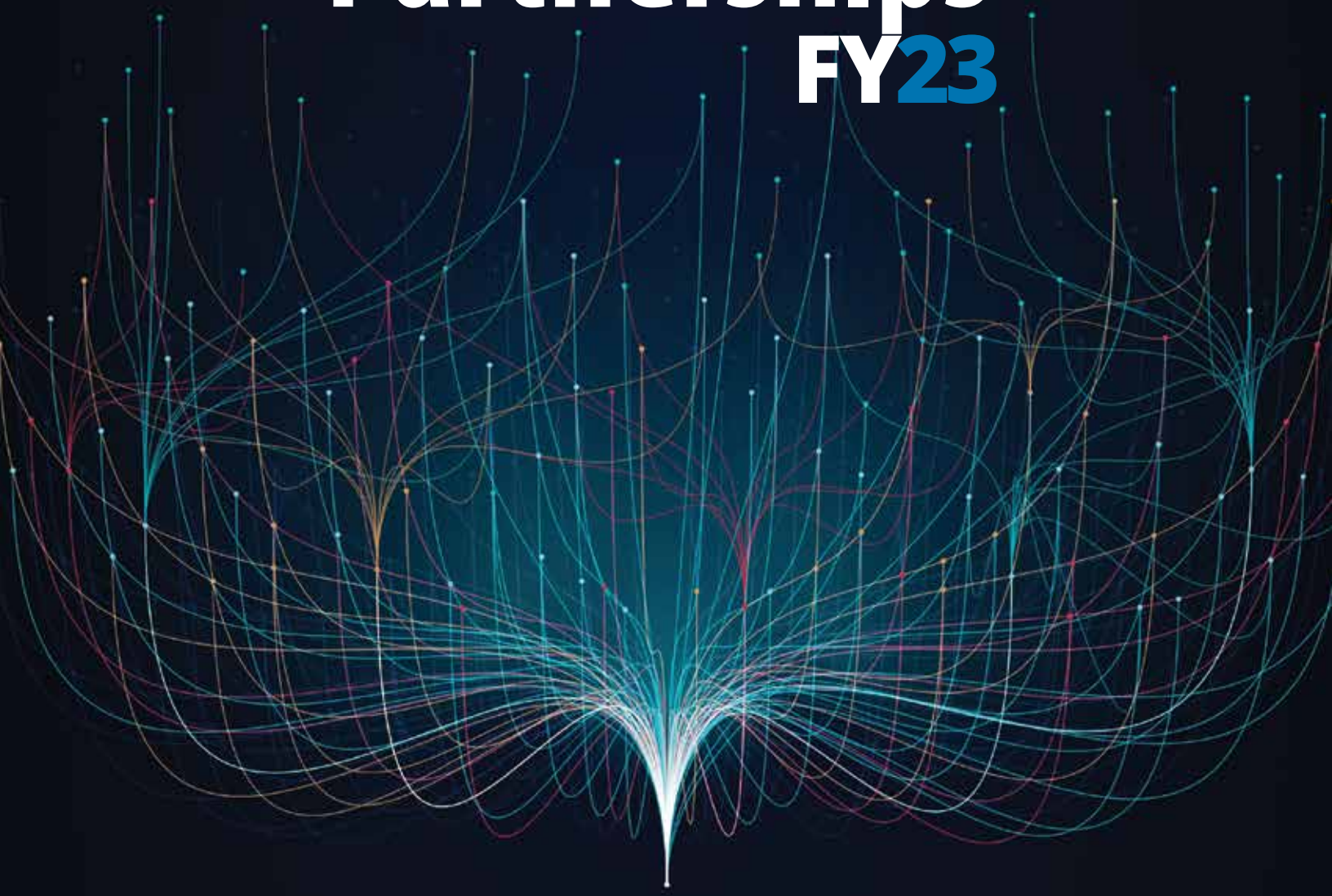
TECHNOLOGY Partnerships FY23



ANNUAL REPORT

Sandia National Laboratories

"OTT continues to value our incredible collaboration with Sandia, including work funded through the Technology Commercialization Fund, investments in its researchers with Energy I-Corps, and developing new pathways for technology commercialization using the Adoption Readiness Level framework. Together, we're committed to creating a future where sustainable, secure, and prosperous energy solutions are more than just ideas—they're a reality accessible to all communities."

— **Vanessa Z. Chan**

Chief Commercialization Officer &
Director of the Office of Technology Transitions

U.S. Department of Energy

"Sandia's Technology Transfer Programs remain strong, helping to deploy and transition mission-inspired inventions and technologies to market while also building resilient technology transfer ecosystems that benefit our local, state, and national economies and broader national security."

— **Dan Sanchez**

Assistant Manager for Programs

National Nuclear Security Administration
Sandia Field Office

"Technology transfer activities contribute significantly to Sandia's key role in the local, state, and national economies. Over the last 20 years, an estimated $140 billion in total economic impact nationwide and $72.2 billion in sales of new products and services resulted from Sandia's Cooperative Research and Development Agreements and licenses. Sandia is committed to the partnerships that strengthen technology transfer and the marketplace, and help us achieve our national security mission."

— **James S. Peery**

Laboratories Director

Sandia National Laboratories

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"By transferring mature technologies out of Sandia and into the marketplace, new companies can be formed that in turn supply the Labs with critical products produced at a more efficient, larger scale than what is possible on-site. These companies provide a critical service to Sandia and a growing number of customers while also creating jobs. So it is a win-win."

— **Doug Kothe**

Associate Laboratories Director & Chief Research Officer
Advanced Science and Technology
Sandia National Laboratories

"An expanding network of partnerships with universities gives students hands-on training and experience while exposing them to the wide range of important research done at the national laboratories. This exposure helps attract a diverse array of top talent to work at Sandia."

— **Basil Hassan**

Director & Deputy Chief Research Officer
Chief Research Office
Sandia National Laboratories

"New partnership programs like Boost enable Sandia's technology transfer mission by expanding the commercialization and partnership ecosystem to include communities that have been traditionally underserved. By removing barriers, more Sandia-developed technologies can be commercialized with benefits for these communities."

— **Mary Monson**

Senior Manager
Technology Partnerships & Business Development
Sandia National Laboratories

LDRD
LABORATORY DIRECTED RESEARCH & DEVELOPMENT

Look for the LDRD logo in this report to discover which technologies grew out of the LDRD program.

To learn more, visit www.sandia.gov/ldrd

Partnerships Help Sandia and U.S. Meet Strategic and Security Goals

Partnerships help Sandia National Laboratories meet its mission needs. Engagement with industry can also help the U.S. meet goals such as net-zero emissions by 2050. Joint research through Cooperative Research and Development Agreements and partnership programs moves technology toward deployment. Licenses transfer Sandia-developed innovations to commercial manufacturing, in some cases creating new companies that supply vital parts for the Labs and other customers. Partnerships with academia advance scientific breakthroughs while training the next generation of researchers.

Among the many Sandia partnerships in this annual report are these examples that are helping our country meet national security goals by enhancing energy security, supplying important resources, and even protecting against disease.

- Making EV battery manufacturing more energy efficient by optimizing the electrode drying process
- Enabling commercial production of digital imaging technology used by national lab researchers and adding enhancements for new users and applications
- Protecting and controlling microgrids so they can continue to be used as a power source, even during emergency situations or severe weather events when the main system is down
- Advancing non-toxic, cost-effective, and long-lasting disinfection technology effective in preventing the spread of viruses, bacteria, fungus, and protozoa toward commercialization

Partnerships are a foundational piece of building national security. Balancing what tasks are done internally at the Labs and which are better performed by or in concert with external partners leverages each party's strengths. Partnerships also contribute to the local, regional, and national economy while keeping the U.S. at the forefront of technical advances.

LDRD Program Essential to Mission Capabilities

Research conducted within the Laboratory Directed Research and Development program is essential to maintaining the vitality of Sandia's mission-critical science, technology, and engineering capabilities. The LDRD program has benefited Sandia's work in all of its national security mission areas, including nuclear security, homeland security, energy security, and global security.

The Labs and its strategic partners gain from collaborative research results. Many technological breakthroughs originating from or improved through the LDRD program are later transferred to industry, commercialized under licensing agreements, and brought to market for the U.S. public good.

Production of Vital Imagers Increases with Commercial Manufacturing

Challenge

When fusion ignition was achieved in 2022, the world's fastest multiframe X-ray imaging technology developed at Sandia National Laboratories captured it happening. The same digital imaging technology is also used at Sandia's Z Pulsed Power Facility, as well as at other Department of Energy facilities to support the National Nuclear Security Administration Stockpile Stewardship mission and DOE program areas such as Inertial Confinement Fusion and High-Energy Density Physics. Named the Ultra-fast X-Ray Imager, the technology was developed at Sandia's Microsystems Engineering, Science and Applications, or MESA facility. The demand for UXI sensors and support has outgrown Sandia's R&D focus, so commercializing the technology made sense.

Collaboration

Two Sandia researchers, Liam Claus and Marcos Sanchez, who were instrumental in design and development of the imaging technology, saw the need for dedicated support for the technology and its expanding applications. They also realized higher volume production would be required before long. They left Sandia and, along with researcher Matthew Dayton from Lawrence Livermore National Laboratory, started their own company, Advanced hCMOS Systems. Knowing they could offer support and supply imagers to existing DOE users while also redesigning the sensors for new research applications, they licensed the technology.

> *The partnership Advanced hCMOS Systems has with Sandia has enabled us to increase the understanding of how to maximize the performance of existing sensors in different customer applications.*
>
> **Marcos Sanchez**
> Co-Founder
> Advanced hCMOS Systems LLC

To date, Sandia has collaborated with AHS to support the packaging, testing, and integration of sensors for use in Z-machine diagnostics. Sandia also worked with the company through a project funded by the TRGR Technology Readiness Initiative to see if new types of photodiodes could be used to make the imagers more sensitive for use in low light applications.

Solution

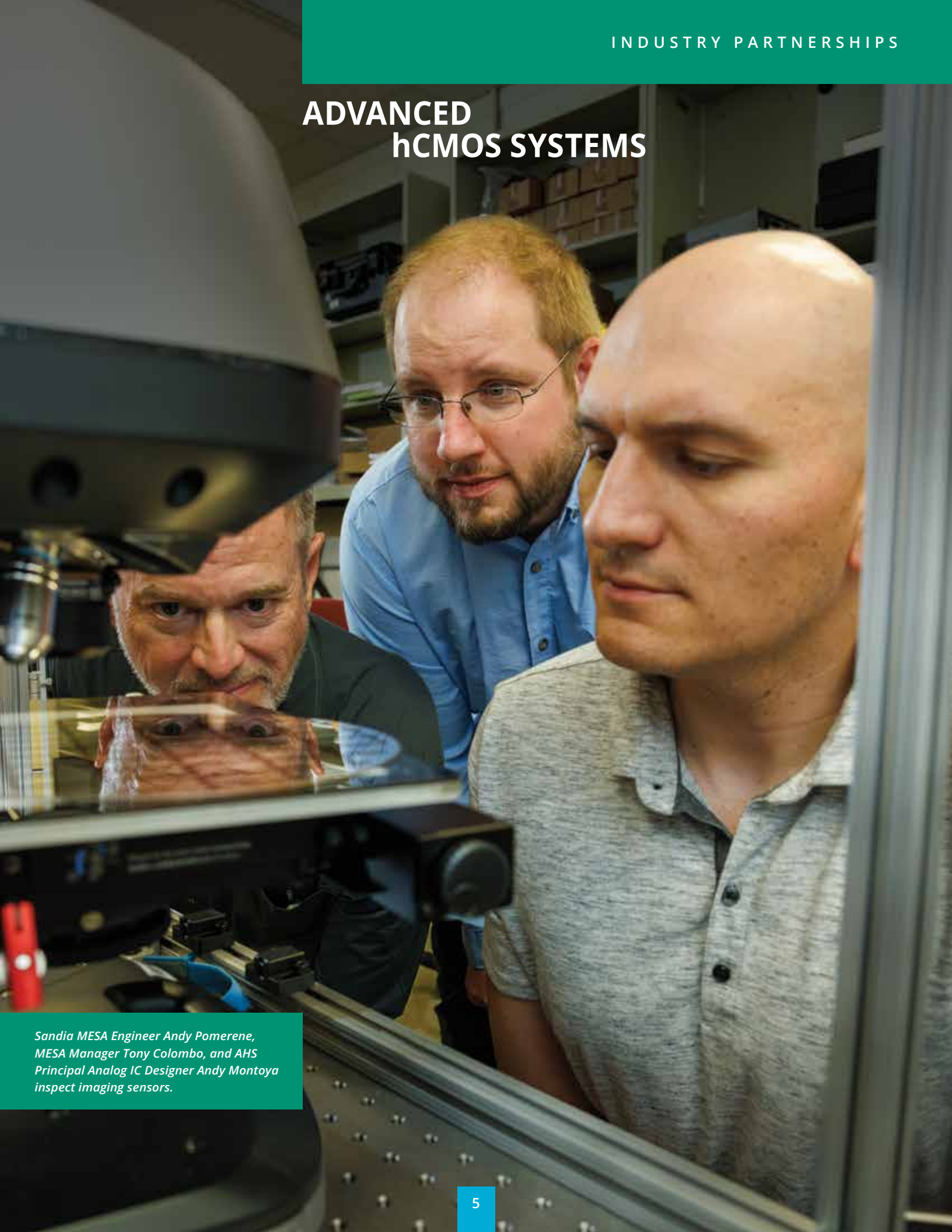
The establishment of a commercial company for UXI technology has enabled six DOE facilities (Sandia, LLNL, Nevada National Security Site, SLAC National Accelerator Laboratory, Los Alamos National Laboratory, Laboratory for Laser Energetics at the University of Rochester) that use the technology to have a commercial option for sensor design, realization, and support services, much like a just-in-time provider for computer/IT services.

