California's

Federal Labs & Research Centers

Stories of Economic Impact, Cutting-Edge Research, and Community Engagement across California

2023 Impact Report

CCST
CALIFORNIA COUNCIL ON SCIENCE & TECHNOLOGY

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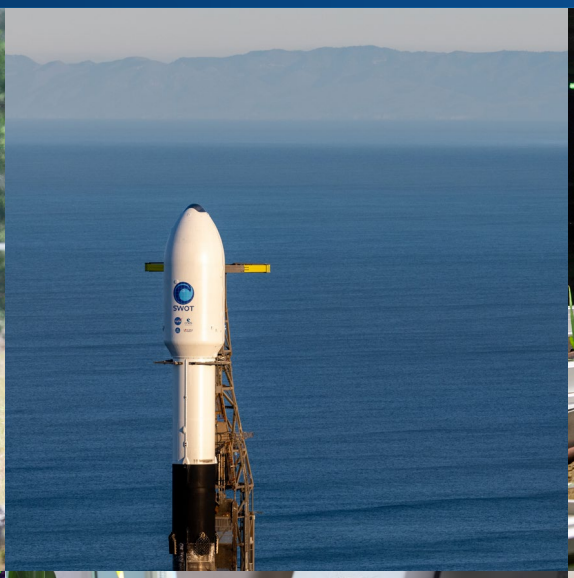

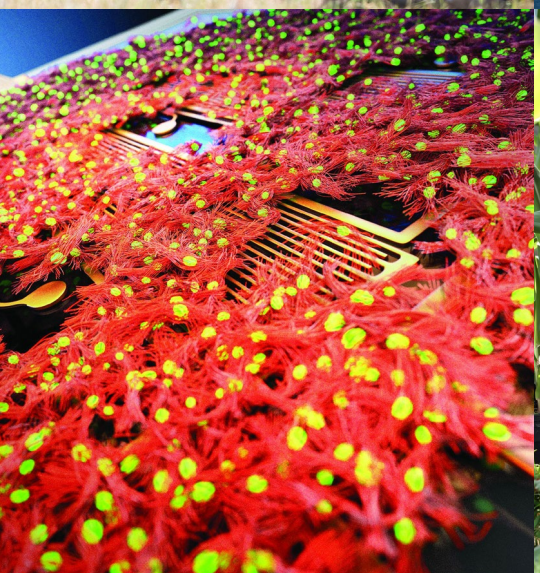

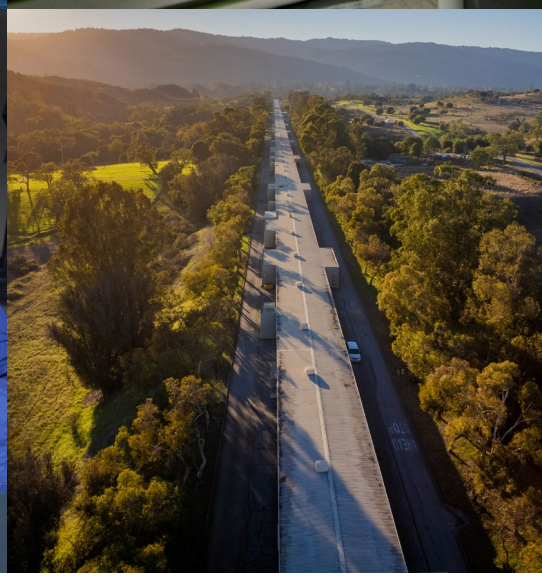

Ames Research Center

JPL
Jet Propulsion Laboratory
California Institute of Technology

BERKELEY LAB

Lawrence Livermore National Laboratory

Sandia National Laboratories

SLAC NATIONAL ACCELERATOR LABORATORY

Acknowledgments

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Note

The California Council on Science and Technology (CCST) has made every reasonable effort to assure the accuracy of the information in this publication. However, the contents of this publication are subject to changes, omissions, and errors, and

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For questions or comments on this publication contact:

California Council on Science and Technology
1017 L St, #438
Sacramento, CA 95814
916-492-0996
ccst@ccst.us
https://ccst.us

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3901 Carter Street #2, Riverside, CA 92501
www.agraphicadvantage.com

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INTRODUCTION

Dear Fellow Californians:

As the California Council on Science and Technology enters its 35th year of providing science and technology advice to the State, we celebrate the world class ecosystem of education and research institutions that sets us apart. Alongside academic powerhouses such as the University of California, California State University, California Community Colleges, Stanford, Caltech, and the University of Southern California, we also take pride in our unrivaled collection of federal laboratories and research centers.

Federal labs and research centers are set apart from other institutions by bringing to bear large-scale, mission-based projects and facilities on some of humanity's most pressing and difficult scientific questions. They represent billions of dollars of federal research investment, providing a wealth of knowledge and expertise that California can draw on. These labs take us deep inside the genetic code, support the foundations of our energy and national security, and even launch us toward the stars.

Today, California is at a crossroads. As the State continues to rebuild in the wake of the COVID-19 pandemic, complex and intersecting disasters—including wildfires, climate change, floods and drought—are radically disrupting the ways in which Californians live and work, and threatening catastrophic loss of life and economic impacts. California's federal labs and research centers are leveraging their world class expertise and technologies—as well as passionate researchers, students, and support staff—to invest in our resilience to disasters.

