Industrial Carbon Capture Project Selections

September 2, 2010

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

Lead Research Organization (Partner Organizations)	**Funding**	**Lead Organization Location** (City, State)	***Project Title* - Project Description**
1) Large Scale Testing of Advanced Gasification Technologies			
Air Products & Chemicals, Inc.	$71,700,000	Allentown, PA	*Development of ITM Oxygen Technology for Integration with Advanced Industrial Systems* Air Products will accelerate commercial manufacture of ion transport membranes modules and initiate the development a 2,000 TPD pre-commercial scale facility ahead of schedule, enabling this technology to enter the marketplace at least two years earlier than previously projected. The ITM technology could produce oxygen at higher efficiencies and at lower capital and operating costs than state-of-the-art cryogenic oxygen production systems, benefitting domestic oxygen-intensive industrial processes in terms of cost, efficiency, and productivity improvements, such as those involved in the making of aluminum, glass, and steel via the use of this advanced technology. Successful development of ITM will also lower the cost of oxy-combustion configurations, enabling lower cost CO2 capture.
Eltron Research & Development, Inc.	$71,377,413	Boulder, CO	*Scale-Up of Hydrogen Transport Membranes* Eltron is developing a Hydrogen Transport Membrane (HTM) technology to cost-effectively separate hydrogen from shifted coal-derived syngas. ARRA funds will decrease the development time until the expected release of this technology to the marketplace by about three years by accelerating the construction and testing of the 12-lb/day and 250-lb/day units, and the construction and testing of the 4-10 TPD Pre-Commercial Module (PCM). Eltron HTM technology will produce pure hydrogen at temperatures approaching commercial water-gas-shift reaction conditions, allowing process intensification via integrated reaction-separation system, with the potential to improve the efficiency of numerous industrial applications including: refineries, production of chemicals and plastics, and iron ore reduction.
Research Triangle Institute	$168,824,716	Research Triangle Park, NC	*Scale-up of High Temperature Syngas Cleanup Technology* The Research Triangle Institute will design, build, and test a warm gas cleanup system integrated with CCS at pre-commercial scale (30-50 megawatt electric equivalent [MWe]). RTI's warm gas cleanup system will remove multiple contaminants (sulfur, mercury, arsenic and selenium) from coal syngas, building on successful field tests at pilot scale (0.3 MWe) using real syngas from Eastman Chemical Company's gasifier. This project also includes: (1) optimization of sour water gas shift for CCS applications, (2) integration of CO_2 capture using activated Methyl Diethanolamine solvent with warm gas cleanup to produce a sequestration-ready CO2 stream, (3) CO_2 compression and drying, (4) deep well injection of CO2 for long-term geological storage, and (5) measurement, monitoring, and verification of the CO_2 storage. Successful warm gas cleanup combined with CCS has the potential to provide high-purity syngas from which up to 90% of the carbon has been removed, at significantly lower costs than current technologies. A number of industrial applications can benefit from this technology, including the production of hydrogen for use in petroleum refineries and petrochemical plants, production of chemicals and plastics, and for iron ore reduction.

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2) Advanced Turbo-Machinery to Lower Emissions from Industrial Sources			
GE Energy	$31,315,237	Schenectady, NY	*Advanced Hydrogen Turbine Development for Industrial Applications* Advanced hydrogen fueled gas turbine technology will be developed applicable to industrial processes that have the potential to separate and capture carbon dioxide. Industrial opportunities are likely to include pet coke gasification, polygeneration and other industrial process that produce hydrogen and require on site power. The turbine advancements will focus on increased efficiency at the lowest possible system costs.
Siemens Energy	$32,330,423	Orlando, FL	
Clean Energy Systems, Inc.	$30,000,000	Rancho Cordova, CA	*Oxy-Fuel Turbo Machinery Development for Energy Intensive Industrial Applications* A first-of-a-kind commercial scale oxy-fuel turbine will be designed, developed, and tested. The oxy-fuel turbine can use a diverse set of industrial fuels including refinery off gases, gasified pet coke, and natural gas and capture >99% of the produced CO_2.
Ramgen Power Systems	$30,000,000	Bellevue, WA	*Ramgen Supersonic Shock Wave Compression and Engine Technology* This additional project expansion will focus on incorporating the supersonic compression technology into an engine. By following a dual track development on the compressor for applications of CO_2 compression only and incorporation into an engine, the technology risk is greatly reduced leading to a higher potential of success for the base compressor design and its ability to be used in Industrial CCS applications.
***3)* Post-Combustion CO_2 Capture with Increased Efficiencies and Decreased Costs**			
ADA-ES, Inc.	$15,000,000	Littleton, CO	*Evaluation of Solid Sorbents as a Retrofit Technology for CO_2 Capture* ADA-ES and partners will design, construct and operate a 1 MWe equivalent gas flow pilot-scale test unit to evaluate the performance and cost of an advanced solid sorbent CO_2 capture technology. Results will be used to prepare detailed designs and cost estimates for industrial- and utility-scale CO_2 capture applications. This advanced solid sorbent-based process has the potential to dramatically reduce the energy penalties and costs associated with CO_2 capture from dilute gas streams found in industrial process applications. The pilot-scale test unit will be constructed and operated at one of the cost-share participant's plant sites for at least two continuous months. The pilot tests and process modeling will provide the information necessary to complete a technical and economic analysis of the process.
Alstom Power	$10,000,000	Windsor, CT	*Oxy-Combustion Technology Development for Industrial-Scale Boiler Applications* Alstom Power will perform oxy-combustion pilot testing at its 5 MWe equivalent gas flow Boiler Simulation Facility (BSF). The results from these pilot tests will be used to perform detailed engineering designs and cost estimates supporting efficient, low-cost oxy-combustion CO_2 capture solutions for the industrial and utility sectors. The oxy-combustion system designs will incorporate advanced oxy-firing systems, advanced process controls and CO_2 purification. The R&D instrumentation, measurements and data acquisition for the pilot-scale tests will be established to refine and validate simulation tools in order

