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Forging a path to energy equity **Page 12**

Powering the moon: Sandia researchers design microgrid for future lunar base

Reliable, resilient microgrid to sustain astronauts, mining and fuel processing

By **Mollie Rappe**

Sandia is well known for designing reliable and resilient microgrids for military bases and vital city services. Now, Sandia researchers are working with NASA to design one for the moon.

This is not the first time Sandia has partnered with NASA to power equipment on the moon. In fact, Sandia provided the

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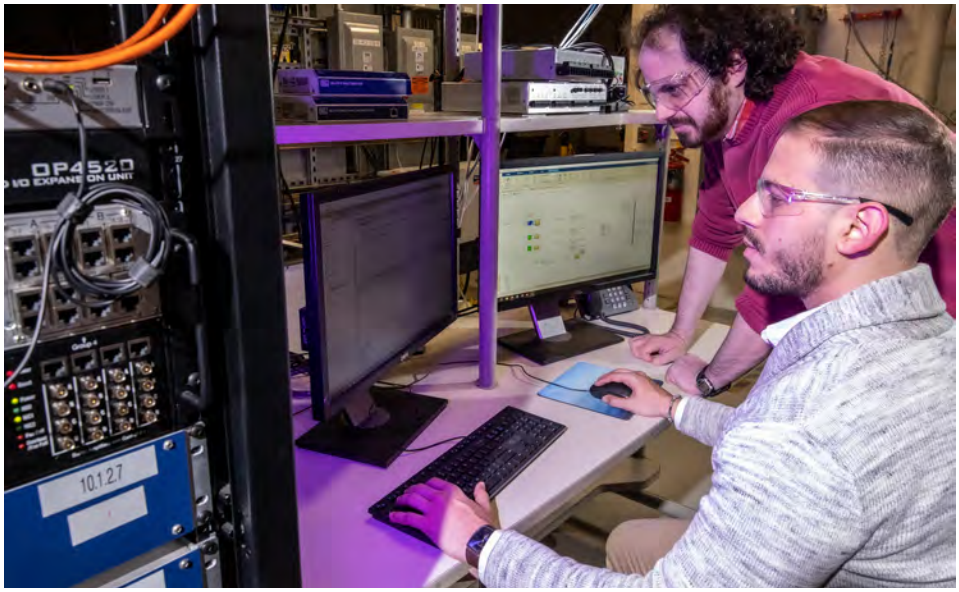

LUNAR TESTING — Sandia electrical engineers Rachid Darbali-Zamora, front, and Lee Raskin test an algorithm on a hardware-in-the-loop setup at the Distributed Energy Technologies Laboratory. **Photo by Rebecca Gustaf**

Seashell-inspired Sandia shield protects materials in hostile environments

SWEET STRENGTH — Sandia researcher Guangping Xu employs a digital optical microscope to examine the unusually hard coatings his lab has produced. The aim is better, cheaper protection of instruments and drivers in danger of fast-moving debris flung by Sandia's Z machine when it fires. The coatings offer many other possibilities as well. **Photo by Bret Latter**

Environmentally friendly coating outperforms conventional materials

By **Neal Singer**

Word of an extraordinarily inexpensive material, lightweight enough to protect satellites against debris in the cold of outer space, cohesive enough to strengthen the walls of pressurized vessels experiencing average conditions on Earth and yet heat-resistant enough at 1,500 degrees Celsius, or 2,732 degrees Fahrenheit, to shield instruments against flying debris, raises the question: What single material could do all this?

The answer, found at Sandia, is sweet as sugar.

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LABNEWS Notes

Lab News may contain photos shot prior to current COVID-19 policies. Individuals in photos followed all social distancing and masking guidelines that were in place when photos were taken.

EDITOR'S NOTE: Please send your comments and suggestions for stories or for improving the paper. If you have a column (500-800 words) or an idea to submit, contact Lab News editor Katherine Beherec at kgbeher@sandia.gov.

TECH RESCUE — Luis "Eddie" Lucero repairs a laptop with a swollen battery at the hardware repair depot. Since December 2020, damaged batteries have been safely disposed of as hazardous waste, while the laptops are repaired and either returned to the customer or wiped and sent to Reapplication. This new process of handling electronic devices with damaged batteries saves Sandia an estimated $1,450 per laptop and reduces the volume of material that is managed as hazardous waste by about 75%. **Photo by Craig Fritz**

A new way to handle laptops with damaged batteries

First year of partnership between ES&H and IT reduced electronic waste, improved safety

By **Mollie Rappe**

You log into your Sandia laptop one morning and notice it's not sitting flat so you pick it up, look at it, only to notice the once-sleek machine is swollen. Now what do you do?

Before December 2020, you might have called the Corporate Computing Help Desk, your department's administrative assistant or even your division's Environment, Safety and Health coordinator for assistance, only to find that your whole laptop had to be disposed of as hazardous waste, said Matthew Shain, an environmental technical professional.

Now, Sandia has a well-defined and centrally managed process for evaluating and handling Sandia-owned laptops, tablets and

cellphones containing a damaged, deformed, bulging, swollen, ruptured or even leaking battery. Similarly, a mobile device with a bulging or separating case should not be ignored; instead, immediately stop using the device, Matthew said.

From January 2021 through January 2022, 561 electronic devices were evaluated and managed by the hardware repair depot within Information Technology Services. This team removed and disposed of the damaged batteries and then either repaired the laptop, tablet or cellphone and returned it to the customer or wiped it and sent it to Reapplication, said Chris Lucero, the service manager for the hardware repair depot.

The process saves Sandia an estimated $1,450 per laptop with a damaged battery and reduces the volume of material that is managed as hazardous waste by about 75%, he added. The team won an **Environmental Excellence Award** last year for implementing this process.

Hazards of damaged batteries and starting a new process

If ignored and not handled properly, a electronic device containing a damaged battery can pose a myriad of safety, security and environmental hazards, Matthew said. Damaged batteries can emit toxic gases, release hazardous chemicals, cause skin burns, catch on fire or even start a fire that damages property.

