

National labs push to get technologies out the door

ANDREA STARR, PACIFIC NORTHWEST NATIONAL LABORATORY

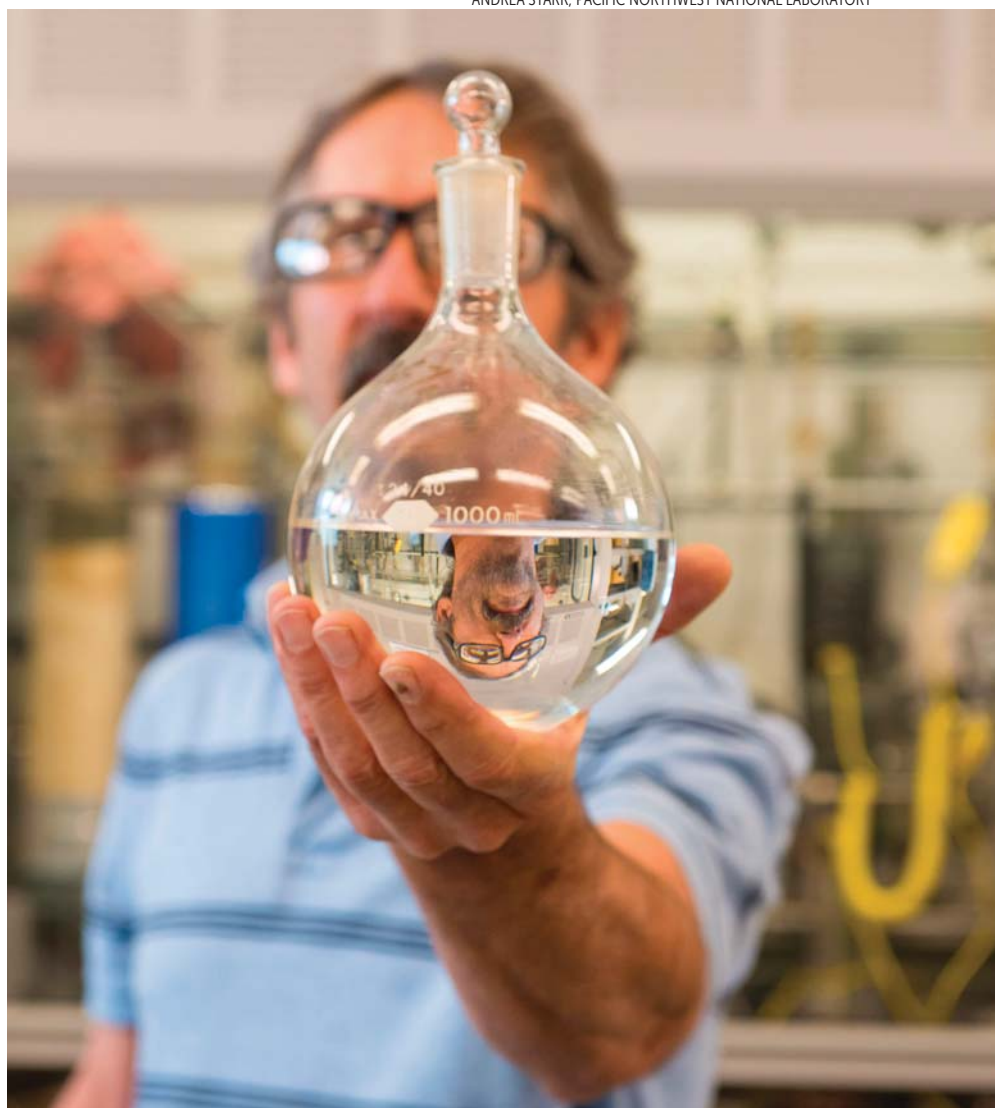
The Department of Energy is cutting red tape on cooperative R&D agreements and is organizing technology showcases.

When Vig Sherrill, an electrical engineer and serial entrepreneur in eastern Tennessee, went looking for a technology for his sixth startup company, he found one at Oak Ridge National Laboratory's annual technology innovation showcase: a process that had the potential to slash the cost of manufacturing graphene by orders of magnitude. He hired the inventor of the process, Ivan Vlasiouk, from the lab and formed a company, General Graphene, which is now producing graphene sheets at "well below" \$100/m²—compared with \$10,000/m² using other, more established manufacturing processes. General Graphene just completed a major round of fundraising and is working toward commercial-scale production in 2022.

Chicago-based LanzaTech, which produces ethanol through fermentation of industrial gases and other carbon-rich wastes and residues, turned to chemists at Pacific Northwest National Laboratory. Together they developed a catalytic process to upgrade the ethanol to a jet biofuel, a 50-50 mix with conventional jet fuel. The company licensed the technology, and in April the Federal Aviation Administration approved the fuel for commercial flight. In October a Virgin Atlantic 747 made the first transatlantic flight using the synthetic fuel mix.