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			to optimize new and retrofit oxy-combustion boiler applications. The project is relevant to the retrofit of the over 40 percent of the world's installed base of industrial and utility boilers.
Membrane Technology and Research, Inc.	$15,000,000	Menlo Park, CA	*Pilot Testing of a Membrane System for Post-Combustion CO_2 Capture* Membrane Technology and Research (MTR) and partners will demonstrate a cost-effective membrane process to separate CO_2 from industrial- and utility-scale processes including boilers, cement manufacturing, steel and aluminum production and chemical refining. MTR will design, construct and test a 1 MWe equivalent gas flow membrane skid capable of 90 percent CO_2 capture from a slipstream of coal-fired flue gas. A six-month field test using the test skid will be conducted at Arizona Public Service's (APS) Cholla Power Plant. Additionally, a small slipstream test will be performed at the National Carbon Capture Center to validate membrane performance. This project will provide sufficient performance data to allow a thorough technical and economic evaluation of the membrane capture process and will verify the relative potential of this approach.
Praxair	$35,000,000	Tonawanda, NY	*Oxy-Combustion: Oxygen Transport Membrane Development* Praxair will expand the development of the Praxair Oxygen Transport Membrane (OTM) module, partial oxidation reactor hardware development and system demonstration that will accelerate commercial deployment of ceramic membrane technology in industrial processes such as synthesis gas generation and oxy-fuel combustion. Development of an OTM combustion system will dramatically reduce the cost associated with operating a CO_2 capture ready oxy-boiler as it would reduce the power cost associated with producing the oxygen by approximately 75percent. Other combustion applications that would benefit from the development of an OTM combustion process include refinery process heaters, ethylene cracking furnaces, steam methane reformers and other process heaters in industrial/chemical plants that might ultimately be required to control CO_2 emissions.
Siemens Energy, Inc.	$15,000,000	Pittsburgh, PA	*Slipstream Development and Testing of Siemens POSTCAP Capture and Separation Technology* Siemens Energy will design, install and operate an advanced CO_2 capture, solvent-based, pilot plant that has significant potential to provide an efficient, low-cost CO_2 capture solution for both industrial- and utility-scale applications. The Siemens POSTCAP CO_2 capture process utilizes an amino acid salt as the solvent that offers cost and performance advantages when compared to state-of-the-art amine-based solvents. The POSTCAP pilot plant will be installed at Tampa Electric Company's (TECO) Big Bend Station and will treat a flue gas slip stream equivalent to approximately 2.5 MWe. Although the CO_2 source for this slip stream pilot-scale testing is from a coal-fired power plant flue gas, it will provide an appropriate design and performance baseline for direct scale-up to many industrial applications.