In the middle of fiscal year 2020, with Sandia's maximized telework posture, there was even more impetus to develop and roll out a formal process for handling laptops, tablets and cellphones containing damaged batteries, Chris said.

Chris took over project management for the process in August 2020, and in December 2020, started a pilot project, in which over 50 devices with damaged batteries were evaluated. Its success led to a large-scale rollout to the rest of the Labs in January 2021.

"In the past year or so, we've learned that we had to improve the efficiency of picking up the devices from Sandians who have devices with defective batteries to protect their health and safety," Chris said. "At first, people at the geographical computer support units had to go to the hardware repair depot to pick up a fireproof bag, pick up the device with a damaged battery from the customer and then deliver it to the hardware repair depot. Now, each geographical computer support unit has fireproof bags on hand. This improvement decreases the amount of time the individual has the defective device in their possession. That, in turn, decreases the time they are exposed to the risk of possible health and safety issues."

Developing the process for handling electronic devices with damaged batteries involved IT, ES&H, industrial health, cybersecurity, hazardous waste and even logistics working together, Chris said. The contractor team that runs the hardware repair depot's daily operations was also key in developing and implementing the process. He added, "It's been a true exercise in collaboration across multiple departments in different divisions."

Getting the process started also involved training the hardware repair depot team on the hazards and risks of evaluating damaged electronic devices and accumulating hazardous waste, Matthew said.

BULGED BATTERY — A swollen battery carefully removed from a Sandia laptop by the hardware repair depot team within IT Services.

Photo by Craig Fritz

How to handle damaged electronic devices and prevent swollen batteries

Handling instructions for Sandia-owned electronic devices containing damaged batteries are posted on a tab on ES&H's Get Rid of It website. First, the device needs to be unplugged, turned off and placed in a safe location away from combustible materials. Do not open, repair or remove the damaged battery from the device, Matthew said.

There are three main ways to get a laptop, or other electronic devices, with a damaged battery to Chris' team. First, the customer can submit a ticket through CCHD and have someone from a computer support unit pick up the device. CCHD provides IT support over the phone and remotely, while the computer support unit provides face-to-face hardware and software IT support.

This method is recommended if the battery is leaking or otherwise poses a more immediate hazard. Second, the customer can pick up a fireproof bag from a computer support unit or the hardware repair depot, place the device with a swollen battery in the bag, and deliver it to the hardware repair depot themselves. Third, for people outside of the Albuquerque metro area, the hardware repair team will coordinate with Sandia's logistics team to ship a properly labeled fireproof box, and the customer can safely return the device with a damaged battery through ground shipping.

Chris mentioned some tips on how to prevent a damaged battery from occurring in the first place. Specifically, periodically powering off and unplugging the laptop from the power supply decreases the likelihood of the battery swelling or otherwise being damaged. Getting into the habit of unplugging a laptop every other morning while catching up on email and plugging it in again when a low battery alert appears could reduce the risk of the battery swelling.

"Don't leave your laptop connected to the power source 24/7 and be aware of the condition of your laptop or other mobile devices," Chris added. "If you see the casing on your laptop start to split, don't tape it; turn it off, unplug it and call CCHD."

Future lunar base

CONTINUED FROM PAGE 1

technical direction for the radioisotope thermoelectric generators that powered the lunar experiments placed by many of the Apollo missions.

NASA's plan for its concept Artemis lunar base is that it will serve as a technology proving ground for the eventual human exploration of Mars, said Jack Flicker, a Sandia electrical engineer. The base camp concept consists of a habitation unit — complete with room for up to four astronauts — as well as the potential for separate mining and fuel processing, called in-situ resource utilization, facilities. Early Artemis missions will include short stays at the base camp with the goal to build up to stays of two months.

The mining and processing facilities could produce rocket fuel, water, oxygen and other materials needed for extended exploration of the lunar surface while decreasing supply needs from Earth. This facility will be located far away from the base camp — so other science and technology activities conducted there won't be disrupted — but the electrical grid for the two units will be connected during emergencies for resiliency and robustness, Jack added.

One part of the Sandia team, which includes electrical engineer Lee Rashkin and control engineer Dave Wilson, is designing an electrical system controller for the mining and processing center's microgrid. NASA is designing the electrical system controller for the habitation unit, as the system will be very similar to the International Space Station's direct-current electrical system, Jack said. Jack and his part of the team are developing the system that will connect the two microgrids and are studying the power flow and operation between the two microgrids.

"There are some very important differences between something like an ISS-type microgrid to something that has the extent of a moon base," Jack said. "One of those differences is the geographic size, which can be problematic, especially when running at low DC voltages. Another is that when you start to extend these systems, there will be a lot more power electronics as well as a lot more distributed energy resources that will exist throughout the base. Sandia has been looking at microgrids with a lot of distributed energy resources for quite a long time."

Distributed energy resources are smaller sources of electricity such as solar panels and wind turbines, while power electronics are devices such as converters that keep electrical systems operating within specifications.

'Cruise control' for moon mining center electric system

Lee and Dave have been designing the software to regulate the electricity of the mining and processing center since early summer 2021. Dave compared their controller to the cruise control in a standard automobile in that it maintains an even voltage level on the grid, despite changing external situations.

The controller needs to be able to maintain an even voltage level on several different timescales, from less than a thousandth of a second to seasons. At the highest level of the control software, on the scale of minutes to seasons, people can control which solar panels generate power and what power-using devices are turned on, Dave said. However, at the

MOON POWER — An artistic rendering of what a resilient microgrid for a lunar base camp might look like. Sandia engineers are working with NASA to design the system controller for the microgrid.

Illustration by Eric Lundin

lowest level, at less than a thousandth of a second, the controller needs to operate rapidly and automatically to maintain outputs at the required levels. They are primarily focused on the middle level of control, Lee said.

