ARPA-E Project Selections

April 29, 2010

These projects have been selected for negotiation of awards; final award amounts may vary.

Lead Research Organization (Partner Organizations)	**Amount**	**Lead Organization Location** (City, State)	**Project Description**
1) Electrofuels			
University of Massachusetts Amherst (University of California San Diego, Genomatica)	$1,000,000	Amherst, MA	*Electron Source – Electric Current:* This project will develop a “microbial electrosynthesis” process in which microorganisms use electric current to convert water and carbon dioxide into butanol at much higher efficiency than traditional photosynthesis and without need for arable land.
Pennsylvania State University (University of Kentucky)	$1,500,000	University Park, PA	*Electron Source – Solar Hydrogen:* Hydrogen consuming bacteria that usually derives its energy from residual light and organic waste at the bottom of ponds will be “rewired” to use electricity. The organism will be able to convert hydrogen and carbon dioxide into a bio-oil that can be refined into gasoline.
The Ohio State University (Battelle Memorial Institute)	$3,977,349	Columbus, OH	*Electron Source – Hydrogen:* An industrially scalable bioreactor approach to incorporate genetically engineered bacteria that metabolize carbon dioxide, oxygen, and hydrogen to produce butanol. The team anticipates at least a twofold productivity improvement over current levels and a cost that can be competitive with gasoline.
Massachusetts Institute of Technology (Michigan State University)	$1,771,404	Cambridge, MA	*Electron Source – Hydrogen:* A bacterium capable of consuming hydrogen and carbon dioxide will be engineered to produce butanol, which could be used as a motor fuel.
Ginkgo BioWorks (University of California Berkeley, University of Washington)	$6,000,000	Boston, MA	*Electron Source – Electric Current:* The project will engineer a well-studied bacterium, *E. coli*, to harness electric current to convert carbon dioxide and water into isooctane, an important component of gasoline.
Harvard Medical School-Wyss Institute	$4,194,125	Boston, MA	*Electron Source – Electric Current:* This project will engineer a bacterium to be able to use electricity (which could come from renewable sources like solar or wind) to convert carbon dioxide into octanol, an energy-dense liquid fuel.
Massachusetts Institute of Technology (Harvard University, University of Delaware)	$3,195,563	Cambridge, MA	*Electron Source – Hydrogen and/or Direct Current:* This project will engineer two microbes, working together, to convert carbon dioxide and hydrogen into oil, which could be refined into biodiesel.
North Carolina State University (University of Georgia)	$2,729,976	Raleigh, NC	*Electron Source – Hydrogen:* The project will engineer a novel pathway into a high-temperature organism to use hydrogen gas to convert carbon dioxide into precursor compounds that can be used to produce biofuels such as butanol.
OPX Biotechnologies Inc. (National Renewable Energy Laboratory, Johnson Matthey Catalysts Inc.)	$6,000,000	Boulder, CO	*Electron Source – Hydrogen:* Microorganisms will be engineered to use renewable hydrogen and carbon dioxide inputs to produce a biodiesel-equivalent fuel at low cost. Catalysts will be explored to convert the microbial fuel into jet fuel.