The unique nature of our federal labs and research centers puts them in an ideal position to pursue research and development in service of the public good. Whether it is developing tools to make our energy grid more resistant to external threats, using satellites to monitor emerging disasters to aid first responders, or deploying new technologies to decarbonize the transportation sector, the breakthroughs developed in these labs continue to benefit millions of Californians every year.

As California continues to move forward and confront big challenges, these labs and centers are ready to help. Here, we invite you to learn about just a few of the many ways that our federal labs and research centers are helping to make California—and the whole nation—more resilient.

Sincerely,

Amber Mace, PhD
CCST
CEO

Peter Cowhey, PhD
CCST Board Chair
UC San Diego

CONTENTS

ACCESSING CALIFORNIA'S FEDERAL LABS

Benefiting Governance and Livelihoods

California is home to a diverse range of federal labs, science centers, and field stations, spanning several U.S. agencies, departments, and bureaus. Six of these are founding members of CCST's Federal Laboratory Affiliates:

National Aeronautics and Space Administration (NASA) Field Centers

- Ames Research Center
- Jet Propulsion Laboratory

U.S. Department of Energy (DOE) National Laboratories

- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Sandia National Laboratories-California
- SLAC National Accelerator Laboratory

Why Tap into Federal Science?

Uniquely Positioned: Federal agencies such as DOE and NASA are uniquely positioned to contribute to California's scientific conversation. They leverage the might of federally directed research resources and facilities — bringing mission-oriented research and scientific facilities that complement the wealth of expertise at University of California, California State University, California Community Colleges, Caltech, Stanford, the University of Southern California, and other campuses.

Trusted Research Partners: Federal research includes many focal areas that can directly inform policy questions at the state level. Federal labs can partner with state agencies and campuses to conduct studies vital for our understanding of natural and physical processes. These federal-state-university partnerships require time for planning and implementation, but they yield collaborations and important knowledge for lifetimes.

Service to Policymakers: Each federal entity boasts a government relations team able to assist local, state, and federal offices. Together with CCST, these liaisons serve as a resource for community members and officials who want to learn more about federal labs and their broader impact for California.

CCST FEDERAL LABORATORY AFFILIATES

Why CCST?

The **California Council on Science and Technology (CCST)** is a nonpartisan, nonprofit organization established via **Assembly Concurrent Resolution 162** in 1988. The resolution directed CCST "to respond to the Governor, the Legislature, and other entities on public policy issues related to science and technology." To deliver independent advice to state policymakers, CCST engages science and technology (S&T) experts across California's research enterprise, including through formal partnerships with the University of California (UC), California State University (CSU), California Community Colleges (CCC), Stanford, the California Institute of Technology (Caltech), the University of Southern California (USC) and the six federal laboratory partners described above.

By connecting policymakers with leading scientists in California and beyond, CCST increases policymaker access to S&T advice that is informed by diverse expert perspectives. Over the past three decades, state leaders have requested CCST reports and expert briefings on many issues of policy importance, from natural gas storage safety to sustainable water futures. The connections we facilitate between policymakers and scientists also enhance the ability of our 12 Partner Institutions to transmit S&T information for the public good, including by expanding opportunities for experts to participate in the policy arena and by identifying questions that will drive future research and innovation.

About the CCST Partnership with Federal Laboratories

In 2005, there was growing interest by state leaders to improve access to expertise found at federal laboratories and science centers across California, and engage them on issues affecting the Golden State.

The call for advice coincided with conversations and coordination already ongoing between CCST and several federal research institutions in California. CCST welcomed six new Partner Institutions.

Of the six institutions, four came from the U.S. Department of Energy: the **Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories,** and **SLAC National Accelerator Laboratory;** and two came from NASA: the **Jet Propulsion Laboratory** and the **Ames Research Center.**

CCST Disaster Resilience Initiative

In 2020, in recognition of a need for more agile science and technology advisory frameworks for the state and the increasing threat of natural disasters in California, CCST launched a **Disaster Resilience Initiative,** focused on increasing the delivery and responsiveness of the science advisory support provided by CCST's science and technology experts to California policymakers. This five-year public-private partnership will convene diverse, interdisciplinary experts from throughout CCST's network to address the State's most urgent disaster resilience advisory needs through a series of needs-finding workshops, briefings to policymakers, advisory meetings, and other engagements.

How CCST Can Help

California's leadership in technology, environmental stewardship, clean energy, and other critical fields relies on its policymakers having access to clearly communicated, scientifically informed advice. CCST can help Legislators, appointed officials, and Capitol and executive branch staff navigate the tremendous resources spread across federal labs and science centers in California. CCST's access to the Federal Laboratory Affiliates has resulted in several high-impact reports that have been useful to state leaders, delivering timely, nonpartisan, scientific analysis on complex issues. Examples include:

- **The Costs of Wildfire in California (2020):** This report summarizes the state of knowledge regarding wildfire losses and their associated costs across key sectors. It challenges the assumptions underlying current fire management policies and proposes a novel framework for understanding the total cost of wildfire in California. The report relied on vital input from expertise at Lawrence Berkeley National Laboratory.

- **Remote Sensing Technologies and Water Resilience (2021):** This Expert Briefing brought together scientists from Lawrence Berkeley National Laboratory, NASA's Ames Research Center, and Jet Propulsion Laboratory to discuss the role of satellite based measurements in sustainable groundwater management with members of the Capitol community.