"Our goal is to come up with a lunar energy power management system that can efficiently maintain a level system on all those timescales," Dave said. "We've got a specialized Secure Scalable Microgrid facility and control-system-design methodology that analyzes this. The facility also has specialized energy storage emulators that can help us determine the specifications for how much energy storage the base needs and their requirements."

The **Secure Scalable Microgrid Testbed** is a unique Sandia research facility the team will use to fine-tune their control system. They will also use the testbed to study questions about power system controllers and the interactions between distributed energy resources, energy storage and power electronics on a DC microgrid that is a scaled and simplified representation of the eventual lunar microgrid, Lee said. Most terrestrial microgrids, and terrestrial electrical grids in general, run on alternating-current power.

Like a high-end model train set, the testbed consists of three interconnected DC microgrids with custom-built electronics to mimic different power-production systems and devices that use electricity. The power-production systems they can mimic include diesel generators, photovoltaic arrays, energy storage emulators and power converters. Each of the emulators can be controlled by a computer, and the microgrids can be configured to test an endless variety of scenarios, Lee said. This provides an excellent platform for running repeated experiments with slightly tweaked control software to compare how the system responds, he said.

"The goal here is top-down engineering: We're trying to determine the control design first, come up with the specifications for the energy storage, and then NASA could use those specifications to get the flight-ready components that meet those specs," Dave said. "A lot of the time people will do the reverse; they'll bring you a battery and say, 'make it work,' which may degrade the microgrid performance."

Other researchers heavily involved in controller development include Marvin Cook, a Sandia computer scientist; Wayne Weaver and Rush Robinett III, engineering professors at **Michigan Technological University**; and Joseph Young, chief scientist of **OptimoJoe**.

'It takes two' microgrids

The second major focus of the Sandia researchers is developing the system that will connect the mining facility and habitation unit microgrids for resiliency and robustness. There are two primary ways to get resiliency in a microgrid. One is to have the ability to flexibly route power where it's needed. The other is to oversize everything to ensure there is enough power even if multiple things fail, Jack said.

"Usually, we have some combination of those two, where it's oversized to some extent, but you are also able to flexibly route power how you need to within a microgrid or between independent, yet cooperative microgrids like we're exploring for the moon," Jack said. "In a contingency event such as an energy storage system failing during an eclipse, we want to be able to port the power at the mining facility over to the base camp to keep astronauts safe."

Jack's part of the team is also exploring how the connection between the two microgrids could operate. Researchers are studying the impact the distance between the mining facility and habitation unit has on transfer efficiency and stability, whether they're five miles apart, or 20. The team is also determining the optimal voltage the connection should operate at, and whether it makes sense for the connection to stay DC or if NASA should convert to AC to make the trip and then back to DC once it reaches the habitation unit.

To answer these questions and explore various contingency scenarios, Jack and Sandia electrical engineers Rachid Darbali-Zamora and Andrew Dow are using two research facilities.

Sandia's **Distributed Energy Technologies Laboratory** is used to study the integration of renewable energy resources such as wind turbines and solar panels into larger energy systems. One of the strengths of this lab is **hardware-in-the-loop** experiments. These kinds of experiments involve connecting a real piece of hardware to software that can subject the hardware to a variety of simulated scenarios including catastrophic blackouts and weather conditions, Rachid said. These experiments are an intermediate step between pure simulation and field tests, he added.

"With this DC power-hardware-in-the-loop setup that we're building in the lab, we can test power converters, the impedance of electrical lines between lunar facilities, we could also test actual energy generation and storage devices," Rachid said. "Basically, we can use it to study a variety of situations so we can design a system that is self-sustaining and can continue operating even if a solar panel array goes down."

The team will also use the **Emera DC microgrid** on Kirtland Air Force Base to see how a power-electronic-heavy system can operate and port power as needed in low-energy contingency scenarios, Jack said.

Of course, the whole Sandia team works closely together, Jack said. For example, they are using toolboxes from the Secure Scalable Microgrid Testbed, and some of NASA's toolboxes in their computer simulations. Eventually they even plan to test Dave's controller in their connection simulations, Rachid said.

"Even though this work is for a microgrid on the moon, the research is also relevant to creating resiliency for communities on Earth," Rachid said. "I'm originally from a small town in Puerto Rico. I hope that some of the lessons that come out of this project in terms of resilience, are lessons I can implement back home."

This project is funded by **DOE's Office of Electricity** as part of a DOE-NASA partnership to combine the expertise, experience and research facilities of both federal agencies.

Mileposts

Wendy Amai 35

Erica Lopez-Hamby 20

Recent Retirees

Ken Chen 28 yrs

Sandia shield protects materials

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That's because it is, in fact, sugar — very thin layers of confectioners' sugar from the grocers, burnt to a state called carbon black, interspersed between only slightly thicker layers of silica, one of the most common materials on Earth, and baked. The result resembles a fine layer cake, or more precisely, the organic and inorganic layering of a seashell, each layer helping the next to contain and mitigate shock.

"A material that can survive a variety of insults — mechanical, shock and X-ray — can be used to withstand harsh environmental conditions," said Sandia researcher Guangping Xu, who led the development of the new coating. "That material has not been readily available. We believe our layered nanocomposite, mimicking the structure of a seashell, is that answer."

Most significantly, Guangping said, "The self-assembled coating is not only lightweight and mechanically strong, but also thermally stable enough to protect instruments in experimental fusion machines against their own generated debris where temperatures may range about 1,500 C. This was the initial focus of the work."

"And that may be only the beginning," said consultant Rick Spielman, senior scientist and physics professor at the Laboratory for Laser Energetics at the University of Rochester, credited with leading the initial design of Sandia's Z machine, one of the destinations for which the new material is intended. "There are probably a hundred uses we haven't thought of." He envisions possible electrode applications delaying, rather than blocking, surface electron emissions.