In 1992 Goodyear Tire and Rubber Company signed a cooperative R&D agreement (CRADA) with Sandia National Laboratories after the Department of Energy encouraged its labs to partner with industry. One result was the development of an award-winning all-weather tire made with innovative polymers, a success the company has said couldn't have happened without Sandia's help in developing modeling and predictive testing tools. Renewed multiple times since, that CRADA is now in its 27th year.

Licensing, spin-offs, and CRADAs



USING CATALYTIC TECHNOLOGY developed at Pacific Northwest National Laboratory, a researcher at Chicago-based LanzaTech transforms ethanol derived from industrial waste gases into jet fuel.

from the DOE labs are hardly new, but they are receiving new attention and emphasis from an administration that hasn't always been known for its friendliness to science and research.

"Making sure we get technology out to the marketplace, that it has an avenue with which to be commercialized, is very important to everybody," says Conner Prochaska, DOE's chief commercialization officer, a new title conferred in November by Secretary Rick Perry. Prochaska says the emphasis on technology transfer has come "straight out of the

White House," in the form of a 2018 memorandum issued by the Office of Management and Budget and the Office of Science and Technology Policy to the federal agencies that support R&D.

Paul Dabbar, DOE undersecretary for science, has taken a particular interest in commercialization activities at the department's 17 labs. He initiated a series of workshops to bring together invited members of academia, manufacturers, potential investors, potential customers, and the laboratories' leaders in focused technology areas. "What I wanted to do

was have venues in which we had a broader group of participants to facilitate conversations," he says. "Not just lab people talking to other lab people."

The first such InnovationXLab Initiative gathering, focused on batteries and energy storage, was hosted by SLAC in September. As of early December, 150 individuals, roughly half of the 300 attendees, have followed up with the labs, says Dabbar. A second InnovationXLab, focused on grid modernization and security, is slated for 23–24 January in Seattle. Two others, one on advanced and additive manufacturing and the other on biotechnology and drug development, are in the planning stages, he says.

But the show-and-tell process can also work at the individual lab level. Mike Paulus, director of technology transfer at Oak Ridge, says roughly half the technologies presented at the lab's annual showcase in recent years have been licensed. Several licenses have been accompanied by CRADAs or other collaborations to mature the technologies. "We try to be flexible and responsive to our licensees, recognizing that small businesses often operate on much shorter

time frames than federal laboratories," he says.

More nimble and flexible

In November Dabbar unveiled two DOE measures aimed at easing the administrative burden of collaborating with the labs. One change allows lab directors to approve CRADAs that fall within a defined scope of work. Previously, the agency had to sign off on all CRADAs, no matter how small or related. Taking the department out of the loop will shave weeks off the approval process, say lab officials.

The second change will provide greater flexibility to the labs to negotiate R&D contract provisions related to indemnification. Potential commercial partners often balk at the standard provisions that require them to indemnify the labs and the federal government.

A year ago Perry extended to all the labs the authority to use a new mechanism, the Agreement for Commercializing Technology (ACT), in performing R&D for industry and other outside entities. The ACT framework allows the contractors that operate the labs for DOE to negotiate commercial terms with

partners and take on some business risks that the agency won't. For example, in exchange for a negotiated fee, contractors can waive DOE's up-front R&D payment requirements or perform R&D for a fixed cost.

Lawrence Livermore National Laboratory used an ACT for a \$50 million pact with the Czech Republic's Extreme Light Infrastructure facility to build a high-average-power petawatt laser beamline (see PHYSICS TODAY, December 2018, page 18). Rich Rankin of Livermore's innovation and partnerships office says the European Union, which funded the Czech user facility, couldn't abide by standard US legal provisions. Because of the ACT, it no longer needed to.

Pacific Northwest, one of the labs that helped pilot the ACT initiative, is by far the largest user, with 130 of them under its belt. Lee Cheatham, the lab's director of technology commercialization and deployment, says DOE is currently piloting an extension of the ACT framework that will for the first time allow defense and other federal contractors to use pass-through government funds to pay for cooperative research at national labs.

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A 3D-PRINTED, LIFE-SIZE REPLICA of the classic 1963 Shelby Cobra sports car was made at Oak Ridge National Laboratory's Manufacturing Demonstration Facility. The majority of the lab's 70 cooperative R&D agreements in 2017 involve that center.

DOE's applied energy programs are required by statute to devote 0.9% of their budgets to supporting collaborations with industry. The largest fraction of those dollars originates from the Office of Energy Efficiency and Renewable Energy, whose fiscal year 2019 budget is \$2.4 billion. Funds allocated to a project must be matched by the industrial partner. Additional money for commercialization can be authorized by DOE program offices, and the labs each have funding that can be used at the discretion of the directors. But Jason Martinez, a CRADA specialist at Sandia, says most CRADAs at the lab are "funds-in," in which the private-sector party puts up the costs and the lab provides the principal investigator.