- **Building a Resilient Energy Grid to Respond to Escalating Hazards (2022):** This scientific session presented at the 2022 Annual Meeting of the American Association for the Advancement of Science (AAAS) took a broad look at the threats facing the energy grid and discussed the qualities that enhance its resilience, as well as the challenges in quantifying a system's resilience. The panel featured researchers from Lawrence Livermore National Laboratory and SLAC National Accelerator Laboratory.

- **Decarbonizing Transportation with Hydrogen (2022):** This Expert Briefing explored the role of hydrogen as a potential avenue for decarbonizing the transportation and trucking and freight sectors. The panel of experts featured a scientist from Sandia National Laboratories.

- **California's Fifth Climate Change Assessment (2022):** CCST, in partnership with the Governor's Office of Planning and Research, hosted a series of six public roundtables to discuss California-specific information and knowledge gaps that will help inform the scope of climate change research conducted as part of California's Fifth Climate Change Assessment. Roundtable participants included experts from Lawrence Berkeley National Laboratory and Jet Propulsion Laboratory.

When to Contact CCST

Policymakers should contact CCST:

- During policy development, to obtain data and advice from subject area experts.
- During the legislative process, to find experts for testimony at policy, fiscal, select committee, and other hearings.
- During implementation and regulatory enforcement, accessing current science to review standards, technologies, efficacy, and relevance.
- When analyzing natural disasters and human-engineered catastrophes and planning for prevention, preparation, response to, and recovery from these events.

If your office is considering legislation, regulations, or other work products that you believe would benefit from science and technology expertise, or if you are seeking data and advice to strengthen your decisions with science, **contact CCST** — and we will help you navigate the bounty of top scientific minds available to California.
(See p.34 for CCST contact information)

FEDERAL LABS RESEARCH BENEFITING CALIFORNIA

In Service to the Nation and Its States

California has a long history of facing a wide variety of disasters and threats, from wildfires and earthquakes to pandemics and bioterrorism. Because of their state-of-the-art facilities, longstanding collaborations, and cross-disciplinary organization, the federal labs in California are uniquely positioned to coordinate the large research projects needed to develop technologies and inform strategies to improve the state's resilience.

Below is a small sample of the labs' recent and ongoing research with major implications for how California prevents, prepares for, responds to, and recovers from disasters. Beyond these important contributions, the labs are vital members of their local communities, employing thousands of Californians, supporting State businesses, and investing directly in these communities. Among the highlights of cutting-edge science and technology are stories of the many ways that the labs use their unique assets to provide tangible benefits to communities within California.

This overview is not an exhaustive list of all projects and research areas at these institutions, nor does it represent all federal labs and science centers located here in California. However, these highlights do illustrate the amazing breadth of federal research and applications available to policymakers in Sacramento.

NASA Ames	NASA's Ames Research Center
NASA JPL	NASA's Jet Propulsion Laboratory
Berkeley Lab	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
Sandia California	Sandia National Laboratories-California
SLAC	SLAC National Accelerator Laboratory

Preparing for Disasters

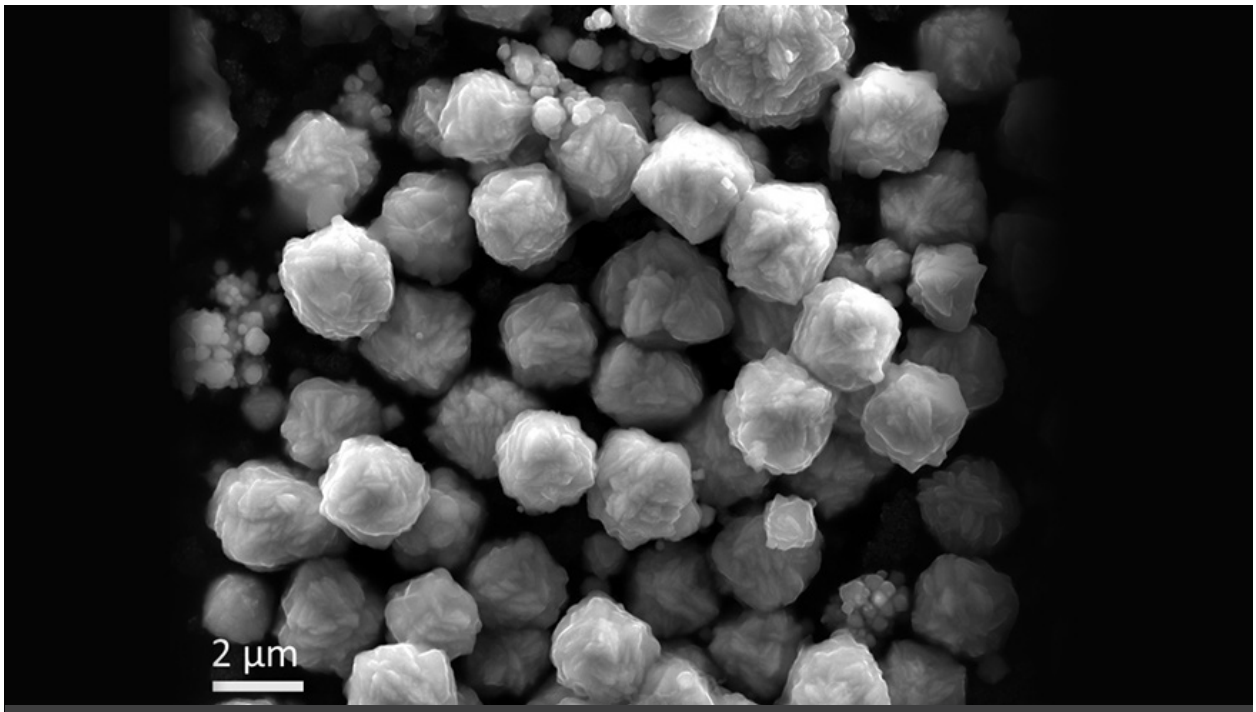
Drought-proofing California's water supplies. A Berkeley Lab study projects that the Sierra Nevada could face persistent low-to-no snow years by the late 2050's. The Lab's Surface Atmospheric Laboratory (SAIL) has installed instruments along the headwaters of the Colorado River to provide researchers and water managers with better predictions of usable runoff to inform future reservoir operations. In response to the loss of snowpack, the region will need new strategies to ensure our water supplies. As one solution, Berkeley Lab research is supporting nature-based and engineered solutions to store more runoff through managed aquifer recharge. Further, through its leadership of the National Alliance for Water Innovation, the U.S. Department of Energy's "'Manhattan Project' for water desalination," the Lab is developing new low-cost, low-energy technologies aimed at enabling use of impaired waters and broader water re-use.