Aiding the nuclear survivability mission

The coating, which can be layered on a variety of substrates without environmental problems, was the subject of a Sandia patent application in June 2021, an invited talk at a pulsed power conference in December 2021 and again in a recent technical article in MRS Advances, of which Guangping is lead author.

The work was done in anticipation of the increased shielding that will be needed to protect test objects, diagnostics and drivers inside the more powerful pulsed power machines of the future. Sandia's pulsed-power Z machine — currently the most powerful producer of X-rays on Earth — and its successors will certainly require still greater debris protection against forces that could compare to numerous sticks of dynamite exploding at close range.

"The new shielding should favorably impact our nuclear survivability mission," said paper author and Sandia physicist Chad McCoy. "Z is the brightest X-ray source in the world, but the amount of X-rays is only a couple percent of the total energy released. The rest is shock and debris. When we try to understand how matter — such as metals and polymers — interacts with X-rays, we want to know if debris is damaging our samples, has changed its microstructure. Right now, we're at the limit where we can protect sample materials from unwanted insults, but more powerful testing machines will require better shielding, and this new technology may enable appropriate protection."

Other, less specialized uses remain possibilities.

The inexpensive, environmentally friendly shield is light enough to ride into space as a protective layer on satellites because comparatively little material is needed to achieve the same resilience as heavier but less effective shielding currently in use to protect against collisions with space junk. "Satellites in space get hit constantly by debris moving at a few kilometers per second, the same velocity as debris from Z," said Chad. "With this coating, we can make the debris shield thinner, decreasing weight."

	Kevlar	Aluminum	Kapton	Spectra	Beryllium	Natural seashell	Carbon black coating
Hardness (Gpa)	N/A	1.25	0.3	7.6	1.7	3	>11
Elastic modulus (Gpa)	70-112	69	2.8	200	287	70	>120
Melting temperature (˚C)	500	660	400	150	1,287	600	up to 1,650

NEW COMPETITOR — Mechanical properties of representative high-strength materials versus natural seashell and Sandia-developed coating.

Graphic by Alicia Bustillos; Data provided by Hongyou Fan and Guangping Xu

Thicker shield coatings are durable enough to strengthen the walls of pressurized vessels when added ounces are not an issue.

Dramatic cost reduction anticipated

According to Guangping, the material cost to fabricate a 2-inch-diameter coating of the new protective material, 45 millionths of a meter, or microns, thick, is only 25 cents. In contrast, a beryllium wafer — the closest match to the thermal and mechanical properties of the new coating, and in use at Sandia's Z machine and other fusion locations as protective shields — costs $700 at recent market prices for a 1-inch-square, 23-micron-thick wafer, which is 3,800 times more expensive than the new film of same area and thickness.

Both coatings can survive temperatures well above 1,000 C, but a further consideration is that the new coating is environmentally friendly. Only ethanol is added to facilitate the coating process. Beryllium creates toxic conditions, and its environs must be cleansed of the hazard after its use.

MATERIAL TEST — Physicist Chad McCoy at Sandia's Z machine loads sample coatings into holders. When Z fires, researchers will observe how well particular coatings protect objects stacked behind them.

Photo by Bret Latter

How testing proceeded

The principle of alternating organic and inorganic layers, a major factor in seashell longevity, is key to strengthening the Sandia coating. The organic sugar layers burnt to carbon black act like a caulk, said Sandia manager and paper author Hongyou Fan. They also stop cracks from spreading through the inorganic silica structure and provide layers of cushioning to increase its mechanical strength, as was reported 20 years ago in an earlier Sandia attempt to mimic the seashell mode.

Greg Frye-Mason, Sandia campaign manager for the Assured Survivability and Agility with Pulsed Power, or ASAP, Laboratory Directed Research and Development mission campaign funding the research, initially had his doubts about the carbon insertion.

"I thought that the organic layers would limit applicability since most degrade by 400 to 500 C," he said.

But when the carbon-black concept demonstrated robustness to well over 1,000 C, the positive result overcame the largest risk Greg saw as facing the project.

Seashell-like coatings initially tested at Sandia varied between a few to 13 layers. These alternating materials were pressed against each other after being heated in pairs, so their surfaces crosslinked. Tests showed that such interwoven nanocomposite layers of silica with the burnt sugar, known as carbon black after being baked, are 80% stronger than silica itself and thermally stable to an estimated 1,650 C. Later sintering efforts showed that layers, self-assembled through a spin-coating process, could be batch-baked and their individual surfaces still crosslinked satisfactorily, removing the tediousness of baking each layer. The more efficient process achieved very nearly the same mechanical strength.

Research into the coating was funded by ASAP to develop methods to protect diagnostics and test samples on Z and on next-generation pulsed power machines from flying debris.

"This coating qualifies," Greg said.

NNSA celebrates opening with ribbon-cutting for new complex

By **Luke Frank**

The NNSA opened the doors April 19 to its new 330,000-square-foot complex at Kirtland Air Force Base that will house more than 1,200 employees who support the national security mission.

Jill Hruby, head of the NNSA, joined other officials and members of the state's congressional delegation for the event at the John A. Gordon Albuquerque Complex. The building is named in honor of Gen. John A. Gordon, the NNSA's first administrator who led the agency within the Department of Energy from its creation until June 2002.

The $174 million LEED Gold-certified complex replaces a patchwork of NNSA buildings, including 1950s military barracks from which staff had been working. The new complex will house multiple organizations that fulfill essential roles by providing programmatic, technical support, legal, security, procurement, human resources, business and administrative functions that directly support the NNSA national security mission.

Complete with office spaces, conference rooms, a data center for rows of servers, secure spaces, a fitness center and more, the facility will end up saving an estimated $40 million in deferred maintenance. Some 2,000 skilled New Mexico tradespeople spent 900,000 work hours over four years to complete the project, despite labor and materials shortages.