Impact

AHS has delivered over 80 packaged and tested sensors to Sandia and designed two new sensors that are currently in fabrication at MESA. Additionally, the company has performed its first redesign of the sensors in a commercial foundry and is awaiting its first prototype device for testing and evaluation. The transition to commercial production will allow AHS to continue supplying DOE laboratories while also selling to a broader spectrum of customers, including universities, industrial laboratories, and high-speed scientific camera manufacturers.

PARTNERSHIP TYPE: License
GOAL: Enabling commercial production of digital imaging technology used by national lab researchers and adding enhancements for new users and applications

ADVANCED hCMOS SYSTEMS



Sandia MESA Engineer Andy Pomerene, MESA Manager Tony Colombo, and AHS Principal Analog IC Designer Andy Montoya inspect imaging sensors.

Constructing a Clean Transportation Future for Off-Highway Equipment

Challenge

As the U.S. and world transition to a clean transportation future, low carbon renewable fuels and electric vehicles are increasingly important. Off-highway construction and agricultural equipment are more difficult to electrify due to their high power requirements. Moreover, for heavy vehicles used in these applications, it's very challenging to get enough energy on board due to the long hours they run and the weight of batteries. That's why lower carbon fuels are being investigated.

Collaboration

Caterpillar is the world's leading manufacturer of construction and mining equipment, off-highway diesel and natural gas engines, industrial gas turbines, and diesel-electric locomotives. The company is continually improving equipment designs to produce less waste, fewer emissions, and consume less fuel. Power density, emissions, and efficiency are all critically influenced by the fuel and air mixing processes. As lower carbon fuels that are very different from diesel are being introduced, research into these fuels' mixing processes is essential. Part of Caterpillar's R&D into sustainable power systems is being conducted jointly with Sandia National Laboratories.

> *Caterpillar is pleased to collaborate with Sandia on generating fundamental spray, mixing, and combustion measurements, which will improve our understanding and simulation of lower carbon fuels. This work will impact future Caterpillar engine designs for methanol and hydrogen, and we appreciate the Department of Energy's support of this effort.*
>
> **Kenth Svensson**
> Principal Investigator
> Caterpillar Inc.

Researchers Dario Lopez-Pintor, Lyle Pickett, and Aleš Srna at Sandia's Combustion Research Facility in California are leading two new projects, in close collaboration with Caterpillar, focused on speeding the development of hydrogen- and methanol-fueled internal combustion engines. Their work targets development of specialized computational tools to help guide the design of new engines and enhance their performance by optimizing the fuel injection and mixing processes. Sandia has many decades of experience in experimentally characterizing fuel injection processes as well as computational modeling, which it deploys to fulfill its national energy security mission.

Solution

Caterpillar continues to develop new engines that work efficiently with lower carbon fuels in order to meet their customers' decarbonization goals. The company is working to develop engines that can run on a variety of fuels, including hydrogen and methanol for off-highway and marine applications.

Impact

The transportation sector is the largest source of greenhouse gas emissions in the U.S., responsible for one-third of all emissions.* Off-highway transportation, rail, and maritime uses account for about 15% of transportation CO_2 emissions.* The use of hydrogen and sustainable liquid fuels enabled by new engine designs can help reduce or eliminate those emissions. A decarbonized transportation system can help create a sustainable economy that benefits everyone.

**https://www.energy.gov/sites/default/files/2023-01/the-us-national-blueprint-for-transportation-decarbonization.pdf*

PARTNERSHIP TYPE: Umbrella Cooperative Research and Development Agreement
GOAL: Optimizing the fuel injection and mixing process for new hydrogen-and methanol-fueled internal combustion engines to be used in off-highway construction and agricultural equipment

CATERPILLAR

Sandia Researchers Lyle Pickett (left) and Dario Lopez-Pintor (right) with Caterpillar Principal Investigator Kenth Svensson in front of a Caterpillar engine being used in a companion project at Oak Ridge National Laboratory.

Better EV Battery Manufacturing Supports Decarbonization Goals

Challenge

Efficient battery manufacturing is the key to the mass production of electric vehicles. In order to lower global emissions and enhance EV production, Ford Motor Company is investing significantly to accelerate research and development of battery technology.

Optimizing the drying process for electrodes, which is one of the most energy-intensive manufacturing steps, will make it possible to reduce energy consumption while maintaining or enhancing battery performance. Changing manufacturing processes can be expensive and time consuming. High performance computer modeling can cut down on the time and cost required, reducing risk for manufacturers.

Collaboration

Sandia National Laboratories Researchers Jeff Horner and Scott Roberts, along with their team including postdoc Scott Monismith, have done extensive work on energy storage systems, including batteries. In addition to the researchers' expertise, Sandia has the high performance computing resources required for a complex modeling problem such as this. Lessons learned on this project will also be transferable to other systems relevant to Sandia's energy security and national security missions.

Researchers at Ford's Battery R&D Group are running experiments and providing measurements for physical properties such as viscosity and vapor pressure of solvents, as well as temperatures and timing of drying processes. These data are used as inputs and validation for Sandia computer models.

> *Sandia's simulation expertise, in-house code and high performance computing capability are essential for helping Ford to develop a deeper understanding and predictive model towards the battery electrode drying process.*
>
> **Wanjiao Liu**
> Technical Expert
> Virtual Manufacturing Research & Advanced Engineering
> Ford Motor Company

Solution

Sandia has developed multiphysics computer codes like Sierra Mechanics which allow researchers to simultaneously simulate fluid mechanics, electrochemistry, chemical species transport, and reaction kinetics. Since Sandia developed the Sierra software, researchers can easily adapt existing code for this project to simulate complex physical processes, like phase changes as the solvent used in battery manufacturing evaporates during the drying process.

As computer models of the process are built with increasing complexity, researchers can test drying under different conditions to see if battery performance changes. For example, if the battery electrodes dry too quickly, the conductive additive might not be evenly distributed, negatively affecting performance.

Impact

The automotive industry is going through a rapid EV transition with the goal of decarbonization, and Ford is investing in domestic battery and EV manufacturing toward that goal. Optimizing the drying process will result in significant energy and CO_2 emissions savings as a step to improving the sustainability and reducing the cost of battery cell manufacturing.

PARTNERSHIP TYPE: Cooperative Research and Development Agreement funded by the Department of Energy's High Performance Computing for Energy Innovation, or HPC4EI, initiative
GOAL: Making EV battery manufacturing more energy efficient by optimizing the electrode drying process

FORD MOTOR COMPANY

Sandia Researchers Scott Roberts and Jeff Horner pose in front of foil to be used in lithium-ion battery electrodes.

Disinfectant 2.0 is Harsh on Germs but Pleasant for People

Challenge

Keeping high-touch surfaces disinfected generally requires frequently repeated applications of disinfectants like bleach, hydrogen peroxide, and other products that have strong odors and can be irritating to skin. When the COVID pandemic hit, the search for better disinfectants took on new urgency. A technology originally developed at Sandia National Laboratories as part of its national security mission was found to provide non-toxic, cost-effective, and long-lasting disinfection. Transferring the technology out of the labs so it could be commercialized was the next step.

Collaboration

After Sandia scientist Hongyou Fan and his team invented the technology, originally called detergent-assisted fabrication of porphyrin nanoparticle photosensitizers, and it won an R&D 100 Award, Bradley Duckworth of Lunano was partnered with Fan through the FedTech Startup Studio program. As part of FedTech, the partners embarked on a customer discovery process and looked at a variety of markets with needs for cleaning, disinfection, and decontamination.

Lunano licensed the technology and ran further tests to confirm the discovery and gather more data. Research with large companies to determine how to best integrate the technology, now called Disinfectant 2.0, into products is ongoing. Lunano has applied for additional patent protection, and is working to scale up production.

> *Our partnership with Sandia has truly been a collaboration. The extensive licensing and technical support that Sandia has provided has set Lunano up for success, and we are grateful for their continual assistance in developing an early-stage technology for commercial use.*
>
> **Bradley Duckworth**
> Chief Executive Officer
> Lunano LLC

Solution

Disinfectant 2.0 is more than 99% effective in preventing the spread of viruses, bacteria, fungus, and protozoa. While disinfectants generally must be reapplied to high-touch surfaces on a regular basis, this new technology has a months-long to years-long life span. Light is the trigger for a chemical reaction that creates substances that kill disease cells while being safe for people. The nanomaterials in Disinfectant 2.0 can be integrated into sprays, compounds, and membranes.

Lunano is pursuing cleaning and disinfecting products first as a way to enter the market. Other commercial applications and the integration of the technology into coatings for manufactured surfaces may follow.

Impact

With a months-long to a years-long effectiveness, Disinfectant 2.0 can make daily cleaning and disinfection a thing of the past. The technology could change the way people clean and disinfect at home, as well as in public spaces like hotels, restaurants, and airplanes.

LDRD

PARTNERSHIP TYPE: License
GOAL: Advancing non-toxic, cost-effective, and long-lasting disinfection technology effective in preventing the spread of viruses, bacteria, fungus, and protozoa toward commercialization

LUNANO

Sandia Researcher Hongyou Fan working with nanocoatings in his lab.

Accelerator Technology Moves Sandia Supercomputing to the Vanguard

Challenge

Integrating new technology with mission-critical applications and code at Sandia National Laboratories and other National Nuclear Security Administration facilities is a challenge. Will the novel technology work well and allow scientists to run their applications without the need to rewrite their code? In order to mitigate risk, the groundbreaking new hardware is first tested at a slightly smaller scale with a prototype system before it is applied to the large, costly, and highly specialized supercomputers used at the Labs.

Collaboration

Sandia has been partnering with NextSilicon for over three years on their hardware and software. The company is delivering 'first of its kind' runtime reconfigurable accelerator technology. NextSilicon's accelerator uses intelligent software algorithms to dynamically reconfigure their hardware to accelerate applications that have been difficult to optimize on traditional architectures.

Penguin Solutions, experts in AI, high performance computing, and accelerated computing is integrating the NextSilicon accelerator technology with components from other companies. The complete computer system will be liquid cooled using a Chilldyne liquid cooling system, improving data center energy efficiency. Penguin Solutions is a part of Intelligent Platform Solutions, a business unit of SGH. Sandia has partnered with Penguin since 2010.

> *We are excited about the opportunity to work in close collaboration with the technical team at Sandia to enable outstanding performance on their most important applications. This unique partnership provides enormous benefits to both Sandia and NextSilicon.*
>
> **Kelly Marquardt**
> VP of Business Development
> NextSilicon Inc.

For their part in the collaboration, Sandia's Vanguard program, led by James H. Laros III, is providing insight into the problems the Labs want to solve with the new computing technology, its specialized applications, and HPC expertise.

Solution

Using prototype computing systems reduces risk. NextSilicon and Penguin will deliver the next Advanced Architecture Prototype System as part of Sandia's Vanguard program. Vanguard evaluates emerging technologies to evaluate their viability to support the NNSA's Advanced Simulation and Computing program and the mission of stockpile stewardship. Testing ensures that Sandia's applications will not only run, but perform well on the new technology. Early examples of this new technology will be delivered and tested in 2024.

Impact

By showing that cutting-edge technology is feasible, it can be applied to future applications at Sandia and other NNSA laboratories. These groundbreaking computing systems can then also be used by researchers worldwide for a variety of purposes. Phil Pokorny, Chief Technology Officer for Intelligent Platform Solutions at SGH said, "We value our continuing relationship with Sandia and the labs and look forward to introducing these new technologies we've partnered on to the HPC community."

PARTNERSHIP TYPE: Joint research funded by NNSA's Advanced Simulation and Computing program
GOAL: Using prototype computing systems to run tests and reduce risk before applying groundbreaking new technology to lab supercomputers

NEXTSILICON & PENGUIN SOLUTIONS

Sandia Researcher Kevin Stroup stands in front of the Vanguard Astra supercomputer.

Better Protection and Control of Microgrids Help Keep the Power On

Challenge

Extreme weather conditions can cause power outages, or electric utilities may decide to temporarily de-energize parts of the power grid to maintain safety. In California, winds, dry conditions, and wildfires are of particular concern.

Microgrids are one way to make the grid more resilient. Even during a broader outage, microgrids maintain electric service to community hubs and critical customers, such as hospitals.

But it's a challenge to protect and control multi-customer microgrids because such microgrids may have many sources with widely varying properties, spread out across the system.

Collaboration

Pacific Gas and Electric Company, a subsidiary of PG&E Corporation, is a combined natural gas and electric utility serving more than 16 million people across 70,000 square miles in Northern and Central California. The company is a pioneer in developing new technology to meet customer needs in the face of extreme weather events.