Climate effects on landslides. Slow-moving landslides, in which earth moves very slowly over a long period of time, can unexpectedly destabilize, causing catastrophic loss of life and property damage. A team of researchers at NASA JPL analyzing these events in California found that landslides in both wetter and drier regions in the State showed similar sensitivity to sudden extremes in precipitation. The study team used data obtained by the European Space Agency in conjunction with the JPL-Caltech Advanced Rapid Imaging and Analysis (ARIA) Center for Natural Hazards to gain new insights into the effects of a changing climate on landslides in California.

Combatting antibiotic resistance. Exacerbated by the overuse of antibiotics in human and livestock, antibiotic resistant bacteria have resulted in increased mortality and financial strain on society. Certain naturally occurring clays have been shown to have antimicrobial properties and kill antibiotic resistant bacteria. Harnessing the activity of compounds within these clays that harbor antibiotic properties offers new therapeutic opportunities for fighting the potentially devastating effects of the post antibiotic era. A team of LLNL researchers have successfully produced fully synthetic versions of antibacterial minerals, while controlling the purity and reactivity of the compounds. Utilizing hydrothermal reactors, the team has developed protocols to synthesize chemically pure materials that mimic the physical and chemical properties of natural samples.

Science to Reduce Explosive Wildfire Risks. Advance a Circular Economy. While increased vegetation helped the land and oceans double CO2 uptake over the last 50 years, historically crowded tree densities and higher temperatures are increasingly producing destructive mega-fires. Berkeley Lab researchers have partnered with UC Berkeley and others to develop a mobile biomass processing unit designed to gasify forest thinnings onsite, aimed at significantly reducing the cost of forest treatment and producing usable gas or liquid fuels. Researchers have also led development of the Functionally-Assembled Terrestrial Ecosystem Simulator (FATES), to model how climate change will affect the regeneration of burned lands and inform reforestation and carbon management strategies. And the Lab's shared biomanufacturing process demonstration unit is being used by researchers and industry to advance the circular economy by pioneering the conversion of waste CO2 – from forest thinnings, farm and industrial wastes, as well as the atmosphere – back into low carbon biofuels and commercially valuable, long-lived materials.

Modeling Extreme Weather Events. Numerical models are critical tools in predicting Earth's climate conditions due to the complex and interrelated processes controlling the



A team of researchers at LLNL are developing new synthetic compounds to aid in combatting antibiotic resistant bacteria Credit: LLNL

weather. Though developing simulations depicting the entire planet's weather is challenging, global coverage continues to be necessary as local behavior spreads rapidly to distant areas of the globe. Using the Energy Exascale Earth System Model (E3SM) as the template, an LLNL-led research team has developed a powerful high resolution new global atmosphere model: the Simple Cloud-Resolving E3SM Atmosphere Model (SCREAM). This high-resolution model is 30 times finer than the typical resolution for global climate models. The new model also captures the structure of important weather events, such as tropical and extratropical cyclones, atmospheric rivers, and cold air outbreaks which are poorly captured by typical climate models.

Measuring Sea level rise. Home to a suite of sea level height satellites and modeling tools since 1978, NASA JPL measures and predicts sea level rise. A recently published study from a team of NASA JPL researchers offers new insights into the rate of sea level rise in the U.S., with results showing an average rise of approximately one foot for most coastlines by 2050. The report utilized data from the Sentinel-6 Michael Freilich Satellite, launched in 2020, the latest in a series of satellite-based ocean height measurement missions conducted in partnership with France's space program.

Unmanned Aerial Vehicles and Smart Mobility. Innovation and diverse aircraft are key to NASA Ames' response to climate change and wildfires. A small, uncrewed vehicle carrying instruments for wildfire and volcano science observations–developed through a small-business partnership with NASA – is one example. To help researchers devise more such uses for drones, aeronautics staff on the Smart Mobility team are creating a test environment at Ames. Technology they're developing and integrating can increase pilots' situational awareness in complex settings such as when fighting wildfires.