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University of California Los Angeles (Easel Biotechnologies LLC, University of California Davis)	$4,000,000	Los Angeles, CA	*Electron Source – Electric Current:* The project will use synthetic biology and metabolic engineering techniques to allow microorganisms to use electricity instead of sunlight for converting carbon dioxide into alcohol fuels that can be high octane gasoline substitutes.
Medical University of South Carolina (Clemson University, University of South Carolina)	$2,342,602	Charleston, SC	*Electron Source – Electric Current:* The project will leverage microbial fuel cell technology to develop a microbial system that uses electricity to convert carbon dioxide into butanol or other alcohol fuels.
Columbia University	$543,394	New York, NY	*Electron Source – Ammonia:* The project will genetically engineer ammonia-consuming bacteria to produce isobutanol from carbon dioxide and electricity.
Lawrence Berkeley National Laboratory (University of California Berkeley, Logos Technologies Inc.)	$3,948,493	Berkeley, CA	*Electron Source – Hydrogen:* A common soil bacterium will be engineered to produce butanol and hydrocarbons from carbon dioxide and hydrogen. The organism would be able to produce its own hydrogen by splitting water in the presence of electricity.
2) Batteries for Electrical Energy Storage in Transportation ("BEEST")			
Sion Power Corporation (BASF, Lawrence Berkeley National Laboratory, Pacific Northwest National Laboratory)	$5,000,000	Tucson, AZ	*Lithium-Sulfur (Li-S) Battery:* The project seeks to develop an ultra-high energy Li-S battery that can power electric vehicles for more than 300 miles between charges. The approach uses new manufacturing processes and six physical barrier layers to address cycle life and safety.
ReVolt Technology LLC	$5,000,335	Portland, OR	*Zinc Flow Air Battery:* A large, high-energy zinc-air flow battery will be developed to enable long range plug-in hybrid and all-electric vehicles. Zinc, suspended as a slurry, is stored in a tank and transported through tubes to charge and discharge the battery.
PolyPlus Battery Company (Corning Inc.)	$4,996,311	Berkeley, CA	*Lithium-Air Battery:* Rechargeable Li-Air batteries for electric vehicle applications will be developed using protected Lithium metal cathodes. This approach has a clear path to scaling commercially, and the batteries may rival the energy density of gasoline.
Pellion Technologies, Inc. (Massachusetts Institute of Technology, Bar-Ilan University)	$3,204,080	Menlo Park, CA	*Magnesium-Ion Battery:* The project will develop an inexpensive, rechargeable magnesium-ion battery for electric and hybrid-electric vehicle applications. Computational methods and accelerated chemical synthesis will be used to develop new materials and chemistries. If successful, this project will develop the first commercial magnesium-ion battery and establish U.S. technology leadership in a new field.
Applied Materials, Inc. (A123 Systems, Inc., Lawrence Berkeley National Laboratory)	$4,373,990	Santa Clara, CA	*Advanced Lithium-Ion Battery Manufacturing:* Low-cost, ultra-high energy lithium-ion batteries will be developed using an innovative manufacturing process. High energy cathodes will be integrated with new anodes and prototype manufacturing will be demonstrated that could achieve an extremely low cost. If successful, this project will establish U.S. leadership in the manufacturing of high energy, low cost advanced lithium-ion batteries.

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Massachusetts Institute of Technology (A123 Systems, Inc., Rutgers University)	$4,973,724	Cambridge, MA	*Novel Semi-Solid Rechargeable Flow Battery:* This is a new battery concept that combines the best aspects of rechargeable batteries and fuel cells. It could enable batteries for electric vehicles that are much lighter and smaller - and cheaper - than today's batteries. This flow battery potentially could cost less than one-eighth of today's batteries, which could lead to widespread adoption of affordable electric vehicles.
Planar Energy Devices, Inc. (National Renewable Energy Laboratory, UC San Diego, University of Central Florida, University of Colorado - Boulder, University of Florida, University of South Florida)	$4,025,373	Orlando, FL	*Solid State Lithium Battery:* This project seeks to develop an ultra high energy, long cycle life all solid-state lithium battery that can manufactured using low cost techniques. Pilot-scale manufacturing of the batteries will be demonstrated using all inorganic materials and solid state electrolytes whose properties are similar to existing liquid electrolytes.
Stanford University (Honda, Applied Materials, Inc.)	$1,000,000	Stanford, CA	*Novel All-Electron Battery:* Researchers will seek to develop an "All-Electron Battery", a completely new class of electrical energy storage devices for electric vehicles. The new battery stores energy by moving electrons rather than ions and uses a novel architecture that has potential for very high energy density.
Recapping, Inc. (Penn State University)	$1,000,000	University Park, PA Menlo Park, CA	*Capacitive Storage:* The project will develop a novel energy storage device – a high energy density capacitor – based on a 3D nanocomposite structure. The approach combines the benefits of high cycling ability, high power density, and low cost.
Missouri University of Science & Technology (Brookhaven National Laboratory, MaxPower Inc., NanoLab Inc.)	$999,997	Rolla, MO	*Lithium-Air Battery:* A new high energy air cathode will be created to enable the successful development of ultra-high energy Lithium-Air batteries. The project will seek to dramatically improve cathode performance through the development of a new electrode structure and improved catalysts.
3) Innovative Materials & Processes for Advanced Carbon Capture Technologies ("IMPACCT")			
Codexis Inc. (Nexant Inc.)	$4,657,045	Redwood City, CA	*Solvents / Catalysts:* Applying biology to the problem of carbon capture, this project will use low-cost carbonic anhydrase enzymes and a novel directed evolution process to increase reactivity to capture CO_2 and ability to resist degradation in the harsh flue gases of coal-fired power plants.
Texas A&M	$1,019,874	College Station, TX	*Sorbents:* Metal organic frameworks (MOFs), new compounds that show great promise for CO2 capture, will have their mesh size finely controlled to improve the selectivity of adsorbing CO_2 and to reduce the energy required.
Massachusetts Institute of Technology (Siemens)	$1,000,000	Cambridge, MA	*Sorbents:* A new method known as electrochemically mediated separation (ECMS) will be developed that will lower the energy required to capture CO_2 and allow for simpler retrofitting to existing coal-fired power plants.
University of Kentucky-Center for Applied Energy Research	$1,955,078	Lexington, KY	*Membranes / Solvents:* A hybrid process for CO_2 capture will be developed that combines nanoscale separation with catalysis to reduce the amount of energy diverted from the power plant to remove CO2 from flue gas.

