhance system reliability and better manage integration of intermittent renewable generation.

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A Smart and Flexible Microgrid with a Low-cost Scalable Open-source Controller

University of Tennessee, Knoxville | Knoxville, TN | $2,400,000

The University of Tennessee, Knoxville will develop open source microgrid (MG) controller to accommodate dynamic changes in MG boundaries based on the current status of power availability and thereby dynamic topology management at the grid distribution level. A universal, open source, flexible MG controller would significantly improve the efficient use of MGs and decrease their management costs.

Distribution System Operator Simulation Studio

ProsumerGrid, Inc. | Atlanta, GA | $3,000,000

ProsumerGrid, Inc. will develop a highly specialized and interactive software tool capable of simulating the operation of emerging Distribution System Operators (DSOs). The software will utilize powerful, decentralized optimization and decision-making algorithms that would allow grid managers and market actors to evaluate the effect of new distributed energy resources (DER), market rules, and business processes at the distribution system level and beyond. The team's software will enable the development of DER scheduling logic, DSO market rules, and energy service transactions.

Resilient Information Architecture Platform for the Smart Grid

Vanderbilt University | Nashville, TN | $3,500,000

Vanderbilt University will develop an open-source standard platform that could simplify the development and deployment of Smart Grid software applications by facilitating integration, interoperability, common system services, as well as model-based design tools. Their platform could allow Smart Grid embedded software to move from hard-coded functionality to plug-and-play architecture. This provides the technological underpinning for resilient distributed software apps for improved and effective energy management.

Coordinated Operation of Electric and Natural Gas Supply Networks: Optimization Processes and Market Design

Newton Energy Group, LLC | Boston, MA | $2,904,745

The project team led by Newton Energy Group, LLC will develop fast, scalable mathematical models and optimization algorithms for dynamic optimization of the operation of natural gas pipeline networks on the time-scales of electric power systems operations. These models and algorithms could enable co-optimized operation of natural gas and electric infrastructures and markets, thereby promoting efficiency in natural gas delivery and use, and coherent gas and electric price formation while reducing energy costs for consumers.

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TRANSPORTATION

Vehicle Efficiency

Gasoline Compression Ignition Medium Duty Multicylinder Opposed Piston Engine Development

Achates Power, Inc. | San Diego, CA | $9,002,986

Achates Power, Inc. will develop a multi-cylinder opposed piston engine operating with compression ignition, while using gasoline as the fuel. The unthrottled nature of the compression ignition process provides high engine efficiency while achieving compliant exhaust emissions with conventional, low-cost aftertreatment. This in addition to the opposed engine architecture could increase fuel efficiency by 40-50% over the comparable spark-ignited gasoline engine. This engine will be more efficient than conventional diesel engines, but without the additional cost incurred by diesel fuel injection and complex exhaust aftertreatment.

Split Micro-hybrid Boosting Enabling Highly Diluted Combustion

University of Michigan | Ann Arbor, MI | $1,923,845

The University of Michigan will develop a high-efficiency engine system that integrates a compact micro-hybrid configuration of a supercharger with an electric waste heat recovery system and employs high rates of recirculated exhaust gases. When combined with sophisticated control strategy, this approach provides a solution for suboptimal engine breathing that is typical of transient engine operation. The performance is projected to match that of a naturally aspirated engine, and have a 20% increase in fuel efficiency compared to a turbocharged downsized engine, at a cost that is half that of a mild-hybrid system.

Storage for Electric Vehicles

Roll-to-Roll Processing Ceramic Battery Electrolyte

Corning Incorporated | Corning, NY | $3,102,359

Researchers at Corning Incorporated will develop roll-to-roll manufacturing techniques to produce thin ceramic electrolytes for solid-state batteries. Solid-state batteries offer higher energy density than conventional lithium-ion batteries, and avoid the use of flammable electrolytes. The technology developed in this project will enable solid-state batteries to be produced economically and at high volumes.

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Transitioning Advanced Ceramic Electrolytes into Manufacturable Solid-State EV Batteries

University of Michigan | Ann Arbor, MI | $3,500,000

The University of Michigan will develop new electrode structures and manufacturing techniques to incorporate Lithium (Li)-conducting ceramic electrolytes into solid-state batteries. Solid-state Li batteries could double the energy density of today's Li-ion cells and also eliminate the use of conventional flammable electrolytes, increasing abuse tolerance and reducing the need for battery thermal management systems.