Building Resilient Infrastructure

Advancing Hydrogen (Electric Fuel Cell) for a Resilient Grid, Strong Economy. Use of hydrogen fuel cells can help industries decarbonize and keep the electric grid resilient during periods of low renewable energy production. Berkeley Lab co-leads the U.S. Department of Energy's Million Mile Fuel Cell Truck Consortium, aimed at developing rugged fuel cells that can power long-haul trucks a million miles, and is a leading lab in developing technologies to lower the cost of electrolysis. Berkeley Lab's geosciences division is also assessing options for underground storage of hydrogen. Through support for California's ARCHES consortium, the Lab is working with the Governor's Office and the University of California to compete for a $1.25 billion federal grant to accelerate the use of green hydrogen for heavy-duty transportation and other hard-to-electrify sectors.

Improving Hydrogen Storage Materials. Hydrogen can store surplus renewable power, decarbonize transportation, and serve as a zero-emission energy carrier for sustainable energy use, but storing hydrogen poses great technical challenges. To overcome the challenges of conventional high-pressure or cryogenic storage, LLNL and collaborators have turned to metal hydrides. They provide exceptional energy densities and can reversibly release and take up hydrogen under relatively mild conditions. The scientists found a new way to ease the thermodynamic limitations on hydrogen uptake after initial release using a novel form of a material called alane—or aluminum hydride.

Water desalination. SLAC will collaborate with Stanford University in a research project led by the National Alliance for Water Innovation aimed at developing energy-

On December 16, 2022, NASA launched the Surface Water and Ocean Topography (SWOT) satellite from the Vandenberg Space Forece Base. Credit: NASA

LLNL partners with city of Livermore to reduce carbon emissions

Lawrence Livermore National Laboratory (LLNL) has signed a memorandum of understanding (MOU) with the city of Livermore to collaborate on advancing climate action in Livermore and build community-wide resilience to climate change impacts. The city's Climate Action Plan (CAP), anticipated to be adopted by the Livermore City Council this summer, will create a roadmap to achieve carbon neutrality (also known as net-zero emissions) by 2045. The CAP also will include adaptation and resiliency strategies to prepare Livermore for a changing climate.

The city is developing strategies to be consistent with state climate mitigation targets and new legislation that requires cities to plan for the impacts of climate change. The goal of the MOU is to present opportunities for collaboration toward advancing climate action in the community of Livermore and beyond. Last year, city officials met with LLNL representatives to discuss cooperating to demonstrate climate technologies at various sites and explore other potential collaborations and funding sources.

LLNL researchers proposed three climate technologies that could be demonstrated at several locations within the city. The first, biogas utilization, focuses on carbon removal from biomass and could be piloted at the sewage plant on the north side of Livermore. The second technology, known as "carbon farming," functions by increasing decomposing plant material and microbes in soil; in urbanized areas like Livermore, improving the soil in this way can improve carbon uptake. Finally, creating localized, autonomous power microgrids can help assure electricity remains online during wider outages.

For more information on this initiative, visit LLNL's website.

efficient technologies to decontaminate nontraditional water sources for diverse uses including agriculture and drinking water. The lab will lend its powerful X-rays to studies that could, for example, reveal the physical processes underlying reverse osmosis, which could in turn suggest new materials for clean water technologies.

Energy Storage, Flexible Demand for an Affordable, Resilient Grid. As California works to triple the capacity of its electricity grid, Berkeley Lab is leading work to ensure this transition is both resilient and affordable. Berkeley Lab's Energy Storage Center engages over 200 researchers to support discoveries both in next-generation batteries and in lower-cost long duration energy storage, in support of DOE's Long Duration Storage Earthshot and the Energy Storage Grand Challenge. This includes storage technology demonstrations and deployments in microgrids to fully utilize renewable sources.

The Lab-led CalFlexHub, funded by the Energy Commission, is developing, testing and

SLAC building resilient—and cool—farms in Central California

Credit: David Krause, SLAC National Accelerator Lab

Four years ago, Gustavo Cezar's team with SLAC's GISMo lab—which stands for Grid Integration, Systems and Mobility—installed smart fans, solar panels, batteries, electricity meters, and weather sensors at a Central California farm. Together they help to keep the animals cool inside the barn and minimize the farm owner's electricity costs, specifically by collecting real-time data, such as from the temperature sensors and the local electricity rates. The system then optimizes the operation of the fans and batteries to ensure the fans run when needed and at the lowest possible cost—an approach that has saved the farmer thousands of dollars each month.

For more information on this initiative, visit SLAC's website.

demonstrating novel software and automation controls to move electric load into non-peak times, making better use of existing generation resources and reducing ratepayer costs.

Reducing Reliance on Diesel Fuels with Hydrogen Ferry. Scripps Institution of Oceanography partnered with Sandia to develop a concept for hydrogen hybrid research vessels that can replace current research vessels powered by diesel engines. In addition to polluting the air and ocean, diesel engines can also corrupt samples and degrade the sensitivity of underwater hydrophones. This collaboration led to $35 million of funding from the California Legislature to build the first hydrogen hybrid research vessel.

Sandia Celebrating Young Women in STEM

Credit: Sandia/California

The Sandia Women's Connection hosted the 30th annual Math and Science Awards. The Labs honored 38 female students from high schools in and around the Livermore Valley. Honorees are nominated by their teachers and awarded for their achievements in either math or science. The transition between high school and college is a critical point for young women as they decide whether to pursue STEM careers. One contributing factor for girls who turn away from STEM is thought to be a lack of female mentors in scientific fields. SWC hopes the awards will inspire juniors to both study STEM majors in college and connect with women at Sandia who can advise and encourage them in those fields.