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GE Global Research Center (GE Energy, Univ. of Pittsburgh)	$3,017,511	Niskayuna, NY	*Phase Change:* A novel phase change process will be developed in which a liquid absorbent changes to a solid when it adsorbs CO_2. Because the CO_2 is captured in solid form, it will be much easier to separate the CO_2 from other flue gases and will decrease the energy required for CO_2 compression and transport.
Lawrence Livermore National Laboratory (University of Illinois Urbana-Champaign, Babcock & Wilcox)	$3,665,000	Livermore, CA	*Solvents / Catalysts:* Synthetic small-molecule catalysts will be developed that greatly speed up the absorption of CO_2, enabling advanced solvents that bind CO_2 less tightly and reduce the energy required to release the CO_2 from the solvent afterwards.
Lawrence Berkeley National Laboratory (Wildcat Technologies, Electric Power Research Institute)	$3,663,696	Berkeley, CA	*Sorbents:* Robotic instrumentation tools and computational algorithms will be used to accelerate the development of metal organic framework (MOF) materials that demonstrate improved selectivity of capturing CO_2 and stability in withstanding the harsh flue gas environment at coal-fired power plants.
Georgia Institute of Technology	$1,000,000	Atlanta, GA	*Membranes:* Metal organic frameworks (MOFs) will be integrated into hollow fiber membranes to improve the throughput and selectivity of the membranes for CO_2 capture.
Notre Dame University (Mid-Atlantic Technology, Research & Innovation Center)	$2,559,563	South Bend, IN	*Phase Change:* Solid compounds will turn into an ionic liquid when they react with CO2 and turn back into a solid when the CO_2 is released. These materials require less energy than today's approaches to capturing CO_2.
ATK (ACENT Laboratories)	$1,000,000	Ronkonkoma, NY	*Phase Change:* A novel technology based on rocket designs will be used to capture CO_2 by passing it through a nozzle at supersonic speeds, which will cause the CO_2 to precipitate out from the flue gas as a solid (dry ice). This approach could allow much lower capital costs and simpler integration with existing coal-fired power plants.
Columbia University (Sandia National Laboratory, REI)	$1,014,707	New York NY	*Solvents / Catalysts:* Weathering is a slow, naturally occurring carbon capture process that stores CO_2 in mineral form. This project would use catalysts and enzymes to greatly accelerate the capture of CO_2 and conversion into mineral form. This could be an alternative to storing CO_2 in underground geologic structures.
University of Colorado at Boulder (Los Alamos National Laboratory, Electric Power Research Institute)	$3,144,646	Boulder, CO	*Membranes:* Very thin ionic liquid membranes will be created that allow CO_2 to pass at high rates, reducing the size and cost of membranes needed for CO_2 capture.
Oak Ridge National Laboratory (Georgia Institute of Technology)	$987,547	Oak Ridge, TN	*Sorbents:* Ionic liquids will be integrated into novel hollow fiber membranes to form an ionic liquid "sponge" that can absorb CO_2.
Research Triangle Institute (BASF)	$2,000,000	Research Triangle Park, NC	*Solvents:* The project will use solvents that exploit a new type of reversible chemical reaction with CO_2. This approach could require 40% less energy compared to current processes.
TOTAL FUNDING	**$106,461,383**		