ASU grant aims to transform global energy landscape

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Arizona State University researchers Dan Buttry (right) and coworkers Helme Castro (left) and Poonam Singh work in the lab. Credit: Mary Zhu

Changing the way the nation generates and consumes energy is at the heart of a multimillion dollar grant awarded to Arizona State University from the Department of Energy.

Under the grant, the university will develop an efficient and cost-effective carbon capture technology using an innovative electrochemical technique to separate carbon dioxide from other emissions originating from power plants.

In what could be an economically enabling breakthrough in the drive to reduce carbon emissions, ASU researchers will explore the real possibility of reducing energy and cost requirements by more than half.

Led by Dan Buttry, professor and chair of ASU's Department of Chemistry and Biochemistry in the College of Liberal Arts and Sciences, the grant is part of a special Department of Energy program designed to pursue high-risk, high-reward advances in alternative energy research.

"Through this type of venture we are working to advance research and spur economic development in the areas of renewable energy and energy security to create solutions that address society's grand challenges," said Sethuraman "Panch" Panchanathan, senior vice president for ASU's Office of Knowledge Enterprise Development. "This innovative project is a collaborative effort of faculty at ASU from multiple disciplines, as well as collaborators from Proton OnSite and the University of Colorado, who are all developing a new carbon capture technology."

Where Solutions Happen

Arizona State University has been building its portfolio in alternative energy research for several years, and currently includes among its capabilities a center for research into electrochemistry for renewable energy applications; several advanced programs on solar energy research; one of the leading testing and certification centers for solar energy; and research into solar-generated biofuels, including advanced work on algae-based biofuels.

The university's awarded grant of $2.9 million over two years follows an initial "seed" grant where the team demonstrated proof of concept of efficient and cost-effective carbon dioxide capture. ASU's project was selected through a merit-based process from thousands of concept papers and hundreds of full applications.

The projects are based in 24 states, with approximately 47 percent of the projects led by universities – all supported by the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) program, which aims to develop clever and creative approaches to transform the global energy landscape while advancing America's technology leadership.

Inspired by the Defense Advanced Research Projects Agency, ARPA-E was created to support high-risk, high-reward research that can provide transformative new solutions for climate change and energy security.

"The potential of this project to advance solutions to the problem of excessive carbon dioxide in the environment is exciting, and we look forward to the team's progress in this area," said Gary Dirks, director of ASU LightWorks. "ASU is a place where the convergence of laboratory research and real-world application creates a unique environment where imaginative energy-related projects are fostered and encouraged."

A New Approach

The carbon capture program was initially supported by ASU LightWorks, which brings together the intellectual expertise across the university centered on leveraging the power of the sun to create solutions in the areas of renewable energy, including generating electricity, alternative fuels and preparing future energy leaders.

"We are extremely excited about this new grant from the Department of Energy ARPA-E program," said Buttry. "The effort is focused on a key issue in fossil fuel-based energy production – how to reduce atmospheric carbon dioxide emissions without consuming too much of the energy content of the fuel. We have recently developed a new approach to carbon dioxide capture that uses an electrochemical process with some design features similar to those in a fuel cell."

Co-principal investigators on this project are Cody Friesen, School for Engineering of Matter, Transport & Energy one of ASU's Ira A. Fulton Schhols of Engineering; Vladimiro Mujica, Department of Chemistry and Biochemistry; and Ellen Stechel, Department of Chemistry and Biochemistry and also deputy director of LightWorks. Buttry and Friesen previously worked on an ARPA-E project developing a radical new design for automotive batteries.

Mujica will use quantum chemical calculations to help understand the binding of carbon dioxide to the carrier compounds. Stechel is simulating the cell behavior, Friesen's group is working on cell design, and Buttry's on the chemistry and electrochemistry of the binding process.

Also collaborating on this grant are two researchers from the University of Colorado, Boulder; Doug Gin, in chemistry, and Rich Noble, in chemical engineering, who are helping to make very thin membranes for the separation process. Katherine Ayers of Proton OnSite, CT, will be involved with cell design and engineering.

The only proven commercially viable technology for flue gas capture uses compounds called amines in the so-called monoethanolamine (MEA) process. Several plant scale demonstrations use this old technology, first patented in 1930. The MEA process has several drawbacks, particularly the energy required for thermal regeneration of the amine capture agent. As discussed in a recent Department of Energy report (DOE/NETL-2009/1366), for typical conditions, the energy required for this process consumes roughly 40 percent of total plant output, and increases the cost of electricity by 85 percent.

Buttry predicts their innovative approach as having an overall efficiency far better than existing efforts.

Provided by Arizona State University

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