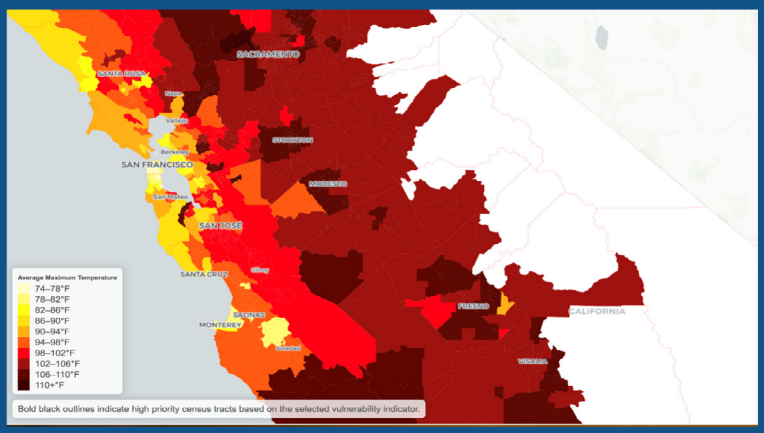
For more information on this program, visit Sandia's website

Improving Energy Resilience Through Longer-Lasting Batteries. Researchers at SLAC and Stanford University may have found a way to revitalize rechargeable lithium batteries, bringing "dead" lithium back to life. The study is one of many aiming to boost the range of electric vehicles and battery life in electronic devices. The new SLAC-Stanford Battery Center will spur collaborative R&D between the lab, the university, and industry to bridge the gap between discovering and deploying sustainable energy storage solutions.

Breaking down energy storage barriers. LLNL scientists and collaborators have developed a broad suite of multiscale simulation capabilities to help identify, assess, and overcome microstructural impacts on ion transport in solid electrolytes. Through new research, the team gained a better understanding of the detailed relationship between microstructure and ionic transport properties. Exploring ion transport can help resolve long-standing debates about the importance of microstructure in solid electrolytes. This knowledge is critical to create viable solid electrolyte materials that retain high ionic conductivity.

Net-Zero Planning. Climate change is an urgent and growing threat to national and global

Berkeley Lab Protecting Vulnerable Fresno Neighborhoods from Extreme Heat.



Credit: Berkeley Lab

Disadvantaged communities bear a great climate and pollution burden, with extreme heat in particular growing in severity, duration, and frequency. Residents of these communities are often among the least prepared to cope with heat waves. A team of Berkeley Lab researchers worked closely with two local community-based organizations in the Fresno area (West Fresno Family Resource Center and Every Neighborhood Partnership) as well as several other local stakeholders to complete two projects focused on advancing climate equity and heat and resilience in several disadvantaged neighborhoods in Fresno, a city with poor air quality that is historically underserved and with most homes built prior to 1980.

security. Sandia is committed to addressing this threat through science, technology, and action. Modeling the way forward in site sustainability, Sandia is developing a plan to achieve net-zero emissions at its Livermore campus, as well as three other related goals: net-zero energy consumption, increased energy resilience, and demonstration of new net-zero technologies. From advancing building efficiency to investing in on-site renewable energy like solar and wind, this effort will incorporate a variety of approaches that not only reduce emissions but also improve laboratory safety and efficiency, while enabling greater resilience to the impacts of climate change.

Environmentally friendly mineral extraction. A new method developed at LLNL improves the extraction and separation of rare-earth elements—a group of 17 chemical elements critical for technologies such as smart phones and electric car batteries—from unconventional sources. Current methods for extracting and separating rare earths from such sources as industrial and electronic waste rely on harsh chemicals, are labor intensive, and are high cost. New research led by scientists at Pennsylvania State University and Livermore demonstrates how a protein isolated from bacteria can provide a more environmentally friendly way to extract these metals and to

Berkeley Lab performed: (1) neighborhood-scale modeling results for 17 active and cooling measures to better cope with extreme heat in Fresno; and (2) modeling of integrated packages including energy efficiency measures, electrified space and water heating, solar PV, and electric vehicles in residential sector single family homes. Both projects employed extensive community outreach to better focus research modeling and prioritize measures. Both projects also utilize the CityBES modeling platform for community-scale modeling of residential sector upgrades to improve resilience to extreme heat and to lower CO2 emissions, and the methodology from these two studies can be applied to other low disadvantaged communities. For the heat resilience project ("Cal-THRIVES"), performed for the Strategic Growth Council, Berkeley Lab developed a cooling toolkit that comprised community cooling guides, technology fact sheets, a heat vulnerability index tool, and policy and program recommendations. The toolkit is available online at Cal-THRIVES.lbl.gov.

Collecting and responding to community feedback was a key part of both projects to help understand how residents cope with extreme heat; to better understand resident needs, preferences, barriers to proposed cooling strategies and how they view community cooling centers; and to inform our modeling assumptions on baseline equipment. Outreach methods included community meetings; focus groups, in-home interviews, and phone interviews. Lab researchers found that most residents (60-70%) are not comfortable in their homes in hot or cold weather very often. This is an area to improve equity and provide better indoor comfort and safety during the summer and winter without increasing energy bills. Residents that lack air conditioning units (about 15% of homes) are especially vulnerable to extreme heat.