"Providing our people with the best modern infrastructure is necessary to develop a top-tier, next-generation workforce for our vital nuclear security missions," Hruby said. "The (complex) that stands before us today embodies the vision we have for a flexible and resilient nuclear security enterprise of the future."

CLEAN CUT — On a blustery afternoon, Marilyn Gordon, left, and NNSA Administrator Jill Hruby, center, ceremoniously cut the ribbon, with Jennifer Gordon looking on, to celebrate the opening of the NNSA's new John A. Gordon Albuquerque Complex. Marilyn and Jennifer Gordon are the wife and daughter of the late John A. Gordon. **Photo by Craig Fritz**

LEED BY EXAMPLE — NNSA's new LEED Gold-certified complex is estimated to save $40 million in deferred maintenance. The Courtyard Atrium, pictured, offers space for staff to have casual meetings or take a break during the workday. **Photo by Craig Fritz**

Hruby Fellow tackles big problems in climate by focusing on smallest details

Kelsey DiPietro is accelerating research through her work in computer models.

By **Amy Treece**

In the world of multigigabit high-speed internet, pre-ordered fast food and Twitter pitch events, there is little patience for slow computer models — especially ones used to combat the Earth's rapidly changing climate. To address this, Kelsey DiPietro, a **Jill Hruby Fellow** appointed at Sandia in 2019, has created algorithms that make computer models of complex systems more efficient by skipping over areas of datum where there is little change and honing in on those with observable shifts.

Kelsey, an applied mathematician with a doctorate from the University of Notre Dame, has made advances in creating fast 3D computational algorithms, with the aspiration of integrating them into DOE's supercomputer-powered **Energy Exascale Earth System Model**, or E3SM.

"These advances will make them more tractable, or more easily solvable in a reasonable amount of time, and that is really key for my current project at E3SM where precise models can take an impossible amount of computation to solve," she said.

She said in computational modeling, researchers adjust their models based on feedback they receive from the experts on her team, which consists of 100 researchers from eight DOE labs and several universities.

"We frequently start with very simplified models of a natural phenomenon, and then rely on other researchers to help validate how realistic or accurate our models may be," Kelsey said. "We can create fast models all day, but if they don't provide enough information or accurate enough information for our partners, then the model is not useful. It is a really dynamic relationship."

The developments Kelsey has made during her time as a Hruby Fellow will allow her to take a previously intractable problem and apply it to adaptive digital meshes that can be manipulated into different shapes and forms and then refined based on user-specified criteria for existing Earth modeling applications.

"My advances will allow for easier integration without any prohibitively expensive computational costs," she said. "This approach could be used for a wide range of applications, but there are certain problems where use of this model is more straightforward. For example, it's much easier to target a problem that evolves on a slow time scale, such as moving ice sheets, than something on a short time scale, like a flash flood."

The E3SM project, concluding in December, has been developing models and simulations that consider the interactions between the water cycle, the Earth itself and the atmosphere, known as Earth-system science drivers. The data for these three drivers is supplied by researchers from different disciplines, and this diversity is what fuels innovation, Kelsey said. "The diverse educational background of people involved in the project — physicists, engineers and mathematicians — helps bring a wide range of ideas."

Diversity aids in solving scientific problems

Kelsey said diversity spurs questions that lead researchers toward new solutions. She credits the diversity of researchers working on E3SM with helping push her project forward.

"Research is constantly pushing you to think outside of the box, but if everyone starts off in the same — or a very similar — box, then it's hard to arrive at different conclusions or future avenues for your work. Since we are constantly trying to push the bounds of computational research, diversity of thoughts and ideas are crucial in creating pathways forward."

SUCCESFUL FELLOW — Early career researcher Kelsey DiPietro is tackling climate change through applied mathematics and modeling.
Photo courtesy of Ira Satinover

When it comes to increasing diversity of gender, Kelsey believes that exposure to science, technology, engineering and math is crucial for women.

"Many of my high school educators discouraged my choice to take STEM Advanced Placement classes, which led to a lot of personal doubt," she said. "Fortunately, in university, I had several professors take note of my talent and encourage engagement in math and science. I still fondly think of my Calculus 2 professor, who not only told me that I had a natural aptitude for the subject but also showed me many of the interesting things math research could do."

Since entering the scientific professional community, Kelsey has been

encouraged by seeing more women attending research conferences.

"Women in mathematics are motivated to organize and get together," she said. "I've been very lucky to participate in several Association for Women in Mathematics networking events and dedicated conferences. These events consistently remind me that even though we may be far from the majority in our field, we are not alone. Our problem isn't intractable."

Sandia Loves Science

Sixty-five years ago, Sandia physicist Richard Claassen laid out his vision for a research organization built on the fundamentals of science and engineering, which helped propel the Labs into an era of discovery. As part of the "Sandia Loves Science" campaign to honor Claassen's legacy and the Labs' rich history of redefining what's possible in advanced science, technology and engineering, Lab News will feature highlighted articles throughout the rest of the year. This profile of Kelsey DiPietro's work is the first of such articles.

The campaign will also feature new videos and opportunities to engage with others during virtual and in-person events to learn more about Sandia's discoveries and share your own science story.

Getting the stars back together again

RESEARCH REUNION — Attendees and panel members of the 2022 Rising Stars Workshop, hosted by Sandia and the University of Texas in Albuquerque.
Photo by Bret Latter

By **Johann Snyder and Teresa Portone**

Kermit the Frog and the Muppets said, "It's great to be together again." Actually, they sang it, but in any event, that sentiment echoed throughout this year's Rising Stars in Computational and Data Sciences workshop, hosted by Sandia April 21-22 in Albuquerque. University of Texas co-organized the event with the Labs and hosted it in Austin, Texas, in 2019, but in the last two years, it was canceled and held virtually due to the pandemic. Attendees agreed that the virtual event could not compare to in-person iterations.