Sandia National Laboratories has decades of experience with microgrids, including simulation, computer modeling, and control and protection. Its experience extends from military bases to large cities, with the work tied to Sandia's energy security mission.

> *This collaboration between PG&E and Sandia was initiated to utilize their expertise and research in inverter modeling, power system simulations, and controls for microgrids. Having a research partner like Sandia allows the utility to focus on technology development and yields a powerful R&D combination to solve real world engineering challenges.*
>
> **Franz Stadtmueller**
> Expert Electrical Engineer
> ATS Grid Technology Engineering & Evaluation
> Pacific Gas and Electric Company

Solution

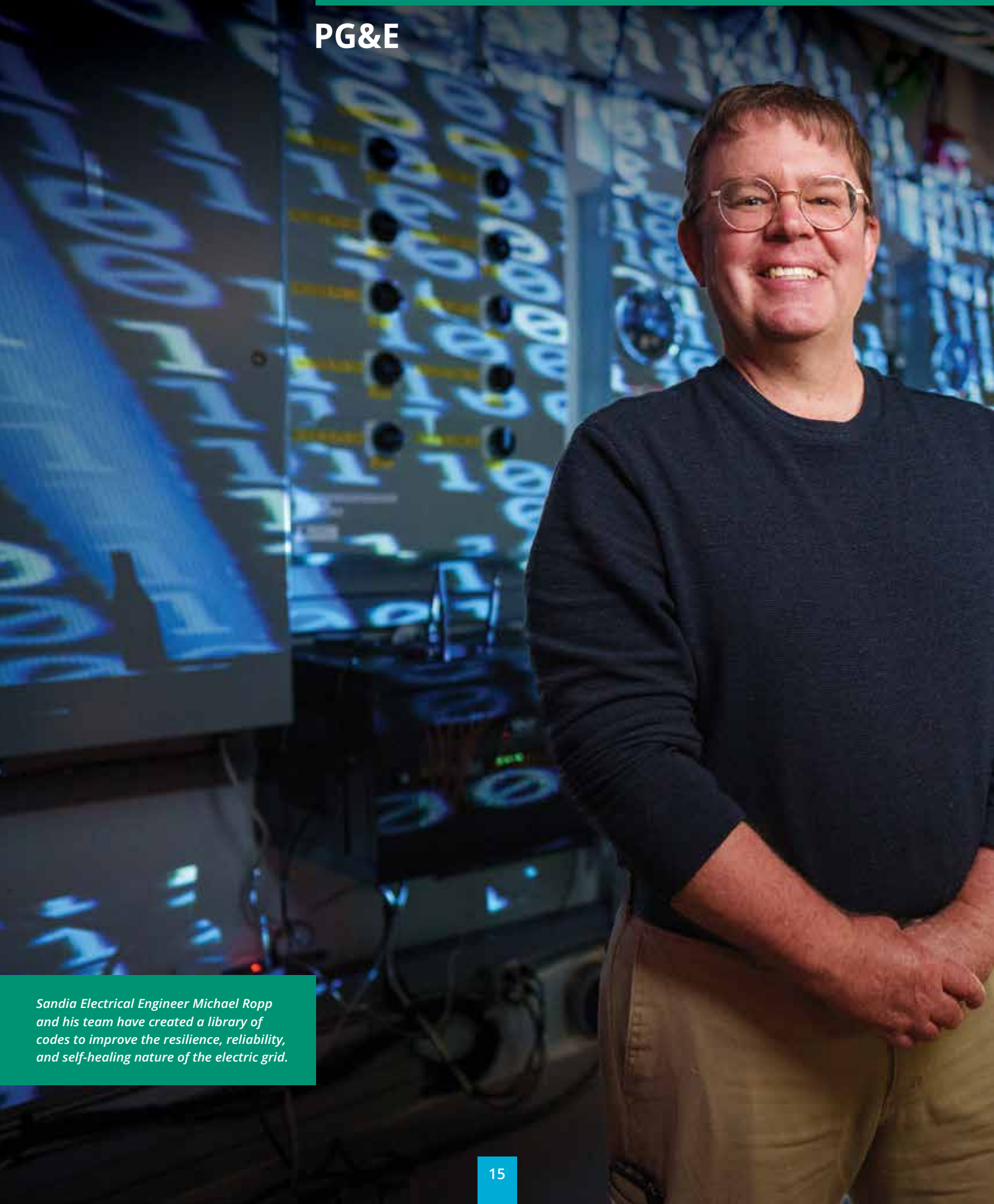
In this project, multi-customer, multi-source microgrids are being studied to better understand their dynamic behaviors, determine how best to use the tools provided by the latest interconnection standards in such systems, ensure that these systems can remain properly controlled and protected, and identify limits and "rules of thumb" that can be broadly applied to this kind of system as they are deployed in more communities.

Impact

With resilient local microgrids, the power can be kept on for more utility customers, even during weather-driven outages. Situations which previously led to long outages might now create only momentary interruptions. Once demonstrated in California, the new knowledge, practices, and tools developed by this Sandia-PG&E partnership can also be applied elsewhere to make the grid more resilient.

PARTNERSHIP TYPE: Cooperative Research and Development Agreement
GOAL: Protecting and controlling microgrids so they can continue to be used as a power source, even during emergency situations or severe weather events when the main system is down

PG&E



Sandia Electrical Engineer Michael Ropp and his team have created a library of codes to improve the resilience, reliability, and self-healing nature of the electric grid.

Trajectory Analysis Software Shapes Development of Flight Vehicles

Challenge

Flight safety analysis for rocket systems is difficult. Trajectory Analysis and Optimization Software, first released in 1996, was created by Sandia National Laboratories scientist David Salguero who saw a need for predicting aircraft and missile trajectories with software that was simple enough so that those without in-depth technical knowledge of calculating trajectories or programming could use it.

Software dealing with safety-critical processes can become outdated, yet developing new code is a slow process with stringent requirements. TAOS continues to be updated by Sandia, which uses it to support its nuclear deterrent mission.

Collaboration

Sandia works with TAOS users from multiple government agencies and contractors to understand their needs and ensure the software continues to be compliant with their requirements. Input from users is also considered in the addition of new features. There are now over 200 licensees of TAOS, with many site-wide licenses accessed by multiple users. In recent years, TAOS has been increasing in popularity, with 100 licenses issued since 2020.

One TAOS licensee is NASA's Wallops Flight Facility, which plays an important role in the understanding of earth and space science. Since its beginnings, Wallops has launched more than 16,000 rockets carrying science experiments, technology, and satellites. NASA Wallops has been using TAOS for sounding rocket analysis in both the Flight Performance and Flight Safety departments for the last several years. They have found that being able to calculate multiple trajectories in one run along with math operations makes TAOS very useful.

> *We selected TAOS over several other codes because of its capabilities and ease of use. We are designing our new wind weighting software to use TAOS and are encouraging its use by the Range Commanders Council community as a common software for wind weighting analysis.*
>
> **Michael Disbrow**
> Flight Safety Engineer
> NASA Wallops Flight Facility

Solution

TAOS is used to model a variety of flight systems from hypersonic reentry vehicles and satellites, to subsonic cruise missiles, unmanned aerial vehicles, and sensor darts. It works well from the conceptual design phase through flight safety analysis. TAOS combines the best capabilities from multiple trajectory solvers into one trajectory analysis and optimization package. Prior codes made it difficult to input data and understand output, where TAOS was designed to be as intuitive as possible. Users also have access to a comprehensive manual which has been lauded as "excellent."

Impact

TAOS is one of the foundational tools used at Sandia for trajectory and flight analysis. It is a part of the development of every flight vehicle at Sandia and is used across the nation by U.S. government agencies and industry partners serving as government contractors.

PARTNERSHIP TYPE: Government Use and Commercial Licenses
GOAL: Improving safety analysis for flight systems by continuing to support and update TAOS software so it can be used for Sandia missions as well as by many licensees

NASA WALLOPS FLIGHT FACILITY

Sandia TAOS Core Developers Nathaniel Grady and Michael Sparapany standing in front of a rocket at the National Museum of Nuclear Science & History's Heritage Park.

Inexpensive Clay Offers New Approach for Capturing Carbon Dioxide

Challenge

Climate security is one of Sandia National Laboratories' missions. Developing a new and inexpensive approach for direct-air capture of carbon dioxide is essential to reduce the amount of CO_2 in the air. But it's technologically challenging. Even though the amount is almost double what it was prior to the Industrial Revolution, there are 2500 nitrogen and oxygen molecules for every one molecule of CO_2 in the atmosphere.

Collaboration

Led by Tuan Ho, a research team including Susan Rempe, Yifeng Wang, Guanping Xu, Nabankur Dasgupta, and Timothy Zwier at Sandia is looking into a new way of capturing atmospheric CO_2 with clay. While Zwier is using microwave spectroscopy, and Wang and Xu are using adsorption experiments, Dasgupta, Ho, and Rempe are using molecular dynamics, a type of computer simulation that looks at interactions of molecules at the nanoscale.

At Purdue University, Professor Cliff Johnston is the curator of the Source Clay Repository, a library of materials available to the global research community. Johnston specializes in the chemistry of clay minerals and has a particular understanding of how molecules interact with surfaces. He and his research team are using vibrational spectroscopy along with other types of measurements to discover if a significant level of CO_2 can be captured by the interlayers of clays.

> *The computational codes and experimental capabilities at Sandia are unique and exceptional to address complex Geoscience challenges. These tools and skills are highly complementary to our capabilities at Purdue.*
>
> **Cliff Johnston**
> Professor
> Earth, Atmospheric and Planetary Sciences and Agronomy
> Purdue University

Solution

Scientists are studying how clay can capture CO_2, in part, because clay is a natural nanomaterial that is abundant and inexpensive. The researchers are looking at specific clays that have interlayers filled with water. Experiments confirm that water confined in clay nanopores absorbs more carbon dioxide than plain water does. Ongoing research is aimed at discovering how to modify the surface chemistry of the clay to capture CO_2 even more effectively, and how to use relative humidity to release the molecules for storage, making the process more energy efficient than other direct-air carbon capture methods.

Impact

A patent has been filed for this clay carbon capture technology so, in the future, it might be licensed to industry and widely used. The joint research with Purdue has also led to four papers being published.

Students are very interested in climate change and want to be part of the solution. Working on this project has given them practical scientific training and experience. Purdue is an alliance partner in Sandia's University Partnerships Network. This initiative promotes collaborative research and helps attract top talent to Sandia as employees to work on problems of national and international significance.

LDRD

PARTNERSHIP TYPE: Sandia University Partnerships Network
GOAL: Reducing the amount of CO_2 in the air by using clay's nanopores as an effective and energy-efficient capture method

PURDUE UNIVERSITY

Sandia Bioengineer Susan Rempe and Chemical Engineer Tuan Ho peer through an artistic representation of the chemical structure of a kind of clay. Their team is studying how clay could be used to capture carbon dioxide.

As a land-grant institution with an expanding national security focused research portfolio, Purdue University complements Sandia's mission-focused work. With Sandia's ongoing presence on campus through our academic partnership, we are cultivating strategic and enduring relationships to make national impact in research areas including hypersonics, cybersecurity, energetics, and microelectronics. Through our combined efforts, we can leverage university networks to secure high-caliber talent for the nation.

Simulations Help Wave Energy Technology Prepare for Ocean Launch

Challenge

Wave energy is one of the many types of renewable energy being harnessed to help create a more diverse energy portfolio. To utilize this energy, wave energy converters capture the waves' motion to generate carbon-free electricity. As part of Sandia National Laboratories' energy security mission, researchers are working to support increased utility scale renewable power, including electricity generated from wave energy.

A major challenge for wave energy is that devices must endure the harsh environment of the ocean. Testing technology in a marine environment adds a high degree of risk and cost: Compared to testing on land, the cost of testing will rise substantially when testing offshore on the surface of the ocean and exponentially if testing underwater due to the expense of specialized equipment.

Collaboration

Sandia and the National Renewable Energy Laboratory use the Wave Energy Converter SIMulator, or WEC-Sim, to provide technical assistance to wave energy technology developers through the Testing Expertise and Access for Marine Energy Research, or TEAMER, program. Sandia and NREL have used WEC-Sim to aid 18 organizations through TEAMER since TEAMER's inception in 2020.

One of the TEAMER award recipients in 2023 was the University of Massachusetts Dartmouth. They received technical assistance for a device they're developing called MADWEC, which stands for maximal asymmetric drag wave energy converter. MADWEC is designed to be low cost, low maintenance, and easily deployable. As part of this project, Sandia, NREL, and UMassD researchers modeled the MADWEC using WEC-Sim.