Among passive cooling measures, window films, roof/ceiling insulation, and cool walls are the among the most effective passive measures overall. Natural ventilation on top floors is very helpful as well (opening windows at night to admit cooler air) but may be limited if outdoor air quality is poor. For active cooling measures, fans improve comfort and can reduce electricity bills; while homes with evaporative coolers only (aka swamp coolers) greatly benefit from getting air conditioners.

For more information on this initiative, visit Berkeley Lab's website

separate them from other metals and from each other. The method could eventually be scaled up to help develop a domestic supply of rare-earth metals from industrial waste and electronics due to be recycled.

Microgrid Development. Sandia is well known for designing reliable and resilient microgrids for military bases and vital city services. Researchers at the Labs are now working with NASA to design a microgrid for an American moon base. The research underway is also relevant to creating resiliency for communities on Earth, designing systems that are self-sustaining and can continue operating even if a solar panel array is damaged. 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.

A drone being used in wildfire response operations is seen flying at the Dixie fire in Northern California in August 2021. Software developed by the STEReO project for coordinating multiple parts of a fire response could be used on a tablet in the field, much like this pilot is using today's commercially available software. Credit: National Park Service/Joe Suarez

Responding to Ongoing Disasters

Assessing and Responding to Energy Grid Threats with GISMo. SLAC's Grid Integration, Systems, and Mobility (GISMo) lab explores the intersection of the power grid, building and ambient intelligence, and human mobility. Building upon the lab's efforts to integrate and utilize large amounts of energy data, the Grid Resilience and Intelligence Project uses artificial intelligence and machine learning to identify vulnerabilities in the grid and build capabilities to anticipate and recover from grid events.

Swift HALE. Through NASA's Small Business Innovation Research program, California's Swift Engineering, with support from NASA Ames, developed a high-altitude, long-endurance uncrewed aircraft to carry scientific instruments and other small payloads. It is designed to stay aloft for 30 days at 65,000 feet, and its first flight provided critical data to prove that design requirements were met. Such aircraft can complement satellites with data on regional scales, and NASA is exploring their use for Earth system science and disaster response. Ames is partnering with the U.S. Forest Service to fly this vehicle in 2023 to demonstrate applications for fire science and management. These platforms have the potential to provide imagery similar to a geostationary satellite. During or after a natural disaster, they could gather real-time data or provide a communications relay.

Observing the SARS-CoV-2 virus. Over the past two years, scientists have studied the SARS-CoV-2 virus in great detail, laying the foundation for developing COVID-19 vaccines and antiviral treatments. Researchers recently used powerful X-rays at SLAC's Stanford Synchrotron Radiation Lightsource to catch the virus severing a critical immunity pathway at the molecular level. Another study using SLAC's cryogenic electron microscopy technology, or cryo-EM, produced 3D images of RNA from the virus, revealing tiny pockets that play a key role in its ability to replicate. These novel views deepen our understanding of how SARS-CoV-2 operates and could potentially inspire new therapeutic approaches.

Effects of Extreme Heat in a Changing Climate. Scientists at NASA JPL are measuring the impacts of drought and rising temperatures using an instrument on the International Space Station called ECOSTRESS, which measures the temperature of plants as they heat up when they run out of water. One recent study that utilized ECOSTRESS data has provided insights into the relationship between California wildfire intensity and water stress in plants measured in the months prior to the fires. Other studies use ECOSTRESS data to explore how built and natural surfaces respond differently to extreme heat in cities such as Las Vegas or Delhi.

NASA Ames: Fighting Fire with Drones

The Scalable Traffic Management for Emergency Response Operations, or STEReO, team at NASA Ames, led by principal investigator Joey Mercer, is designing software and communication tools to help disaster responders work more safely and efficiently. Part of their approach is to scale up the use of unmanned aircraft systems, or UAS, also called drones.

Drones are good for capturing thermal images of the landscape below. The heat signatures obtained can help determine where firefighters should establish fire-containment lines dug either by bulldozer or by hand. "The smarter we are about their operations, the smarter capabilities we can create," said Mercer. "They're running operations at night. They don't know what terrain they'll encounter, or where they can launch their aircraft from. There are so many details about their working environment that are hard to capture in conversation or get lost in translation."

To help make their tools as useful as possible, Mercer and members of his team join wildland firefighters in the real-world setting of active wildfires. Between the Dixie, Caldor, McCash, and Windy fires, scattered across the state, but concentrated in Northern California, they shadowed drone pilots and incident personnel from three different agencies: CAL FIRE, the U.S. Forest Service, and the National Park Service.

On the frontlines of the Dixie fire, a drone was sent to look for any traces of fire down a steep gully. The thermal data it collected helped decide whether crews could safely attempt to hold the fire there, or if they should work from the next ridgeline, even if it meant losing more acres to the flames.

The location of nearby piloted aircrafts is one example of essential information the STEReO team is working to provide to drone pilots. The challenge of tracking those aircraft is the focus of STEReO's prototype tool kit for drone pilots.

At the McCash fire, the team deployed the pilot kit for the first time during an active incident. This was an important opportunity, both for the team to test their technology in a true operational setting, and for the firefighters to see it at work. That context easily and efficiently revealed how the tools could be improved in the next round with certain tweaks.