"On Zoom, you don't get to have one-on-one conversations with people," said Sandia computer scientist Jennifer Loe, who participated in the virtual event two years ago. "There are just different conversations that organically come up when you're with people in person." That is one of the goals of Rising Stars: to help women make personal connections with other women in their field and build a community of collaboration and encouragement.

Rising Stars is a workshop for women graduate students and postdoctoral appointees interested in pursuing academic and research careers. It consists of technical research presentations

and practical career-development panels. Acceptance to the workshop is an honor due to its selective nature; only 25% of nominations are accepted each year on average, comparable to selection rates of some of the most prestigious conferences in the field. Attendees represent institutions both inside and outside the U.S. and are some of the top individuals in their field, not only technically, but also as leaders in their community.

Karen Willcox, director of the Oden Institute for Computational Engineering and Sciences at the University of Texas at Austin, initially conceived of the workshop. When she reached out to Jim Stewart, then-senior manager in Sandia's Center for Computing Research, about partnering for the event, he instantly recognized its importance.

"This really does, above anything else, show women in this field that they are not alone. There are many women out there dealing with the same challenges," Stewart said. "This workshop helps them build that confidence while also providing them a professional network that, hopefully, will last their whole career."

This year, Lawrence Livermore National Laboratory joined Rising Stars as the event's newest partner. Jeff Hittinger, the director of the Center for Applied Scientific Computing at the laboratory, encouraged women in attendance with a confidence boosting message: "Imposter syndrome is real, but take heart, you belong here."

The theme of connection, belonging and finding other like-minded researchers was high on the list of what participants enjoy about Rising Stars. National Science Foundation postdoctoral fellow Heather Wilber said, "It's just good to meet other women (in this field). I'm excited to network with people who are also doing work in large-scale applications in data science."

Sandia Truman Fellow and quantum scientist Alicia Magann said, "Quantum computing is still an emerging field, and it's a field that doesn't have a lot of women in it. Having the chance to come here, meet other women, talk with them about this work — it's not something that happens very often."

Rising Stars offers a foundation of support and community for attendees, but the key to providing this community comes from the interactions that can only take place when people are face-to-face.

GREAT MINDS — Attendees interact with each other during one of several networking sessions interspersed through the workshop. **Photo by Bret Latter**

Museum Artifact Center to present largest display of nuclear weapons

NUCLEAR COLLECTION — On April 22, the National Museum of Nuclear Science and History broke ground on a new center that will feature the largest collection of unclassified nuclear weapon units in existence. The Nuclear Defense Heritage Collection contains about 120 individual items, systems and deployment technologies. The museum has raised $600,000 to build the 5,000-square-foot Jerry L. Adams Museum Artifact Center.

From left, Museum Director Jim Walther; National Atomic Museum Foundation Board Trustee Dave Jansen; Sandia Director of Communications Frederick Bermudez; Terry Adams, brother of the late Jerry L. Adams; Past chairperson of the National Atomic Museum Foundation Wayne Laslie; Jerry L. Adams' daughter; Sandy Wick, wife of Jerry L. Adams; and a Jerry L. Adams' family member participated in the groundbreaking. **Photo by Lonnie Anderson**

Sandia researchers connect the dots between energy equity, energy storage

By **Diana Hackenburg**

Energy storage technologies, particularly those with longer duration capabilities, are not only critical for implementing widespread use of renewable energies but also ensure governments consider energy equity when developing policies and industry rules, according to a paper published in the Electricity Journal by Sandia researchers.

"Over the last couple of years, the concern is that there's a large segment of the population that may not be able to take advantage of energy storage technologies," said lead author Will McNamara, an energy storage policy analyst at Sandia. "Our goal was first and foremost to educate the public about what energy equity is."

According to the authors, underserved communities face disparities related to electricity service and access to new distributed energy resources, like on-site renewable energy generation and energy storage. These disparities include a higher proportion of income spent on energy, a higher likelihood to reside near fossil fuel and resource generating facilities that create health-threatening pollution, and more frequent and longer power outages than wealthier areas.

As more utility customers seek reliability and resilience through distributed energy resources, many communities often do not have the same level of access to these opportunities. Thus, energy equity is when access to the basic levels of energy required by individuals and families is equally available to all, regardless of race, geography, social standing or economic position.

One of the team's key findings is that achieving energy equity falls mainly upon state regulators to identify gaps in their jurisdictions and take proactive steps to correlate energy policies with energy equity goals. The second main takeaway is that energy storage is a key steppingstone for achieving both decarbonization and energy equity.

To accomplish federal and state decarbonization goals aimed at addressing climate change, energy storage is vital because renewable energy sources like wind and solar are intermittent, said Will. "The sun doesn't shine all day and the wind doesn't blow all the time, so to cover those ebbs and flows of those intermittent resources, we're going to need storage with long-duration capacities. While current storage technologies offer a duration of four hours, in the future it is projected that storage needs will necessitate durations at the 10-plus hour, weekly, monthly or seasonal levels."

Energy storage is also becoming a tool for achieving equity in policymaking. For example, lawmakers in California — a state that has endured massive wildfires, rolling blackouts and the continued threat of large-scale grid outages — have been at the forefront of addressing energy equity issues, with support for helping low-income communities install behind-the-meter battery projects.

Behind-the-meter energy storage, Will said, is installed directly on the energy user's premises and provides backup electrical during power outages, such as the massive blackouts associated with large wildfires. Lessening the likelihood and length of power outages can help decrease the burden on disadvantaged communities who may have limited means to find alternative housing or replace spoiled food.

Another example noted in the paper are the additional incentives for energy storage available to individuals in low-income communities in Massachusetts doing solar projects. As the authors note, however, participation by low-income communities has remained low, prompting decision-makers to rethink how to design the program to expand access.

Sandia's role in thinking critically about energy equity stems from the Labs' responsibility to help provide policy analysis for state-level energy storage deployment efforts, as directed by the DOE's Office of Electricity. Will said that in addition to being a free service, states also appreciate that Sandia researchers do not advocate for specific policies. "We come in really just wanting to figure out what's best for an individual state without any end result in mind, and that's very unusual."