> *This partnership has had a profound impact. The analyses performed by Sandia and NREL provided us with detailed and helpful insight on the performance of the MADWEC wave energy converter device and its components under various wave conditions, empowering us to make informed design decisions for improved performance with a short turnaround time.*
>
> **Mehdi Raessi**
> Professor
> Mechanical Engineering Department
> University of Massachusetts Dartmouth

Solution

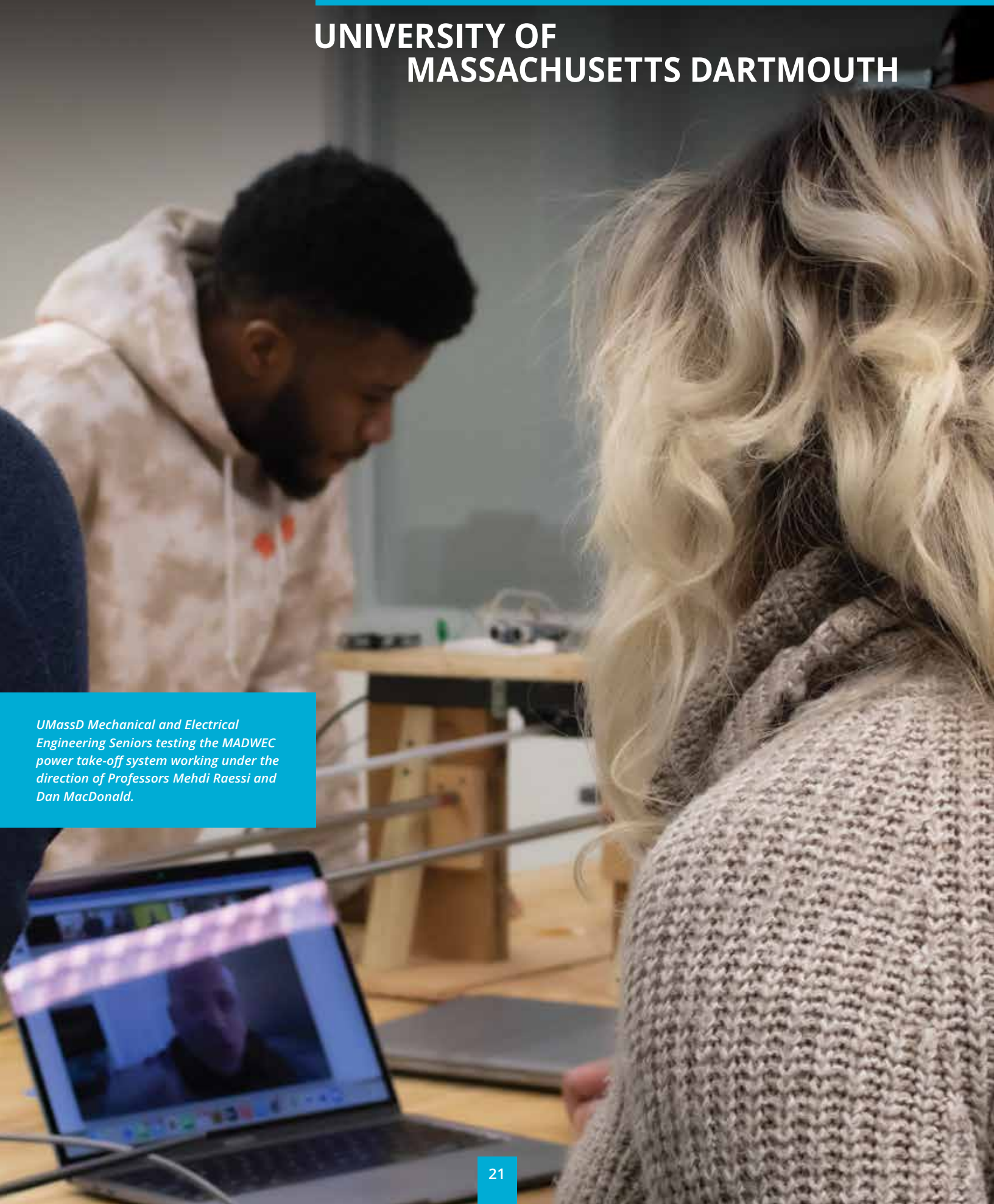
During the TEAMER award, Sandia researchers optimized the geometry of the MADWEC's tethered ballast system and assessed its performance in linear wave conditions to increase its power generation. Furthermore, the WEC-Sim model allows systematic assessment of various power take-off design options to achieve the highest power output and efficiency.

Impact

Assistance by TEAMER using the WEC-Sim software is helping to move wave energy technology further along the path toward commercialization. Wave energy devices like MADWEC could one day power millions of U.S. homes, businesses, remote communities, and even military bases. Sandia is committed to pursuing clean energy innovations in ocean wave energy technologies to advance the mission of reaching net-zero carbon emissions.

PARTNERSHIP TYPE: Collaborative research supported by the Department of Energy's Water Power Technologies Office and a Cooperative Research and Development Agreement
GOAL: Furthering research on a wave energy converter to test its durability and increase its power generation capabilities so it can move toward commercialization

UNIVERSITY OF MASSACHUSETTS DARTMOUTH



UMassD Mechanical and Electrical Engineering Seniors testing the MADWEC power take-off system working under the direction of Professors Mehdi Raessi and Dan MacDonald.

Emergency Operations Center Protects Sandians and Community

EMERGENCY OPERATIONS CENTER

A recently constructed Emergency Operations Center at Sandia National Laboratories with advanced capabilities is providing a larger, more flexible, and robust environment for Sandia's Emergency Management organization. Previously, the organization was spread across two older buildings with insufficient space.

The new, nearly 26,000-square-foot facility can house five times as many people as the former space, helping Sandia adhere to National Incident Management System standards. The Emergency Operations Center has redundant power and communications technology, ensuring it can operate independently for at least 72 hours. It is one of the few facilities in the region with this level of resiliency. A kitchen, dining area, temporary sleeping areas, and showers accommodate personnel who may be onsite continuously during an emergency.

Sandia Environment, Safety & Health Director David Stuhan, Sandia Chief Operations Officer and Deputy Labs Director David Gibson, Sandia Director James Peery, Under Secretary for Nuclear Security and Administrator of the National Nuclear Safety Administration Jill Hruby, U.S. Representative New Mexico 1st Congressional District Melanie Stansbury, NNSA Sandia Field Office Manager Daryl Hauck and NNSA Infrastructure Modernization Division Acting Director Amanda Tapia-Pittman at the ribbon-cutting August 7.

With 105 dedicated computing systems and large video walls, real-time drone footage or other pertinent data feeds can be displayed throughout the facility so everyone involved can communicate effectively with a common operating picture during an emergency event.

Sandia Emergency Operations coordinates with partners including local, tribal, state, and federal emergency services, as well as utility company stakeholders. The annual Offsite Interface Briefing, held at Sandia, builds and maintains partnerships with agencies that may be called in to support an incident at Sandia or provide protective actions to the public.

The new Center, located outside of the Sandia technical area, provides easier access for external partners.

Formal and informal agreements between Sandia and outside organizations are crucial so that the partners can support each others' emergency management planning and operations. With the new Emergency Operations Center, Sandia reinforces its commitment to maintaining a robust emergency response system that safeguards its workforce, the community, and the critical national security mission-related work carried out at the Labs.

Partnerships Brought Together Elements Needed for New Data Center

ENTERPRISE DATA CENTER

Sandia National Laboratories' Data Center Consolidation program had the goal of moving all dispersed computing resources to a centralized location as a way to reduce waste and save energy. At Sandia California, a data center built in the 1970s was showing its age and limitations. The legacy data center did not have the infrastructure required for current IT needs or future growth. After an extensive evaluation, it was decided to replace the 40-year-old data center with a new building.

The modern Enterprise Data Center was created to handle the latest equipment and technologies needed to support Sandia missions. It took the collaborative efforts of Sandians, as well as partnerships with outside companies to conceptualize, design, and build the 6,000-square-foot facility, which is home to Enterprise Computing, High Performance Computing, Mission Services, Disaster Recovery, and more.

Top: Sandia California's new Enterprise Data Center, commissioned in FY2021.

Left: Point 1 technician installing innerducts into Sandia California's underground system of conduits.

Bottom: Point 1 technician pulling in fiberoptic cable connecting campus buildings to the Data Center.

Point 1 Electrical Systems was one of the companies that worked on the data center and was crucial for its success. The company was responsible for Outside Plant Fiber, which is how the facility is networked to all the other buildings on the campus.

The OSPF is run through a system of underground conduits, accessed through manholes, where, fiber is routed from the data center to the destination building. At each end the fiber is spliced into cassettes, completing the path and enabling users to reach Sandia internal resources, both in California and New Mexico, as well as connect to the internet. Point 1 designed the system, planned the routes and quantities, and did all of the installation. The company also installed the Inside Plant Fiber, known as structured cabling. All told, 455 miles of optical fiber and 1752 optical fiber ports were used.

Delivering High Performance Computing to Everyone, Anywhere

Supercomputers are essential for Sandia National Laboratories researchers solving important mission-related challenges. Although high performance computing is critical, the number of projects queued for the specialized machines continues to grow. After 30 years of supercomputing experience, Sandian Victor Kuhns was determined to come up with a way to meet increasing HPC demand.

Kuhns designed software to deliver HPC with regular computers, essentially creating a personal supercomputer. He and two additional staff members, Blake Kinnan and Connor Brown, left Sandia in early 2022 to spin-out Hoonify Technologies, a company formed to make supercomputing accessible for everyone.

Two other Hoonify co-founders, Andrew Clark and John Zivnuska, later left Sandia using the Entrepreneurial Separation to Transfer Technology program.

ESTT supports Sandia's technology transfer mission and allows employees to leave the Labs to start up or expand technology companies, with guaranteed reinstatement for up to two years. Clark, with cybersecurity and leadership experience, and Zivnuska, with a finance and business operations background, brought needed skills to the new company, helping to accelerate product development.

ENTREPRENEURIAL SEPARATION TO TRANSFER TECHNOLOGY

Top: Hoonify Chief Operating Officer John Zivnuska, Vice President of Product Blake Kinnan, Vice President Software Development Connor Brown, Chief Technology Officer Victor Kuhns, and Chief Executive Officer Andrew Clark.

Left: Hoonify's Cub gives researchers secure access to HPC in the office, in the lab, or even in the field.

With Hoonify, HPC can be delivered to everyone, anywhere. Hoonify's solution complements the work performed on large supercomputers and can be scaled to the size of the problem, delivered in-office, in-field, or via data centers for private hosted HPC solutions. Their software, TurbOS™, is now being used by national laboratory scientists, defense contractors, and academia.

In 2023, Hoonify was selected for the Q Station startup accelerator, took "Crowd Favorite" at the Roadrunner Venture Studios program, and was selected for the 2024 NewSpace Ignitor startup accelerator. The company also secured significant angel investment for their pre-seed round.

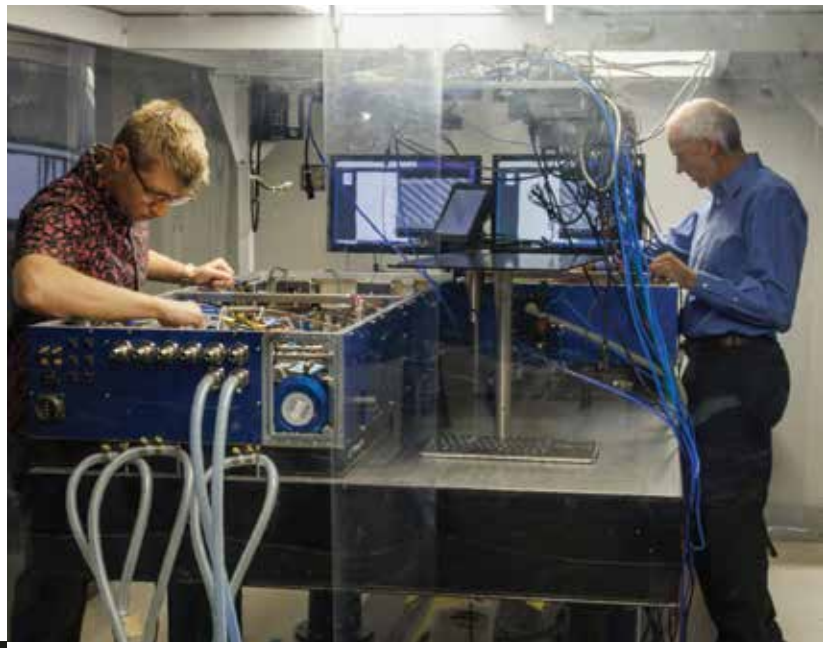
The need for HPC is expanding for scientists, engineers, and analysts across industries, and Hoonify meets this today with on-demand and affordable solutions.

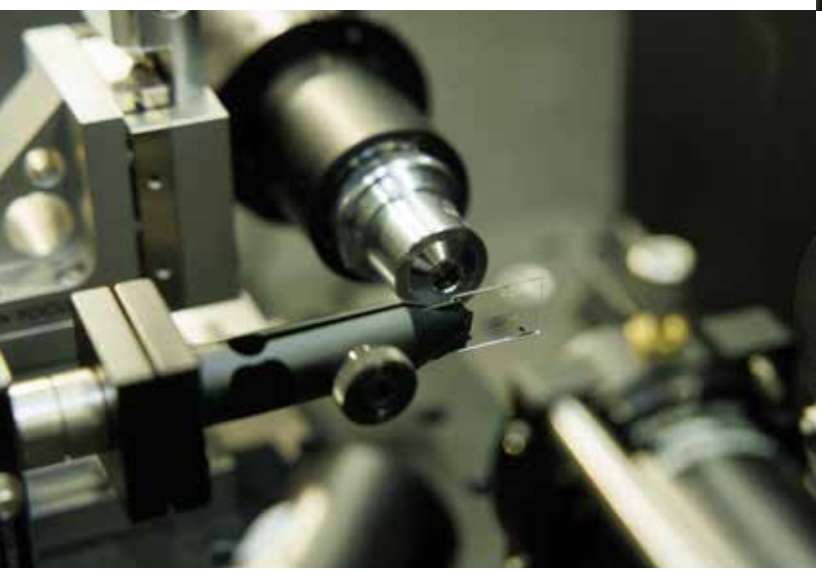
Nanotech-Optic Eliminates Distortion from High-Powered Lasers

NEW MEXICO SMALL BUSINESS ASSISTANCE

Located in Albuquerque since 1988, Voss Scientific provides a wide variety of scientific and R&D services and products, including turnkey data acquisition systems for transient event capture, computational plasma physics modeling, and directed energy sources including high-powered lasers. Beam distortions due to thermal effects pose a major challenge for the development of next-generation lasers. To address this, Voss developed a nanotech-optic that elegantly eliminates these distortions.