All about impact

The labs have clearly gotten the technology-transfer message from DOE. Argonne National Laboratory recently elevated its commercialization program to become a directorate, the lab's fourth. Paul Kearns, Argonne's director, says DOE also has upgraded the weight it gives to technology commercialization in its annual assessments of the labs' performance.

"We're all about impact," Kearns says when asked which commercialization

mechanism the lab favors. "One of my better days as the lab director was when I was able to deliver not one but three seven-figure royalty checks to employees at the lab." The involved technology, a nickel-manganese-cobalt cathode that greatly improved the energy density, safety, and time between charges of lithium-ion batteries, has been licensed to General Motors, BASF, LG Chem, and others.

Argonne's Chain Reaction Innovations, a technology entrepreneurship mentoring program for inventors from across the nation, has attracted applications from between 80 and 100 startup hopefuls for only 6 available spots during its first two years. A third selection process is under way. Similar technology incubators, each funded in part by DOE, are in place at other national labs, including Lawrence Berkeley and Oak Ridge.

Sixty of the 70 CRADAs signed at Oak Ridge in 2017 involve the lab's Manufacturing Demonstration Facility, which focuses on the materials, processes, and equipment for additive manufacturing. The center produced a 3D-printed, full-scale replica of the original Shelby Cobra,

the Anglo-American roadster of 1962–63. Other items fashioned include a house, excavator, jeep, and submarine. Paulus says the facility staff "as part of their day jobs are expected to work with industry to demo how to use equipment and how to optimize processes."

Oak Ridge's high-performance supercomputers—including Summit, now rated as the world's fastest—enable the computational design of new materials. Once synthesized, the new materials' performance is tested at the lab's Spallation Neutron Source. Through a CRADA with Oak Ridge, Fiat Chrysler Automobiles developed a high-temperature aluminum alloy for auto engines. The work took two years, much less than the typical time required to go from design to manufacture, Paulus says. The lab is seeking additional licensees for the technology.

A CRADA signed in July by Sandia and Canada's Emera Technologies covers R&D on community-scale direct-current microgrids. Emera Technologies CEO Rob Bennett said in a statement that a large and growing portion of electricity generation, storage, and home use

requires conversion of alternating current to DC. He expects DC power systems and microgrids to form a large part of US energy infrastructure.

The CRADA may also advance Sandia's research on the control and stability of DC microgrids for military applications. The lab offers a facility housing three interconnected DC microgrids and another where research on energy systems integration takes place. Sandia's virtual power plant software anticipates the performance of energy storage and intermittent renewable sources to determine how to optimize operations and power balance.

Through CRADAs with Livermore, the Metal Improvement Company, now known as Curtiss-Wright Surface Technologies, developed a laser-peening process that can be used to prevent metal fatigue and extend the lives of jet fan blades. Some 100,000 blades have been processed and have saved the aviation industry billions of dollars, according to a Livermore spokesperson. The two lab researchers who developed the technology left to become employees of the company.

"It would be great if the American

people had a concept for the number of things that have come out of the national labs," says Livermore's Rankin. Many of the improvements to auto fuel efficiency, medical instrumentation, the internet, and cybersecurity are by-products of work performed for the government, he notes.

In another form of collaboration, known as the Strategic Partnership Projects (SPP) program, the partner pays the full cost of having work performed at the lab and retains all intellectual property that results. Similar to an ACT, an SPP offers less flexible terms and must be approved by DOE. Sandia's Martinez says the SPP is "very transactional, 'Here's a battery, test it and send the data back to us.' A CRADA will be 'Here's this battery technology, let's augment it in some way.'" The labs are prohibited from competing with industry while performing SPP work.

Yet another type of technology commercialization occurs at DOE user facilities, such as the light sources, neutron sources, and nanotechnology centers, where industrial and academic users have developed new materials and pharmaceuticals with help from lab scientists.

The researchers are allowed to use the facilities for free, provided they seek to publish their results. To perform proprietary work, they must pay a fee.

A more indirect sort of technology transfer occurs when lab researchers take ideas with them, rather than technologies or intellectual property per se, when they leave. Martin Casado is a notable example. Now a partner in the venture capital giant Andreessen Horowitz, Casado started two businesses in software-defined-network technology that were later acquired by larger companies. He credits his days working in network security and intelligence at Livermore as the source for many of the ideas he later commercialized while pursuing a PhD at Stanford University. He now returns to the lab periodically to help teach researchers about entrepreneurship.

"The labs are great at tackling real-world problems that other people don't have the luxury or are unlucky not to have to deal with," Casado says. "They are a massive untapped potential as a talent pool and knowledge that you just don't get elsewhere."

David Kramer **PT**

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