Alternative Fuels and Bio-energy

Dual Mode Energy Conversion and Storage Flow Battery

Proton Energy Systems | Wallingford, CT | $2,500,000

Proton Energy Systems will develop a hydrogen-iron flow battery that can generate hydrogen for fueling fuel cell vehicles and also store energy on the electric grid. This dual -purpose device can be recharged either using grid electricity or through photoregeneration by exposure to sunlight. The device will operate at much higher efficiencies than traditional electrolyzers, and will offer multiple value streams to enable widespread adoption of distributed storage and hydrogen fueling.

Precious Metal Free Regenerative Hydrogen Electrode for Fuel-Cell Vehicles

Pajarito Powder, LLC | Albuquerque, NM | $2,790,000

Pajarito Powder, LLC and its team will develop a reversible hydrogen electrode that would enable cost-effective hydrogen production and reversible fuel cells. The key to this technology is the replacement of precious metal catalysts with low overpotential base metal catalysts to dramatically lower the costs of electrolyzers and fuel cells.

Converting Biogas to Liquid Fuels by Low Energy Electrical Corona Discharge Processes

Oregon State University | Corvallis, OR | $2,256,677

Oregon State University will develop a process that converts methane (the main constituent of biogas) to higher chain hydrocarbons when passed through a corona discharge at close to ambient temperature. This is a radically different approach to carbon-carbon bond formation that could enable the selective conversion of biogas into high value products with energy expenditure similar to that required for thermal processes.

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Ammonia Synthesis for Fuel, Energy Storage, and Agriculture Applications

Starfire Energy | Aurora, CO | $1,424,691

Starfire Energy will develop a modular, small-scale Haber-Bosch (HB) type process for ammonia synthesis that is less energy-intensive and more economical than conventional, large-scale HB because a novel electroactive catalyst allows the use of lower temperatures and pressures. Small-scale HB reactors could enable distributed ammonia production as a zero-carbon fuel, for energy storage and agriculture and to be more compatible with energy inputs from intermittent distributed energy resources.

Disruptive Supplies of Affordable Biomass Feedstock Grown in the Open Ocean

Marine BioEnergy, Inc. | San Diego, CA | $2,146,988

Marine BioEnergy, Inc. will develop an open ocean cultivation system for macro algal biomass, which can be converted to a liquid fuel precursor. The system cycles between nutrient-rich deep water and sunlight at the ocean's surface to produce the biomass, and can also submerge to avoid storms and ships. The team’s technology could enable energy crop production in significant regions of the open ocean, with an initial focus on the U.S. Economic Exclusion Zone off California.

Developing Ground Penetrating Radar (GPR) for Enhanced Root and Soil Organic Carbon Imaging: Optimizing Bioenergy Crop Adaptation and Agro-ecosystem Services

Texas A&M AgriLife Research | College Station, TX | $4,600,000

Texas A&M AgriLife Research will develop ground penetrating radar antenna arrays for 3D root and soil organic carbon imaging and quantification. Visualization of root traits with one mm resolution in soils could enable breeders to select climate-resilient bioenergy crops that provide higher yields, require fewer inputs, improve soil health, and promote carbon sequestration.

Novel Technologies to Solve the Water Use Problem of High Yielding C4 Bioenergy and Bioproduct Feedstocks

University of Illinois at Urbana-Champaign | Urbana, IL | $4,995,967

University of Illinois at Urbana-Champaign will apply molecular breeding and transgenic approaches to isolate sorghum plants with improved water use efficiency and determine genes that drive this trait. Improved water efficiency could help increase biomass harvest by as much as 22%, while reducing the water-input needs of crops by 40%. Such innovations could permit economical farming on 10 million acres in the U.S. where water is currently limited.

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SynPLASTome 2.0: Synthetic Plastid Genome to Reprogram Chloroplast Function for the Production of Fuels and Chemicals

University of Tennessee, Knoxville | Knoxville, TN | $3,500,000

The University of Tennessee, Knoxville proposes to develop synthetic genomes for plant chloroplasts and incorporate them into energy crops. Synthetic chloroplast genomes will allow researchers to engineer more complex traits into bioenergy crops, and could greatly accelerate the yields from biomass energy crops along with the production of specialty chemicals.