Lacking the expertise in nanoscience and equipment necessary to fabricate the optic, the support of Sandia National Laboratories through the New Mexico Small Business Assistance Program was sought. Sandia researchers at the Center for Integrated Nanotechnologies worked to develop the process for creating the necessary nanostructures that produce the desired optical effect and can handle the high-power laser light without being destroyed.





Top: Voss Scientific Scientists Trevor Rubin and Alex Lovesee perform a routine inspection of a novel, high-powered, nanosecond-class laser system developed by Voss Scientific.

Left: A metamaterial sample, produced though the NMSBA partnership with Sandia, is evaluated for its ability to survive high-energy laser beams.

Results from the NMSBA project enabled Voss Scientific to obtain a $1.15 million Phase II Department of Energy Small Business Innovation Research grant. Development of the optic is ongoing. If successful, the technology will significantly improve the performance of high-powered lasers while substantially reducing their costs. Voss Scientific expects to increase commercial sales by augmenting its product line with nanotech-optic enabled lasers. The company and their manufacturing partners in New Mexico, InSync Inc., CNC Machining, and Sandia Electro-Optics Corporation, expect substantial additions in annual revenue.

The work has been mutually beneficial to Voss Scientific, Sandia, and the DOE in that it supports the national labs' broader goals in laser development and energy research. The nanotech-optic can be scaled in size to support lasers capable of fusing hydrogen atoms together for controlled thermal nuclear fusion for clean electricity production; a goal which the DOE has pursued since the 1950s. For practical energy production, technology like the optic developed by Voss Scientific with the support of the NMSBA is essential.

To learn more about NMSBA, visit www.NMSBAprogram.org

Quantum Computing Programs Expand to Reach Larger National Audience

QUANTUM SYSTEMS ACCELERATOR

The Quantum Systems Accelerator, co-led by Sandia National Laboratories and Lawrence Berkeley National Laboratory, aims to promote national leadership in quantum information science. After just a few years, the QSA ecosystem is playing a key role in advancing quantum infrastructure and workforce development in New Mexico and across the country. Programs previously launched by QSA are bearing fruit, expanding from local pilots to programs reaching regional and national audiences.

Partnering with other labs, academic research institutions, and commercial organizations throughout the region, QSA is a part of the Elevate Quantum consortium that was named a Designated Tech Hub by the U.S. Economic Development Administration. A Tech Hub designation is a strong endorsement of a region's plan to supercharge a critical technology ecosystem and become a global leader over the next decade.

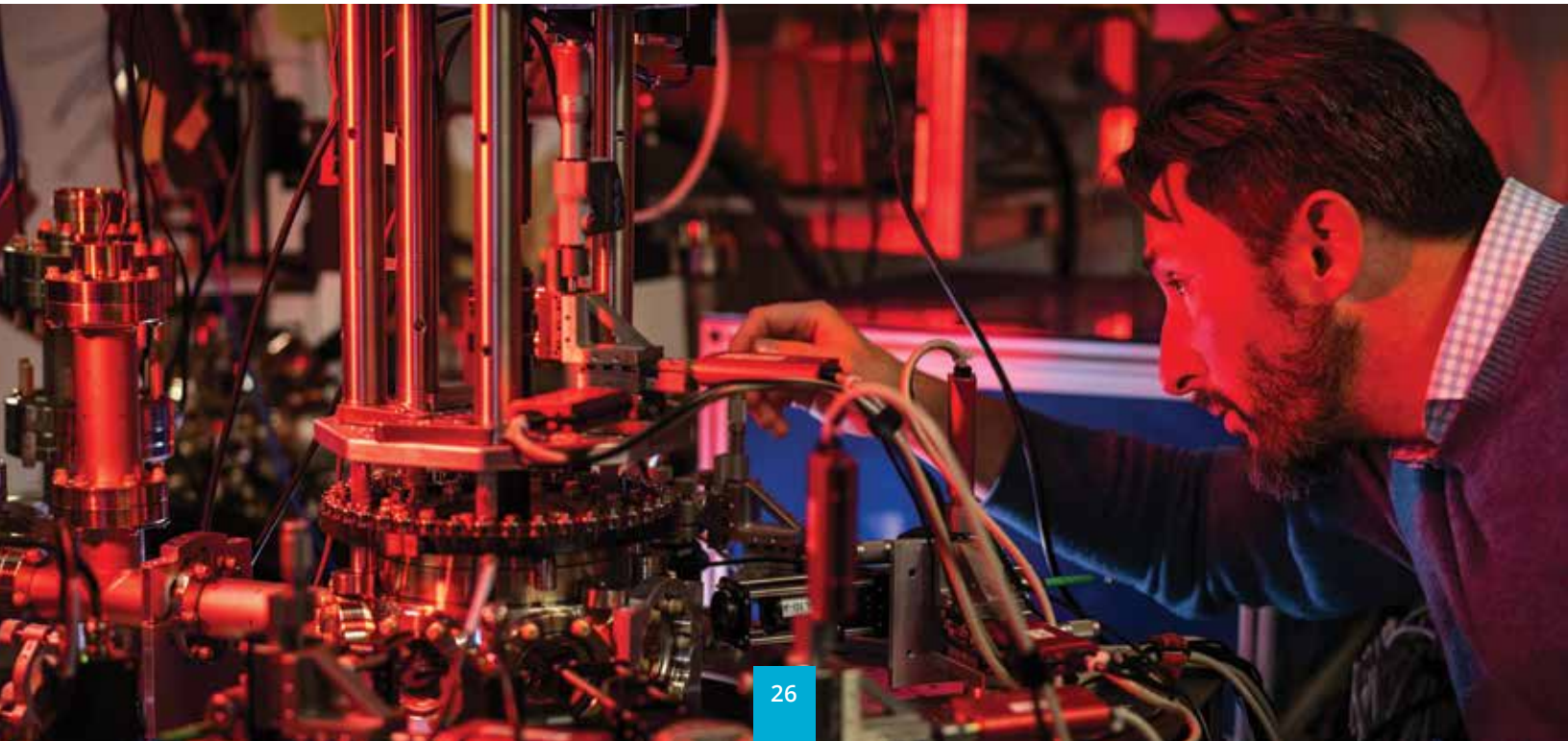
From nearly 200 consortia that applied, EDA designated 31 Tech Hubs, with only two focusing on quantum technology. All the Tech Hubs are designed to support global competitiveness and the program is funded as part of the CHIPS and Science Act of 2022.

To learn more about QSA, visit www.quantumsystemsaccelerator.org/

Elevate Quantum can leverage efforts that QSA began locally, such as QCaMP, an educational program to introduce high school teachers and students in underserved communities in New Mexico and California to Quantum Information Science, and expand it to a larger audience across the U.S.

The Quantum Learning Lab, begun as a pilot at CNM in Albuquerque in partnership with the Air Force Research Laboratory, Los Alamos National Laboratory, and industry partners, is helping to address the nation's critical need for a quantum workforce by providing hands-on learning opportunities to students, educators, and professionals in New Mexico. This is another QSA program that can reach a larger, more diverse audience as it is expanded through Elevate Quantum.

Sandia Researcher Jon Sterk working in the ion-trapping lab at Sandia where research is conducted to advance quantum systems needed for QSA.



SS&TP Celebrates 25 Years of Collaboration and Economic Growth

SANDIA SCIENCE & TECHNOLOGY PARK

The Sandia Science & Technology Park celebrated 25 years of economic growth on September 12, hosting a celebration attended by over 400 people. The event at the National Museum of Nuclear Science and History featured 30 exhibitors including Park companies and organizations, partners, and Sandia National Laboratories organizations.

Attendees learned about the incredible range of products and services available and the history of the SS&TP. Forming and growing the Park was made possible by collaborations between public and private partners. Those partnerships were recounted and applauded at the anniversary event. People networked, and met their neighbors from the Park and community.

Aerial view of the Sandia Science & Technology Park.

Attendees listen to speakers at the SS&TP anniversary event.

Opening remarks by Sandia Senior Manager of Technology Partnerships & Business Development Mary Monson, National Nuclear Security Administration Sandia Field Office Assistant Manager for Programs Dan Sanchez, Sandia Science & Technology Park Development Corporation Chairman of the Board Sherman McCorkle, and Nuclear Museum President and CEO Jennifer Hayden were informative.

Some of the facts shared were about the tremendous impact the SS&TP has had on the economy. Speakers reported that 40 companies and organizations employ over 2000 people at the SS&TP. Total investment, both public and private, is $485.6 million. Companies within the Park have paid $7.7 billion in wages and salaries since 1998.

The SS&TP is associated with Sandia and adjacent to Kirtland Air Force Base. The Park serves as a partnership tool by providing direct access to industry to further the Labs' technology transfer mission. Park companies can license technology and take part in Cooperative Research and Development Agreements with the Labs. The Park's location also makes it convenient for residents to serve as valued suppliers to Sandia and KAFB.

From vacant land covered in tumbleweeds to a thriving business and technology hub, the SS&TP is looking forward to continued success and economic impact.

To learn more about the SS&TP, visit www.sstp.org

Nuclear Energy Technology Moves toward Market with Help from TRGR

TRGR TECHNOLOGY READINESS INITIATIVE

Kairos Power is a nuclear energy engineering, design, and manufacturing company commercializing a fluoride salt-cooled high-temperature reactor (KP-FHR) with a mission to enable the world's transition to clean energy. The company's testing and manufacturing facility in Albuquerque will support the design, construction, and operation of the Hermes demonstration reactor in Oak Ridge, Tennessee, planned to be online by 2026.

Kairos Power is developing a Burn-up Measurement Sensor to analyze graphite fuel pebbles during operation, identifying how much fuel has been used and whether a pebble could be reused. Unlike a conventional reactor, KP-FHR allows fuel to be added and removed without shutting down, so burn-up measurements must be done quickly.

Bottom left: Engineering Manager Gareth Whatcott holds a surrogate fuel pebble similar to those that will be analyzed by the Burn-up Measurement Sensor to enable online refueling.

Top right: Radiation Detection Engineer III Ahmed Moustafa pictured in Kairos Power's RAPID Lab, where engineers perform rapid prototyping and iterative testing to advance KP-FHR systems.

The company was able to access Sandia National Laboratories' specialized equipment, including a high-speed digitizer and gamma-ray detector, and the expertise of Sandia Researcher Sudeep Mitra in gamma spectroscopy to support development of the BUMS. The research helped Kairos gain insights into what sensor types will work and which reaction byproducts to measure as markers for fuel consumption. Instead of fuel pebbles, a detector emulator was programmed with the expected radioactive spectrum.

This assistance was available to Kairos through the TRGR Technology Readiness Initiative, a program focused on technology maturation for New Mexico companies that have licensed technology from the New Mexico national laboratories, or are engaged in a Cooperative Research and Development Agreement with one of the labs. TRGR supports Sandia's technology transfer mission.

Kairos Power has made an initial commitment to invest up to $125 million in New Mexico to support its vertical integration strategy. To date, the company has made nearly $50 million in capital investments and hired more than 90 full-time employees in Albuquerque with an average salary exceeding $100,000.

To learn more about TRGR, visit www.NMTRGR.org

3D Printing Technology Sees Entry Point in Aerospace Market

ENERGY I-CORPS

All six Energy I-Corps proposals that Sandia National Laboratories submitted for Cohort 16 were awarded this year. In the Department of Energy's program, which aligns with Sandia's technology transfer mission, researchers and industry mentors define technology value propositions, conduct customer discovery interviews, and identify market pathways.

Electro3D is one of the Sandia teams that is using knowledge gained from Energy I-Corps to advance their technology. Their electrochemical 3D printing system leverages existing techniques but is a game changer since it does not require the part being printed to be submerged in an electrolyte bath. This means the method is compatible with more materials and is easier to scale. Also, unlike powder or wire-fed 3D printers, Electro3D uses a liquid feedstock, and the constantly flowing electrolyte creates a more consistent material.

Team Electro3D Principal Investigator Karl Walczak (left) and Entrepreneurial Lead Mikey Garrett (right) celebrating their graduation from Energy I-Corps with DOE Chief Commercialization Officer and OTT Director Vanessa Chan.

As team members Karl Walczak, Mikey Garrett, and Garrett Williams started talking to potential customers in the 3D printing industry and prototype labs about the possibility of selling them printers, they realized that this would not be the ideal first market to enter. Further customer discovery calls led them to a more suitable entry point. In the aerospace industry, Electro3D's ability to do rapid prototyping of metal parts such as lightweight and durable solar cell gridlines, nonstandard printed electronics, and circuit boards will give the technology an edge. Once their technology readiness level is higher, they can move on to other markets.