Another differentiating aspect of Sandia's policy and outreach work is having direct access to technical experts in energy storage research and development. "Having that knowledge — being able to call upon the engineers that are part of our group and across all of the labs — is really beneficial, and we are able to incorporate that perspective into our outreach work."

As for next steps, the authors acknowledge that embracing energy storage as a tool for equitable policymaking is an ongoing effort. Will said Sandia's energy storage policy and outreach group regularly holds workshops with state energy commissions and could foresee carving out a half a day just to cover equity issues. "Every state that our policy and outreach team has talked to over the last year has identified equity as being a concern."

BEHIND THE METER — Sandia researchers make the case that energy storage could be an important tool in policymaking to achieve both energy equity and climate security goals. **Photo by Jon Moore**

Chemist honored for 'major impacts' in physical chemistry

By **Michael Ellis Langley**

Chemist Krupa Ramasesha has received a competitive award for her major contributions to the field of physical chemistry, in only her seventh year at Sandia.

Krupa, who works in gas phase chemical physics at the Combustion Research Facility at Sandia/California and began as a postdoc in 2015, is one of three outstanding early career scientists selected from around the world to receive the **American Chemical Society Physical Chemistry Division Lectureship Award** from the Journal of Physical Chemistry.

In his recommendation letter to the selection committee, Sandia chemist David Chandler wrote that Krupa's "research career to date is exceptional."

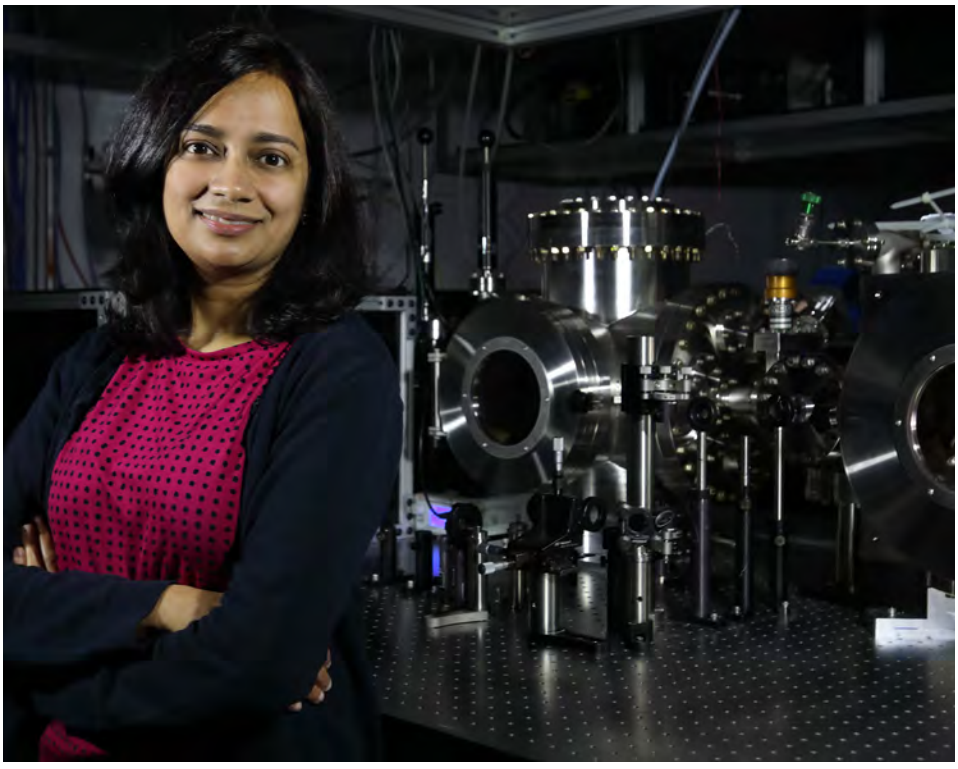
"She has made major impacts across the spectrum of the Journal of Physical Chemistry's research areas, including atmospheric chemistry and proton transfer dynamics in molecules, hydrogen-bonding dynamics in liquids and solid-state atto-second dynamics and transfer," David wrote. "Overall, the broad scientific impact of her career foreshadows the great promise of her future and makes her highly deserving of this award recognizing young leaders in physical chemistry."

David cited the fact that Krupa has built, and is still expanding, a new suite of ultrafast physical chemistry tools for studies in gas, liquid and solid state during her time at Sandia. He referenced her investigation of gas-phase chemical dynamics on picosecond (a trillionth of a second) to femtosecond (one millionth of one billionth of a second) time scales using ultrafast infrared spectroscopy, ultrafast core-level spectroscopy and ultrafast electron diffraction.

According to the journal, the awardees are physical chemists, chemical engineers and researchers of any nationality involved in physical chemistry research from academia, industry or national laboratories, representing the best minds in the field. The Lectureship Award honors the contributions of investigators who have made major impacts on the field of physical chemistry in the research areas associated with each section of the journal.

"This award credits the work I have done with my colleagues — past and present — and I feel incredibly grateful and thrilled that our research has been recognized in this way," Krupa said. "The award affords greater visibility for the work we do, and it provides additional impetus to continue to do impactful science in the coming years."

Krupa will receive a $1,500 honorarium and will deliver her award lecture at the fall meeting of the American Chemical Society in Chicago from August 21-25.



SIGNIFICANT SCIENCE — Chemist Krupa Ramasesha received the American Chemical Society Physical Chemistry Division Lectureship Award from the Journal of Physical Chemistry, selected from an international group of scientists. **Photo by Dino Vournas**

Facility opens for interagency counter-weapons of mass destruction training

By **Manette Newbold Fisher**

Interagency teams that would respond to incidents involving weapons of mass destruction and radiological threat scenarios are training at a new Sandia facility. The ribbon-cutting for the facility was hosted for the Nuclear Emergency Support Team, or NEST, last month.