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4) Geologic Storage Site Characterization - $50 million			
Board of Trustees of the University of Illinois	$5,000,000	Champaign, IL	*An Evaluation of the Carbon Sequestration Potential of the Cambro-Ordovician Strata of the Illinois and Michigan Basins.* The University of Illinois will evaluate the lateral extent of the Knox dolomite and Mount Simon sandstone formations in the western portion of the Illinois Basin. This assessment of additional data will determine the feasibility of this region's opportunity for industrial sources to store CO2. The project will also increase efforts to understand the geochemistry of these formations and the potential changes that will occur when exposed to CO2.
North American Power Group, Ltd.	$5,000,000	Greenwood Village, CO	*Two Elk Energy Park Carbon Site Characterization Project.* North American Power Group will conduct a detailed characterization of the region by drilling a series of shallow and one deep well. One deep stratigraphic characterization well and three characterization wells will be drilled and core collected for detailed analysis. This region is home to several natural gas processing plants which could utilize these sinks for storage.
Sandia Technologies, LLC	$5,000,000	Houston, TX	*Site Characterization - Triassic Newark Basin-New York & New Jersey.* Sandia Technologies will investigate CO2 storage opportunities from industrial sources in the Newark Basin region. Activities will include extended seismic data acquisition; drilling, coring, and logging a well; and additional modeling. The project will also help to develop baseline assessments of the target formations and benefit future industrial CCS injection operations by having validated the formations.
South Carolina Research Foundation	$5,000,000	Columbia, SC	*Geologic Characterization of the South Georgia Rift Basin for Source Proximal CO2 Storage.* South Carolina Research Foundation will evaluate the feasibility of CCS in the Jurassic/Triassic saline formations of the Mesozoic South Georgia Rift. Characterization will include expanded seismic acquisition; traditional coring; 200 sidewall cores; and collection of porosity and permeability data. This project will benefit local industry by enhancing the scientific understanding of geologic formations within the proximity of the industrial sources of CO2 emissions located in the region.
Terralog Technologies USA Inc.	$5,000,000	*Arcadia, CA*	*Characterization of Pliocene and Miocene Formations in the Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO2.* Terralog Technologies will characterize the Pliocene and Miocene sediments in the Wilmington Graben for high volume CO2 storage. Characterization will include expanded seismic acquisition; drilling a characterization well; extending the depth of another characterization well; and expanding the associated geologic, geomechanical, and flow models. This project will benefit local industry by identifying significant industrial sources in the region; evaluating the costs associated with transport to the geologic storage site; and characterizing the performance of the targeted geologic storage formations.
University of Alabama	$5,000,000	Tuscaloosa, LA	*Site Characterization for CO_2 Storage from Coal-fired Power Facilities in the Black Warrior Basin of Alabama* The University of Alabama will characterize the stratigraphy and structure and assess the storage capacity and injectivity of the Cambrian-Devonian carbonate strata in the Black Warrior basin. The

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			characterization will include additional seismic survey; adding depth to a characterization well; taking sidewall cores and logging the characterization well; and expanded modeling. These activities will further facilitate and accelerate future design and operations of industrial CCS storage in the region by more accurately determining CO_2 capacity and injectivity.
University of Kansas Center for Research, Inc.	$5,000,000	Lawrence, KS	*Modeling CO_2 Sequestration in Saline Aquifer and Depleted Oil Reservoir to Evaluate Regional CO_2 Sequestration Potential of Ozark Plateau Aquifer System, South-Central Kansas* The University of Kansas will complete a regional assessment of structural and stratigraphic framework and field development of both Morrowan-Chesterian reservoirs and the underlying deep saline Arbuckle formation. The project will establish an industry consortium to engage in dialog with local industrial-based CO_2 facilities. The efforts will help to develop baseline assessments of the target formations and validate them for future industrial CCS storage operations. This work could help to facilitate future industrial source project development in these formations.
University of Texas at Austin	$5,000,000	Austin, TX	*Gulf of Mexico Miocene CO_2 Site Characterization Mega Transect* The University of Texas at Austin will conduct a regional evaluation of storage opportunities in Miocene aged formations with a focus on specific reservoirs once identified. The project will lease currently available regional 3D seismic data and acquire a new seismic acquisition system (P-Cable) that is optimized for ultra-high resolution 3D and 4D seismic imaging of shallow and mid-range depths to allow detection of shallow structural features. Both types of data will help to develop baseline assessments of the target formations to measure and monitor their characteristics and validate them for future industrial CCS injection operations.
University of Utah	$5,000,000	Salt Lake City, UT	*Characterization of Most Promising Sequestration Formations in the Rocky Mountain Region* The University of Utah will collect and analyze rock core and geophysical data from the Cretaceous Dakota Sandstone, the Jurassic Entrada Sandstone, and the Pennsylvanian Weber Sandstone formations. Activities will include a comprehensive downhole logging and Vertical Seismic Profile suite and additional coring with the expanded analyses associated with both logging and coring. The project will benefit industrial sources of CO_2 in the Rocky Mountain Region by developing baseline assessments of the target formations and validating them for future industrial CCS injection operations.
University of Wyoming	$5,000,000	Laramie, WY	*Site Characterization of the Highest-priority Geologic Formations for CO_2 Storage in Wyoming* The University of Wyoming will enhance characterization of the Moxa Arch and Rock Springs Uplift deep saline storage formations. Enhanced characterization activities will include drilling a stratigraphic test well on the Rock Springs Uplift and acquiring additional logging and cores. The project will benefit future industrial CO_2 storage projects by characterizing regional storage opportunities.
TOTAL FUNDING	**$575,547,789**		