Since completing the program, Principal Investigator Walczak has won an R&D 100 Award for Electro3D technology and presented to venture capitalists.

The team is also in discussions with a startup space solar cell company interested in licensing. Funding from Sandia's Division 8000 Royalty program and the Department of Energy's Office of Technology Transitions Energy I-Corps will help with prototype development and the transition to commercialization.

To learn more about Energy I-Corps, visit https://energyicorps.energy.gov/

Other Sandia teams that took part in Cohort 16:

- CUBES
- Diamond Semiconductors
- Fire Map
- Ridged Electrodes
- Track Analytics

Sandia Teams Move Technologies toward Commercialization

FEDTECH

The Department of Energy's Emerging Tech Studio is a FedTech program where participants learn how to launch a technology-focused venture by leveraging intellectual property from DOE's national laboratories. During the 2023 program, entrepreneurs formed teams focused on two Sandia National Laboratories technologies.

FAID

Fentanyl Analog Independent Detection technology was developed by Sandia Researcher Joshua Whiting. Fentanyl, and its analogs, or chemically similar synthetic opioids, are extremely powerful drugs up to 50 times stronger than heroin, so even a few grains can be lethal. That's why exposure to fentanyl is a concern for first responders—detecting its presence helps them to take appropriate protective measures. Detection can also aid in interdiction of illicit drugs being shipped, and determine if fentanyl has been added to other drugs.

FAID was designed to provide accurate and rapid detection of fentanyl. It heats up the substance being sampled to 1,000 degrees in less than a second. The molecules are then broken apart and can be identified using Sandia-developed analytical chemistry techniques.

Sandia's fentanyl detection capability has gained interest, including funding from the Department of Homeland Security under the Commercialization Accelerator Program and a new Small Business Innovation Research call, DHS241-001: Agnostic Detection of Synthetic Opioids and Other Illicit Drugs. Sandia has been approached by several companies, including startup TraceDTX, and plans to support efforts in further development and deployment.

Right: Members of the Sandia Fentanyl Analog Independent Detector team, from top, left to right, Bryan Weaver, Nathan Wolff, Jason Sammon, Joshua Whiting, Phil Miller, Alex Hare, holding the prototype FAID system, and Ashur Rael.

EPDR

Sandia's Electronic Polymer Dosimeter for Radiotherapy technology was invented by Sandia Researchers Isaac Avina and Patrick Doty. They created a patch that can better prevent damage of healthy tissue in proton radiation cancer treatment. The main component of this patch is a neutron/proton sensor that Sandia patented. WearableDose has successfully incorporated and completed negotiations with Sandia for an exclusive license for the technology.

LDRD

To learn more about FedTech, visit www.fedtech.io

New Module Helps Potential Partners Find DOE Funding Opportunities

LAB PARTNERING SERVICE

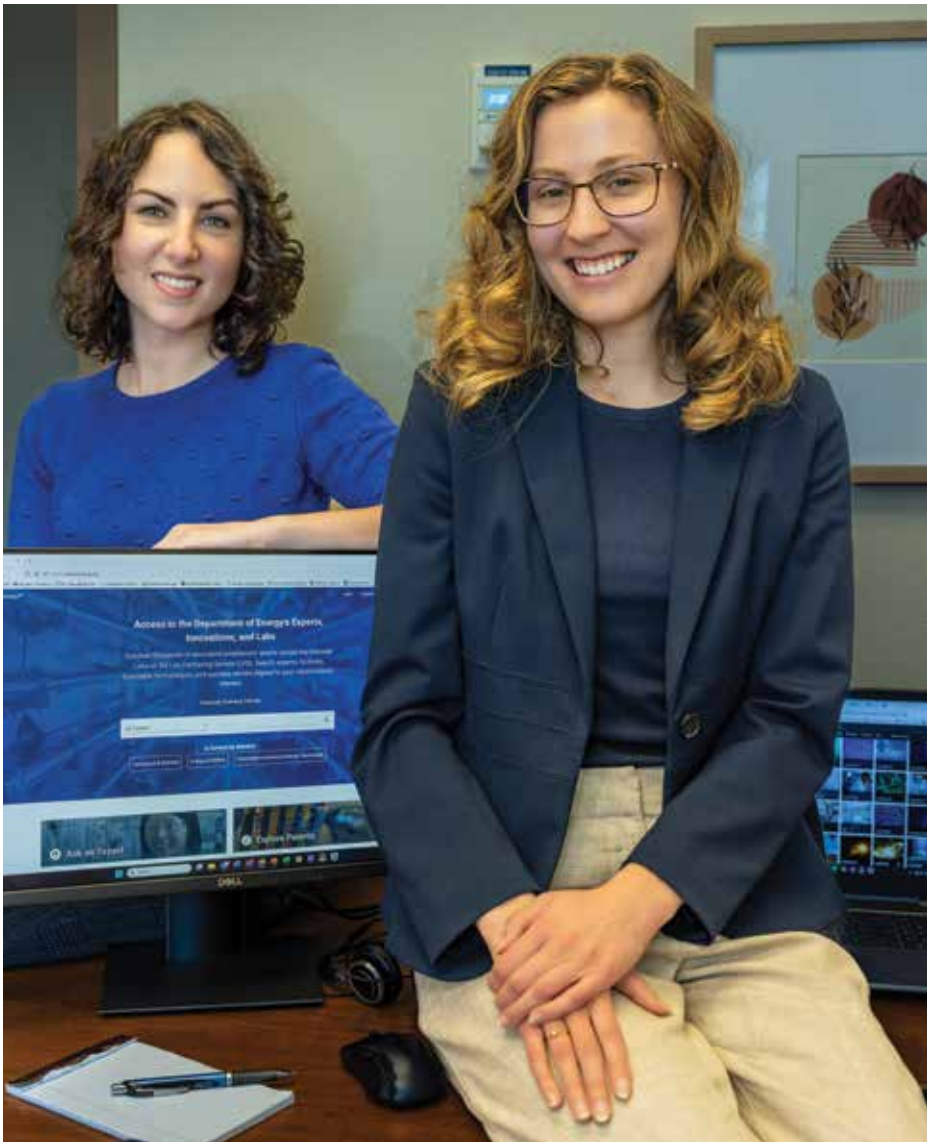
The Department of Energy's Lab Partnering Service is a suite of online services providing access to people, projects, and patents from across the DOE national laboratories, including Sandia National Laboratories. LPS provides investors, industry partners, and other parties looking to advance energy innovation a single online platform where they can connect with leading technical experts to quickly answer innovation questions, as well as discover opportunities for building partnerships.

Sandia continues to partner on LPS site development efforts. In 2023, Sandia, the National Renewable Energy Laboratory, and the DOE Office of Technology Transitions identified a need to add another feature to LPS—a funding opportunity announcement aggregator.

This new module brings a variety of DOE funding opportunities together in one place, allowing potential lab partners to browse opportunities from various offices and programs. A new Propose a Partnership form makes it easier to connect with a lab and propose a joint project attached to a particular funding opportunity. With a known source of funding, proposed research partnerships can be more focused and have a better chance of being launched.

From each funding opportunity listed, LPS users can explore lab experts and facilities related to the technology area. They can then fill in a simple form where they describe their idea for a proposal and what capabilities they are seeking from a DOE lab.

DOE OTT hopes that by aggregating funding opportunities on one site, along with the rest of the free LPS services, they will encourage new partners—whether individuals, companies, or members of academia—to start collaborating with the national laboratories. These partnerships help fulfill the DOE's and Sandia's technology transfer mission, moving lab technology to the marketplace.



Sandians Lauren Amagai and Jessica Knight worked on a new funding opportunities module for the LPS website.

To learn more about LPS, visit www.labpartnering.org

Two New Programs Promote Clean Energy Commercialization

TECHNOLOGY COMMERCIALIZATION FUND

Two Department of Energy Technology Commercialization Fund programs were launched last year by Sandia National Laboratories with a focus on commercializing clean energy technologies. The TCF projects tie to Sandia's energy security and technology transfer missions.

Boost

Almost any industry or area of life can be impacted by the need for new energy resources. Boost focuses on local energy challenges, particularly in communities that are underserved and underrepresented in technology transfer. In 2023, Sandia hosted workshops across rural New Mexico and Alaska to listen to community members describe their local challenges. Sandia and FedTech searched for DOE national laboratory intellectual property that could help solve these problems.

The first cohort of Boost entrepreneurs received resources and business training, and conducted customer discovery interviews during a Startup Studio. They then made pitches about their technologies to judges at the first Boost Showcase. In 2024, Boost will extend its outreach to 10 additional communities and start a new cycle of venture creation.

C4

The C4 (Co-locate, Collaborate, Community, & Communicate) Partnering Model creates a strong regional clean energy commercialization ecosystem for manufacturing focused on collaboration and rapid technology development using a novel industry-informed partnering approach for research, development, demonstration, and deployment. Its goal is to help U.S. industry commercialize lab-developed technologies.

In 2023 C4 started work on its first Challenge Problem, partnering with Sunnoo, a New Mexico company, and student teams from New Mexico State University, University of New Mexico, and New Mexico Tech. The teams investigated enhancements to Sunnoo's solar-powered EV charging system focusing on efficiency. This, and additional planned Challenge Problems with other industry partners, give students real world experience on an engineering project and help the labs move technology to market.

The first cohort of Boost entrepreneurs with Sandia and FedTech team members at the Boost Showcase.

To learn more about TCF, visit: https://www.energy.gov/technologytransitions/technology-commercialization-fund

To learn more about Boost, visit: https://www.boostplatform.org

To learn more about C4, visit: https://www.sandia.gov/c4/

Innovation and Intellectual Property Celebrations

Sandia National Laboratories Integrated Partnerships Organizations hosted Innovation and Intellectual Property Celebrations in both New Mexico and California. The annual events recognize staff whose work furthers Sandia's technical innovation and engineering excellence.

Along with granted patent inventors and commercial copyright authors, the events recognize Mission & Classified Innovators for their contributions to the Labs' national security mission. Director-nominated Up & Coming Innovators are also recognized for their impactful solutions to complex challenges in addition to entrepreneurial talent.

In New Mexico, awards were presented to 124 patent inventors, 49 copyright authors, 15 Mission Innovators, and 12 Up & Coming Innovators. In California, 22 patent inventors, 1 copyright author, and 10 Classified Innovation Recognition Award recipients were honored.

Charles Rath was recognized for making significant contributions to a new and successful business enterprise.

Former Sandian Charles Rath, President and CEO of RS21, was inducted into Sandia's Entrepreneurial Hall of Fame. He co-founded the company based on skills and knowledge acquired during his time at Sandia. RS21 creates technology-driven solutions for cities, countries, agencies, and businesses challenged by the physical, social, and economic forces that will drive our world in the 21st century.

NMSBA Innovation Celebration

The New Mexico Small Business Assistance Program held a celebration at the Lobo Rainforest building in Albuquerque. New Mexico small businesses and laboratory principal investigators that achieved outstanding innovations through NMSBA were recognized. Three Sandia projects were showcased.

Results from the High Laser Induced Damage Threshold Metasurface Phase Retarder Leveraged Project enabled the lead company, Voss Scientific, to obtain a $1.15 million Phase II Department of Energy Small Business Innovation Research grant. After completing its project, Integrated Deposition Solutions was awarded a $100,000 grant from the state of New Mexico and an additional $50,000 from NASA. The lead company on The Emergency Response Leveraged Project, Gold Standard Radiation Detection, is in late state testing of its products with $29,000 in presales and is negotiating a licensing agreement with a manufacturer.

Los Alamos National Laboratory's Predicting siRNA Leveraged Project received the Honorable Speaker Ben Luján Award for Small Business Excellence for demonstrating the greatest economic impact. With the technical insight it gained, Mercury Bio, the lead company, raised $2 million in an initial investment round, hired a new CEO, scientists, and technicians, acquired more lab space, and is in the process of raising another $20 million for development of its drug delivery platform and process.

Mecury Bio Chief Operating Officer Paul Laur and Los Alamos Principal Investigator Garrett Kenyan accepting the Ben Luján Award at the NMSBA Innovation Celebration.

R&D 100 Awards

The R&D 100 Awards celebrate the year's 100 most innovative technologies. Sandia National Laboratories competes with universities, corporations, and other government laboratories for these prestigious awards.

Individual Awards

Electro3D

An additive process that leverages fluidics with electrochemistry to produce high-quality materials and parts rapidly, Electro3D allows for new possibilities in the world of electrochemical metal 3D printing. Not only does it allow users to print materials into less extreme environments, but it eliminates cost and transport limitations. The process also can be used to analyze and even build materials through an electrodeposition printhead that reduces mass transport losses. The printhead attached to commercial robots or 3D printing stages has the potential to be a more energy-efficient and economical pathway to generate materials and parts.

Materials Learning Algorithms

Electronic structure is fundamental for understanding virtually all molecular and material properties. The MALA software framework uses machine learning to predict the electronic structure of materials faster and at greater scales than what was previously feasible. Density functional theory, for which the Nobel Prize was awarded in 1998, is the most heavily used approach for electronic structure calculations. However, the method is complex, expensive, and limited to small scales because the computation cost increases cubically with the system size. MALA delivers the accuracy of density functional theory at a fraction of the cost.

