

through the process loop compared with a liquid. On the other hand, having a stable solid that can be heated to 160 °C or so to drive off the CO₂ at 5–6 atmospheres means that less compression is required to liquefy the CO₂ for transport.

The University of Notre Dame also is developing phase-changing liquids. In that process, says Stephen Takach, managing director of the Center for Sustainable Energy at Notre Dame, enough water and residual CO₂ are left after desorption to carry the phase-changing solid ionic salt back to the absorber in a slurry.

As with other CO₂ capture projects, it isn't clear what will happen to the Notre Dame project when the ARPA-E money runs out. "We're in the stage of building a demo unit, and our plan is to operate it in the May timeframe and acquire data from the test run. In that process it will become clearer what the natural next steps are," says Takach. Options include applying for a grant from DOE's Office of Fossil Energy, which in March issued a broad solicitation for R&D projects through its National Energy Technology Laboratory, or partnering with industry, perhaps on a different application for the technology. In Notre Dame's case, two of the researchers have formed a spinoff company to develop the ionic-liquids technology for refrigeration applications.

Ready to go

"The intention, from the time this program was created [in 2010], was that these projects would be positioned well to compete for a funding solicitation from Fossil Energy," says ARPA-E's Sawyer. "This technology requires government support in the absence

of a carbon price." She says papers from IMPACCT projects have been published in top chemical and chemical engineering journals and that a second spinoff has been created from a project at Texas A&M University.

A Columbia University project seeks to turn captured CO₂ into a solid that can be easily and safely transported, stored aboveground, or integrated into products such as paper filler, plastic filler, and construction materials. In nature, the reaction of CO₂ with various minerals over long periods of time—a process known as carbon mineralization—will yield a solid carbonate. But carbon mineralization as a CO₂ capture and storage method is limited by the speeds at which the minerals can be dissolved and the CO₂ can be hydrated. The Columbia team is using a process involving a combination of chemical catalysts to increase both rates. Ah-Hyung Park, the principal investigator with the Columbia group, says the next step will be teaming with RTI International to build a skid-mounted system for installation at a coal-fired plant.

If successful, the Columbia project would produce a long-term solid CO₂ storage solution that would eliminate the worry of monitoring gas in underground storage. But that solution could have its limits; converting the gigatons of CO₂ produced annually into solid form would create "mountains of carbonate everywhere," cautions Perry.

"The technologies themselves will make this community better positioned for whatever the future does hold," says Sawyer. "Whether they take some alternate path or not, I think that these technologies and the community of carbon capture will look very different than it did before ARPA-E made this investment." **David Kramer**

news notes

GROWing abroad. The first batch of about 60 NSF Graduate Research Opportunities Worldwide (GROW) fellows will head off this summer for international research stints of 3 to 12 months.

The GROW program is open to master's and PhD science and engineering students who hold three-year NSF graduate research fellowships, of which about 2000 are awarded annually. In announcing the program last December, NSF director Subra Suresh said, "GROW will prepare NSF graduate research fellows to engage successfully in the global research enterprise by

connecting them to leading scientists and research infrastructures around the world." Suresh moved to Carnegie Mellon University in March.

It is still uncommon for US students to do research abroad. According to the American Institute of Physics Statistical Research Center, among physics PhDs from the combined classes of 2009 and 2010, about 10% of US citizens went to another country for a postdoc (see <http://www.aip.org/statistics/trends/reports/phd1yrlater0910.pdf>). Across science and engineering, 3.4% of US citizens who received their PhDs in 2001–07 were living abroad in 2008, according

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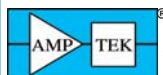
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to an NSF report from last year (see <http://www.nsf.gov/statistics/infbrief/nsf13300>).

The 10 GROW partner countries so far are Chile, Denmark, Finland, France, Japan, Norway, Singapore, South Korea, Sweden, and Switzerland. GROW awardees will receive a \$5000 allowance from NSF for travel and research; host countries cover living expenses. NSF aims to grow GROW to 400 fellowships a year. TF

Bassi-Veratti archives online. In March the Stanford University Libraries and the Biblioteca comunale dell'Archiginnasio in Bologna, Italy, unveiled the digitized archives of Laura Bassi (1711–78), Europe's first female physics professor. Bassi burst onto the intellectual scene in 1732, when she publicly debated 49 physics and mathematics topics with the scientific literati. The debates resulted that same year in a PhD degree from and a teaching post at the University of Bologna.

Through her teaching, research, and correspondence, Bassi was instrumental in spreading Newtonian experimental physics throughout Italy. She was a regular at Bologna's popular annual "carnival anatomy"—15-day debates covering many topics—and with her husband, physicist Giuseppe Veratti, she established a laboratory and taught physics

and philosophy in their home. In 1776 Bassi was named professor of experimental physics at the Bologna Academy of Sciences. After her death, Veratti took over the chair; he, in turn, was succeeded by Paolo Veratti, one of the couple's eight children.



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The Bassi-Veratti collection consists of some 672 personal and professional documents relating to Bassi, her husband Veratti, and their families; the documents are mostly in Italian, but the inventory is listed in both Italian and English. The collection may be accessed at <http://bv.stanford.edu>. TF ■

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