The building is a dedicated counter-weapons of mass destruction research and development training center that supports the growing needs of the NNSA's Stabilization Program. This program is responsible for the scientific and technical training expertise in partnership with the Departments of Defense and Justice.

"Due to its capabilities and ability to host trainings at one site, the center will improve the safety of the nation and the globe," said Sarah Mahoney, manager of Applied Technologies and leader of the building's construction.

Previously, training occurred in multiple locations, buildings, classrooms and outdoor locations, said Arthur Shanks, Nuclear Incident Response Program manager.

The new facility enables all relevant Sandia-based training to take place at one site, which enhances efficiency for all involved. Expectations are that this facility will host at least one series training every week.

"The ability to have a facility focused on these trainings will greatly help with the high throughput we have coming through Sandia each year and will make the experience better for everyone," Arthur said. "The building is certified for explosives use and it gets people out of the weather that can sometimes negatively impact the ability to train properly."

Arthur said one of the biggest challenges with training was much of it was outside and at multiple locations, "So, if the wind and weather came up, it impacted the ability to do some types of training. Because the trainings were at different locations, a lot of time was wasted moving between facilities, working through different facility rules and reviewing venues' safety processes. The new facility removes those inefficiencies."

BUILDING SUCCESS — Steve Bradshaw, NNSA Stabilization Federal Program manager, acknowledges the successful completion of the training facility. **Photo by Bret Latter**

NEW TRAINING SPACE — Sandia Applied Technologies Manager Sarah Mahoney and NNSA Stabilization Federal Program Manager Steve Bradshaw perform the ribbon-cutting for the new facility. **Photo by Bret Latter**

During the ribbon-cutting, NEST federal leadership presented two awards from DOE and NNSA for completing the facility and creating a first-of-its-kind joint enterprise: a Meritorious Service Award from Deputy Under Secretary Jay Tilden for counter-terrorism and counterproliferation, and an Achievement Award from DOE Secretary Jennifer Granholm.

Both awards honored the team for its support and dedication to the National Security Council-directed capability improvements and recognized the team's ability to complete the facility during the pandemic. Arthur said the facility construction was completed on time and under budget, both major successes considering unexpected challenges presented by COVID-19. Prior to the ribbon-cutting, the facility already hosted more than a dozen trainings.

"The facility gives Sandia and the DOE a professional, formal and efficient space to perform rigorous trainings that are critical for our nation," he said.

Sowing seeds, feeding families

By **Meagan Brace**

As part of National Volunteer Month in April, groups of Sandia volunteers helped their communities by packaging and distributing boxes of food and preparing garden beds for vegetables.

Sandia partnered with **Roadrunner Food Bank** to host a mobile food pantry at an AMC movie theater on April 22. Families waited in a line of cars to pick up food while volunteers loaded boxes into vehicles. By the end of the morning, Sandia distributed groceries to nearly 200 families. On April 30, a group of 20 volunteers from Sandia helped Roadrunner sort and package enough cereal at their warehouse to feed more than 800 families.

As the largest food bank in New Mexico, Roadrunner plays a major role in distributing food to people facing food insecurity. The nonprofit feeds an average of 70,000 people per week throughout the year.

On April 23, 15 Sandia employees and their family members helped the **Rio Grande Food Project** pull weeds, prime plant beds, transplant sunflowers, turn the compost and plant onions, beets, arugula, kale, lettuce, asparagus and basil in their urban garden.

Since 1989, the Rio Grande Food Project has worked to prevent and alleviate hunger throughout the Albuquerque metro area. The food pantry feeds more than 775 people each week and teaches the community how to grow fresh produce.

CULTIVATING CROPS — From left, postdoctoral appointee Atri Bera, systems engineer Joseph Mohagheghi and postdoctoral appointee Garrett Marshall plant asparagus – a 15-to-30-year crop – at the Rio Grande Food Project's urban garden. **Photo by Meagan Brace**

PIT STOP — Sandia engineer Edna Martinez promotes Roadrunner Food Bank's mobile food pantry to passing cars on Coors Boulevard outside the AMC movie theater. **Photo by Craig Fritz**

BURYING BULBS — Mechanical engineer Caroline Winters plants onions in one of 14 vegetable beds at the Rio Grande Food Project's urban garden. **Photo by Meagan Brace**

LOADING DOCK — Edna, left, and technologist Alex Hickman volunteer at Roadrunner Food Bank's mobile food pantry outside a movie theater on April 22. **Photo by Craig Fritz**

Plant tomatoes with Seed2Need

Community Involvement is seeking 70 volunteers to plant tomatoes with **Seed2Need** on May 14 at 8:30 a.m. Families are welcome. Seed2Need grows and harvests produce to fill food pantries.

Contact **Katrina Wagner** to register.

TO-GO BOXES — As cars pulled up to the Roadrunner Food Bank's mobile food pantry, Sandia volunteers like managers Haiqing Schwarz, left, and Samantha Darling loaded boxes into the back of their vehicles. **Photo by Craig Fritz**

FRESH FOOD — Environment, safety and health coordinator Kara Komula, front, was one of 15 volunteers who helped plant a variety of vegetables at the Rio Grande Food Project on April 23. The organization uses the urban garden to help educate the community about growing their own food. **Photo by Meagan Brace**

PREPPING BOXES — Business management professional Marlon Sadler prepares boxes that will each hold two bags of cereal at Roadrunner Food Bank. **Photo by Meagan Brace**

SCOOPING CEREAL — Computer scientist Bryan Watson scoops a pound of cereal into a plastic bag at Roadrunner Food Bank. Sandia volunteers packaged more than 1,700 bags of food on April 30. **Photo by Meagan Brace**

FEEDING FAMILIES — Postdoctoral appointee Jessica Kopatz was one of 20 volunteers who measured cereal, prepared boxes and packaged enough food at Roadrunner Food Bank on April 30. **Photo by Meagan Brace**