META Optics Studio

If designed correctly, a metalens can perform the function of a highly focusing, high-speed traditional

lens while being a fraction of its weight and absolutely flat. This has revolutionized the field of optical imaging and extended its possibilities by severely reducing size, weight, and power requirements while extending the imaging resolution to well below the subwavelength limit. META Optics Studio, built for the design, simulation, and optimization of flat meta-surfaces, is the only known software capable of simulating a centimeter-sized meta-surface at nanometer resolution within a few hours.

Pre-Symptomatic Volatile Organic Compounds Detector of Seizure Events

This invention improves the lives of people with epilepsy. The wearable detector identifies skin-emitted gasses that indicate an episode is imminent. The detector's pre-symptomatic warning enables the wearer to seek shelter and to communicate with family and health care providers before the seizure occurs. This dramatically lessens the stress of those formerly at the mercy of these unpredictable events. The instrument includes several components made in Sandia's silicon microfabrication facility.

Special Recognition Award

Market Disruptor – Services – Silver Award

Materials Data-Driven Design

This project enables manufacturers to account for the internal structure of materials when shaping and forming a part for the first time by leveraging a proprietary deep learning model. Materials Data-Driven Design, or MAD^3 is innovative

software that leverages the power of machine learning to modernize the forming and stamping processes of sheet metals. It predicts the parameters that characterize the directional mechanical behavior of a metal alloy 1,000 times faster than existing solutions. As a result, the software significantly reduces expensive and time-consuming forming and stamping trials.

Joint Award

Sandia researchers won this award as a partner with Los Alamos National Laboratory, National Renewable Energy Laboratory, and the National Rural Electric Cooperative Association.

PowerModelsONM: Optimizing Operations of Networked Microgrids for Resilience

PowerModelsONM software optimizes networked microgrids for power restoration during blackouts and other extreme events. It is the only physics-based optimization software package featuring networked microgrids for modeling restoration of electric power distribution feeders. Utilities can use PowerModelsONM to plan for networked microgrids to support rapid recovery during extreme-event-induced grid outages.

FLC Awards

The Federal Laboratory Consortium Awards Program annually recognizes federal laboratories and their industry partners for outstanding technology transfer efforts.

National and Mid-Continent Best in Region Awards for Interagency Partnership

Hypersonic Glide Body Transition to Production for Army and Navy

A collaboration to enable external partners to work side-by-side with Sandia experts to transfer the glide body to industry at the request of DOD sponsors required the rapid development of innovative new Sandia policies to facilitate technology transfer.

Far West Best in Region Award for Excellence in Technology Transfer

QUASR: Increasing Accessibility to Rapid Testing

A new company is working with Sandia and the TRGR Technology Readiness Initiative to advance QUASR technology licensed from the Labs so it can move to market. The technology is being used for rapid and accurate point-of-care diagnostics tests for pathogens.

DOE TTWG Awards

The Technology Transfer Working Group awards celebrate the exceptional work done by the 17 Department of Energy national laboratories to support American competitiveness and security through a streamlined commercialization process.

Early Career Professional Award

Jess Jungwirth was recognized for her efforts on the Intellectual Property/Licensing team, including maturing Sandia's IP marketing strategies and platforms and spearheading new initiatives to promote Sandia's innovative accomplishments and related programs.

Economic Development Award

Judy Hendricks, John Martinez, and Robert Westervelt (along with John Rogers and Julia Wise from Los Alamos National Laboratory) were recognized for developing the TRGR Technology Readiness Initiative.

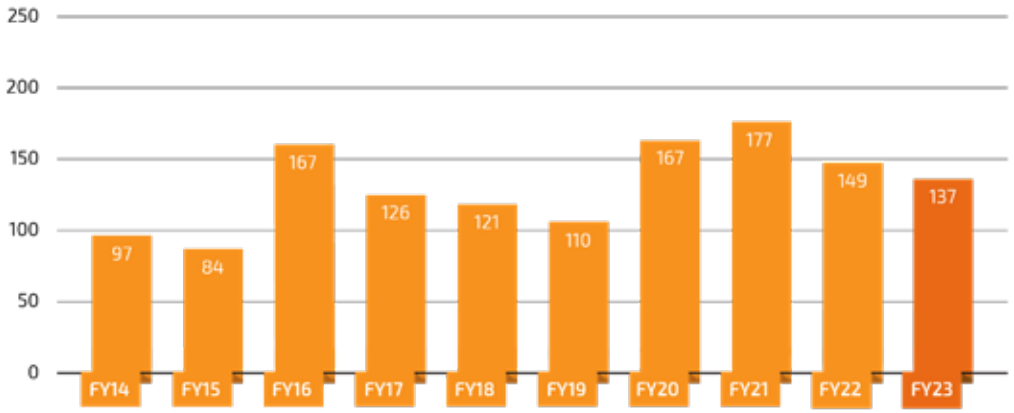
NMTC Women in Technology Awards

Women in Tech Honoree

Susan Seestrom was recognized by the New Mexico Technology Council for being a passionate ally and mentor for women working in STEM fields throughout her 30+ year career.

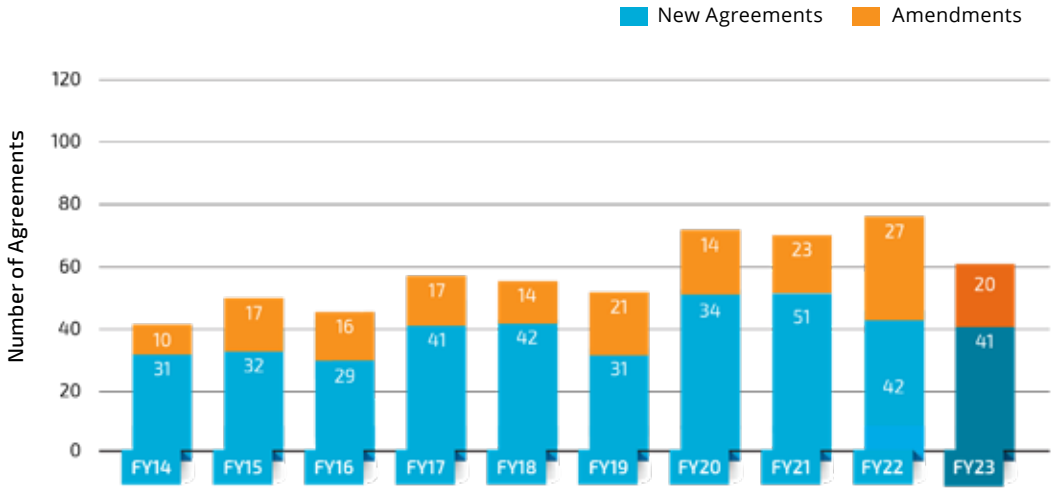
Copyrights

Copyright Submissions

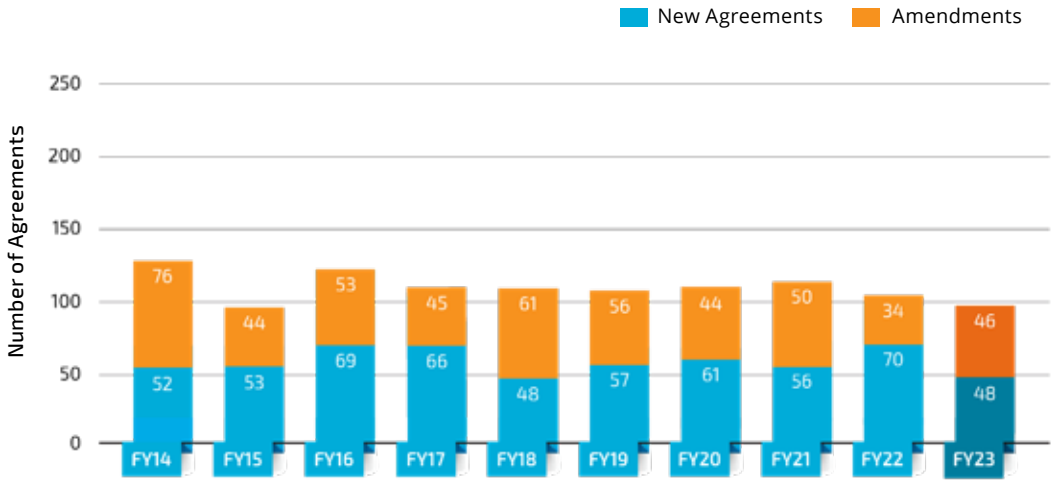


CRADAs and SPP/NFE Agreements

Cooperative Research and Development Agreements (CRADAs)

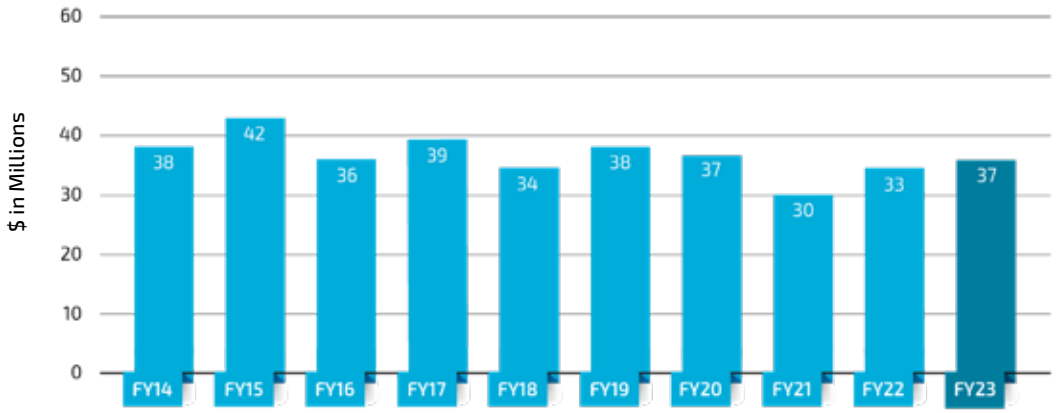


Strategic Partnership Project/Non-Federal Entity (SPP/NFE) Agreements



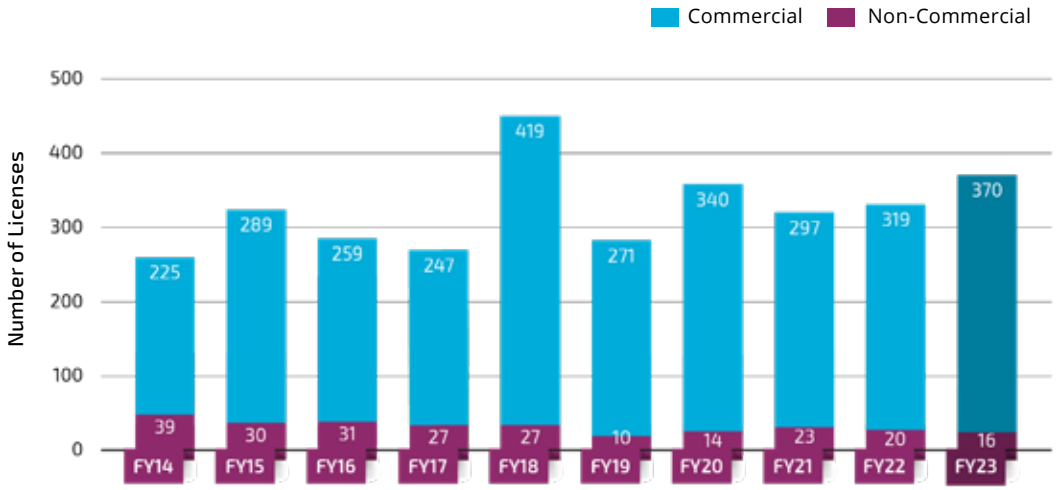
Industry Funds-In to Sandia ($M)

Industry Funds-In

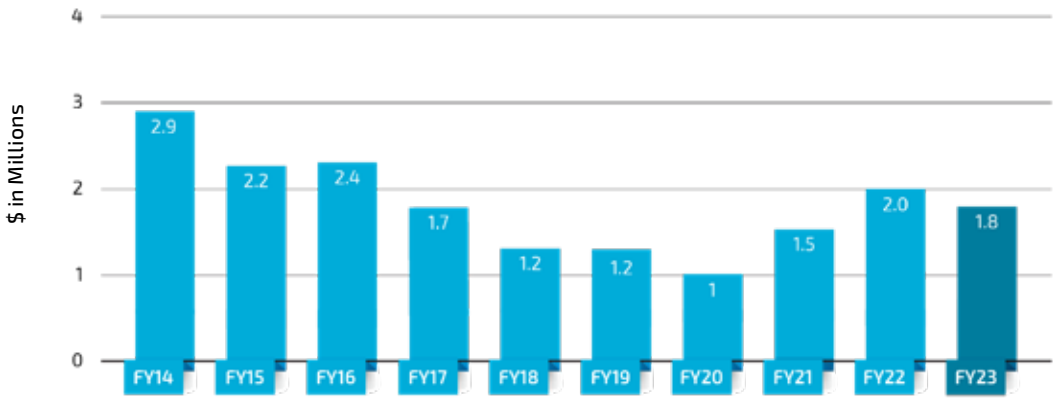


Licenses

Licenses

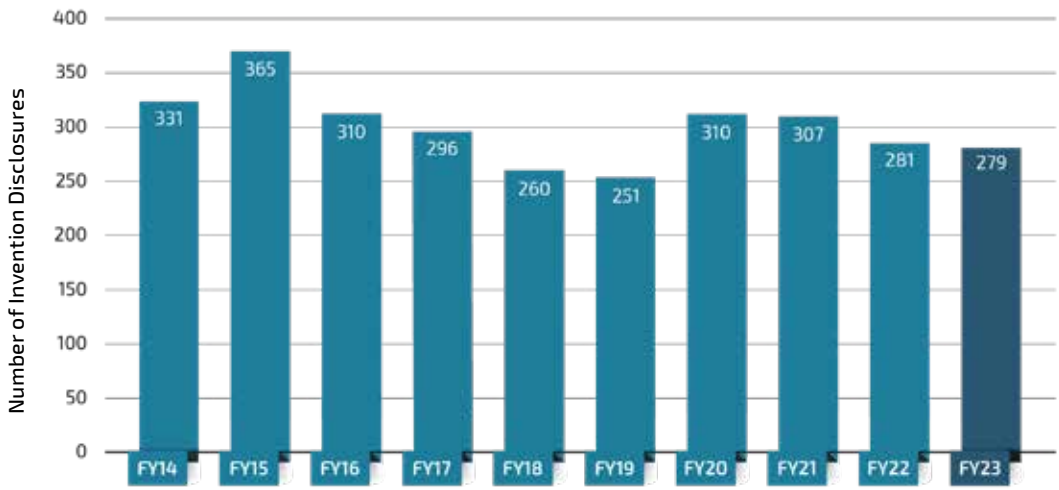


Licensing Income ($M)

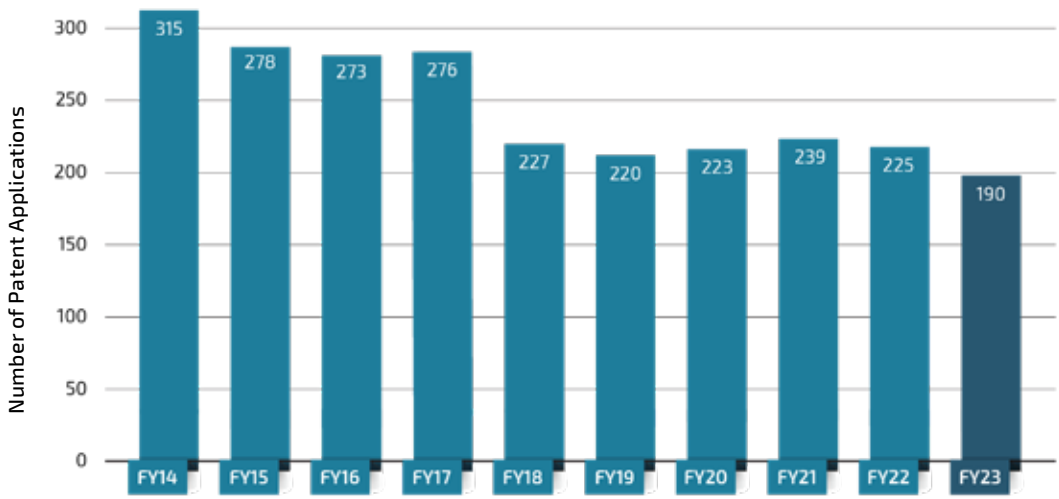


Patent Activity

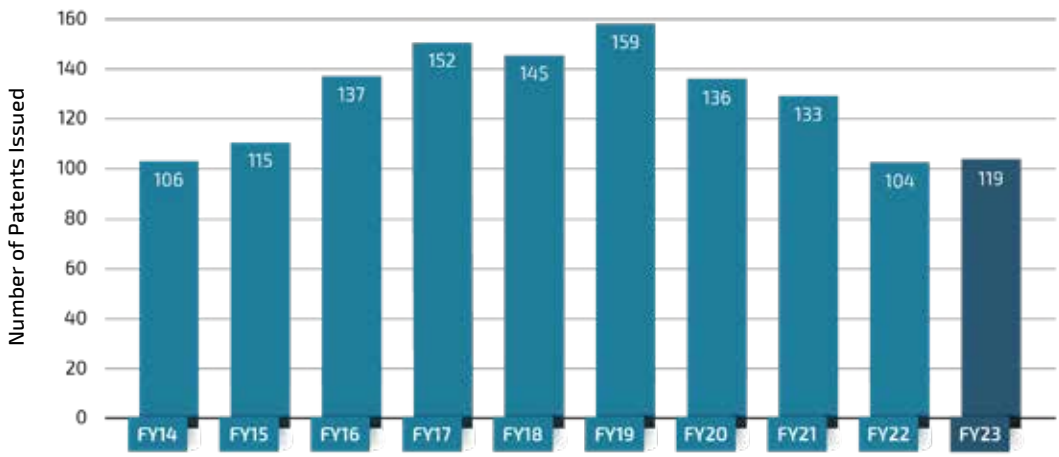
Invention Disclosures



Patent Applications



Patents Issued



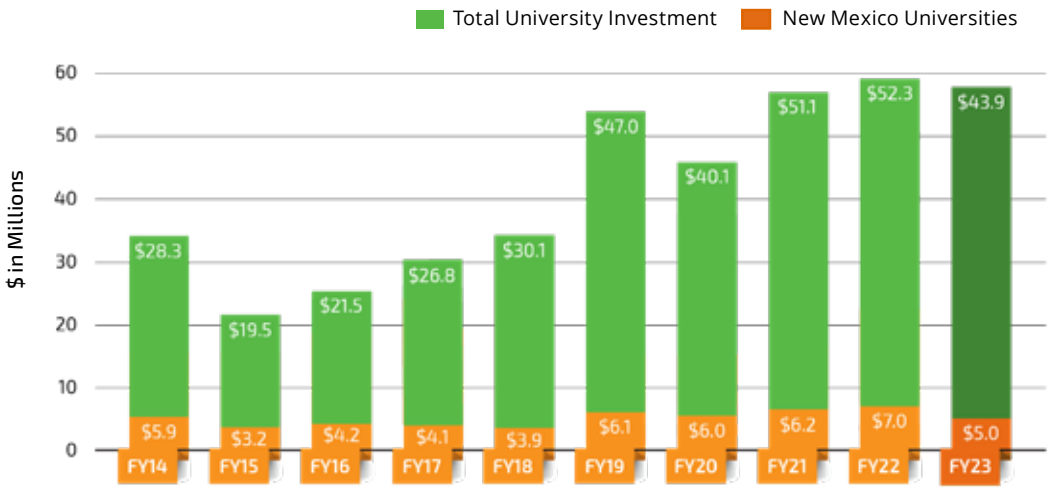
University Partnerships

Since 1997, when the Campus Executive program was established, Sandia National Laboratories has formally cultivated university research to expand its science and technology base. Through the Campus Executive program, Sandia formalized agreements with about 20 schools that defined partnership goals, including research collaboration areas and talent pipeline objectives. In 2016, Sandia began more focused collaborations with a subset of the Campus Executive schools under its Sandia Academic Alliance Program. These schools had strong historical partnerships with Sandia, possessed synergistic research competencies and capabilities, and shared Sandia values and an affinity for national security work. In 2021, Sandia began its minority-focused program, Securing Top Academic Research and Talent, with Historically Black Colleges and Universities.

Sandia also revisited its strategy for university engagement in 2021, and implemented the new Sandia University Partnerships Network in 2022. The SUPN is a graduated spectrum of relationships with universities across the United States. The objectives of this network are to partner broadly with universities based on merit to ensure diversity in Sandia's pipeline of top talent and innovative ideas, and to establish and cultivate enduring strategic and mutually beneficial relationships with a focused set of schools.

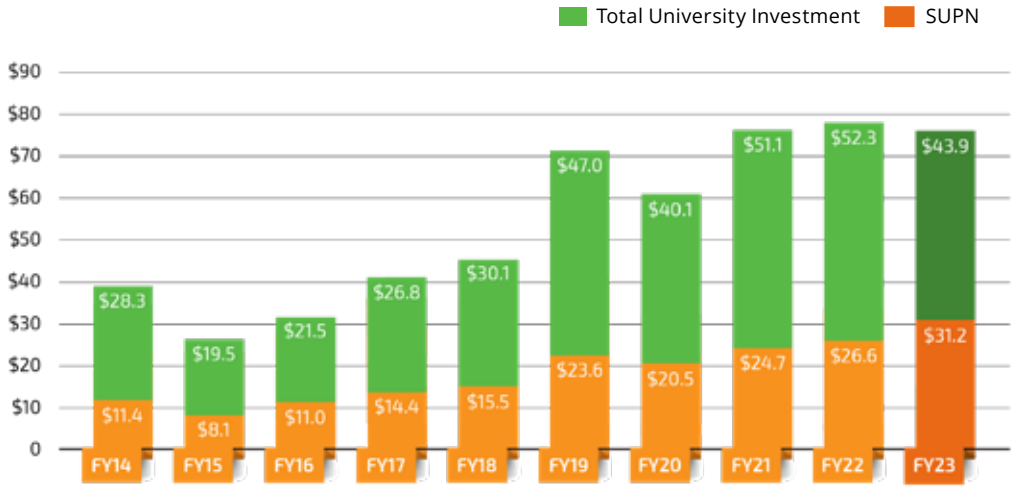
The Academic Programs Office, under the auspices of the Chief Research Officer, serves as the point of contact for university research, and implements those processes that enable and enhance university partnerships.

Investments in Research at New Mexico Universities*



Investments in Research with Sandia University Partnerships Network*

These programs pair Sandia executives with university officials at schools that share research interests and capabilities.



*Historic data has been updated to reflect current university structure and some investment numbers may have changed from previous reports.

Sandia Science & Technology Park

Companies and Organizations	40
Employees	2003
Buildings	27
Public Investment in the Park*	$99.5M
Private Investment in the Park*	$386.1M
Total Investment in the Park*	$485.6M
Increase in Tax Revenue*	$4.4B
Increase in Wages*	$7.7B
Average Salary of Full-time Jobs in Park	$92K
Average Salary of Full-time Jobs in Metro Albuquerque	$60K

**Since Park opened in 1998.*

2023

During the calendar year, 6 companies moved into the Park and 2 companies expanded their facilities.

SANDIA SCIENCE & TECHNOLOGY PARK

New Mexico Small Business Assistance

	Sandia: 2000-2023
New Mexico Small Businesses Assisted	2,524
Rural vs. Urban Businesses	
Rural (58%)	1,463
Urban (42%)	1,061
Combined	2,524
Dollar Amount of Assistance	$50.7M

	Sandia and Los Alamos: 2000-2022*
Return on Investment (ROI)**	$1.77
(For every $1.00 of state tax credit invested)	
Economic Impact	
Small Business Jobs Created and Retained	12,199
Average Reported Salary (2022)	$69.7K
Increase in Revenue	$539M
Decrease in Operating Costs	$322M
Investment in NM Goods/Services	$197M
New Funding/Financing Received	$297M

**Surveys are performed six months to one year after project completion.*

***ROI is based on salaries of jobs created and retained.*

2023

During the calendar year, Sandia invested $2.3M helping 133 small businesses in 16 counties throughout New Mexico. There were 58 Sandia Principal Investigators across 40 departments that supported NMSBA.

New Mexico Small Business Assistance NMSBA

Entrepreneurial Separation to Transfer Technology*

Sandians Who Left on ESTT	180
To Start up a Company	80
To Expand a Company	100
Companies Affected by ESTT	131
Start-up Companies	64
Expansion Companies	66

**Since ESTT began in 1994.*

2023

During the fiscal year, 5 Sandians were approved to leave on ESTT.

ESTT
Entrepreneurial Separation to Transfer Technology

TRGR Technology Readiness Initiative*

	Sandia and Los Alamos: 2020-2023
Companies Assisted	17
New Licenses	14
New CRADAs	3

**Since TRGR began in 2020.*

2023

During the fiscal year, Sandia invested $597K assisting 11 companies.

TRGR Technology Readiness Initiative

Thank you to everyone who contributed to this report.

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Partnerships National Reach

Explore our interactive data map which illustrates the amazing breadth of work Sandia National Laboratories does with industry, university, government, and lab partners around the U.S.

https://www.sandia.gov/partnerships_reach/

TECHNOLOGY
Partnerships

Sandia National Laboratories

CENTER for COLLABORATION and COMMERCIALIZATION

To learn more about the Center for Collaboration and Commercialization, visit **www.C3abq.com**, or stop by our partnership space in downtown Albuquerque at 101 Broadway NE.

IPO Integrated Partnerships Organizations

To learn more about industry or university partnership opportunities with Sandia, visit **www.sandia.gov/partnerships** or contact us at partnerships@sandia.gov

To learn more about licensing and technology transfer at Sandia, visit **https://ip.sandia.gov** or contact us at **ip@sandia.gov**

Academic Programs

To learn more about academic partnerships at Sandia, visit **www.sandia.gov/working-with-sandia/academic-partnerships** or contact us at acadalli@sandia.gov

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Small Business First

To learn more about how to do business with Sandia, visit **http://sbu.sandia.gov** or contact us at supplier@sandia.gov