Drone pilots remain fairly rare at wildfire response operations, while the fire community works with partners like STEReO to find the safest, most efficient ways to take advantage of their unique contributions. As California's fire season burns on, the NASA team will continue its observations in the field, learning from the firefighting experts how STEReO's tools could help them most.

For more information on this work, visit NASA Ames' website.

Rebuilding with Resilience

Combatting Climate Change by Transforming CO2. SLAC scientists and their collaborators at Stanford and around the world are developing ways to transform carbon dioxide into something more useful. In one project, scientists at SLAC and Stanford made a new catalyst that works with either heat or electricity. Their work aims to bridge these two approaches to spur chemical reactions with the goal of discovering more efficient and sustainable ways to convert carbon dioxide into useful products. Meanwhile, an international team of scientists used advanced X-ray sources at SLAC and Argonne National Laboratory to discover how a soil microbe could rev up artificial photosynthesis. Their results, which showed a bacterial enzyme converts carbon dioxide into other compounds 20 times faster than plant counterparts, could further efforts to turn carbon dioxide into fuels, fertilizers, antibiotics and more.

E-Nose. A rapid and non-invasive screening tool could "sniff out" COVID-19 in patients' breath with a spaceflight-proven, re-usable electronic nose (E-Nose) technology from NASA Ames. Originally developed for trace chemical detection in space, its sensors are being tuned to detect COVID-19 through breath analysis. Using an instrument attached to a smartphone – and NASA expertise in advanced machine-learning methods – the results from the E-Nose will combine with body temperature and other non-invasive symptom screening to provide more accurate on-the-spot answers. The screening results can then be transmitted via cellphone or WiFi networks.

Earthquake Recovery. Major earthquakes in California can destroy or damage thousands of buildings and critical energy and water infrastructure. To prepare for future large earthquakes, Berkeley Lab is using its advanced supercomputers to run regional-scale, fault-to-structure simulations of earthquakes and associated infrastructure response to assess the earthquake risk to buildings and energy system infrastructure across the entire Bay Area. The Lab is a partner in the Large-Scale Laminar Soil Box System, the largest facility in the U.S. for assessing how soil around a structure will influence its performance during an earthquake. After a major earthquake, safety assessments and repairs can take many months, disrupting critical operations and delaying economic recovery. To speed up recovery, Berkeley Lab has developed, extensively tested and deployed an optical sensor system that building managers can use to quickly pinpoint the location and extent of damage in critical infrastructure systems.

COVID-19 Assessment Tools. A simple-to-use COVID-19 exposure assessment tool (CEAT) developed by members of the COVID-19 International Research Team, including researchers at NASA Ames. People tasked with making safety recommendations for their organizations, such as businesses, schools, and civic groups, can use the tool to inform their approaches to reducing viral exposure. The tool applies to groups of up to 250 people, both indoors and out, and relies on information users would have available or could reasonably estimate. CEAT addresses mechanisms that are within the organization's control and communicates a clear and easily interpretable result. Demonstration of the tool, from published studies of COVID-19 transmission events, shows it accurately predicts transmission, outperforming older and more established models. CEAT has been implemented by multiple institutions to improve their safety decision making, including NASA Ames.

CALIFORNIA'S FEDERAL LABS: 2023 IMPACT REPORT

Six federal laboratories and science centers have formal partnerships with CCST. The following reports offer a glimpse of the resources and expertise that each lab can offer to California's decision makers, including examples of ongoing collaborations with universities, businesses, and agencies, and where federal research has been successfully translated into policy advice or industry solutions.

NASA

- NASA's Ames Research Center
- NASA's Jet Propulsion Laboratory

DOE

- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- Sandia National Laboratories – California
- SLAC National Accelerator Laboratory

ECONOMIC IMPACTS

Federal Budget:	$8.4 billion
Payroll:	$3 billion
Employees:	More than 27,000
Patents Issued:	More than 1,200
Procurement to California Businesses:	$1.7 billion
Procurement to Small Businesses:	$650 million

NASA'S AMES RESEARCH CENTER

www.nasa.gov/ames
Moffett Field, Santa Clara County
(AD-23, SD-13)

Eugene L. Tu, PhD, Center Director

Lisa Lockyer, Government Affairs
lisa.l.lockyer@nasa.gov | (650) 604-3009

Michele Johnson, Office of Communications
michele.johnson@nasa.gov | (650) 604-6982

Impact to the Region and State

Founded in the San Francisco Bay Area more than 80 years ago, NASA's Ames Research Center has shaped the region with its passion for knowledge and technology. Today, by bridging public and private partnerships to capitalize on the innovation and entrepreneurship resident here, Ames is helping NASA take essential steps forward to the Moon – through Silicon Valley. In parallel, the Ames presence in this important region offers California easy access to NASA technologies, facilities, and expertise. Ames and its partners provide California with the opportunity to quickly connect to a wide range of potential solutions to challenging regional concerns.

Many NASA-developed technologies and discoveries have practical applications and significant future commercial value through the creation of new industries, products, services, and jobs (e.g., small, inexpensive satellites). NASA Ames is deeply committed to collaborations, both public and private. In fiscal year 2022, the NASA Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) programs provided more than $31 million in Phase I and Phase II awards to California firms, and an additional $19 million in Post Phase II investments through Phase II-Extended, Sequential Phase II, and Civilian Commercialization Readiness Program awards to assist the firms in bridging the "valley of death" to bring their technologies to the marketplace.

Resources and Expertise

NASA Ames' service to California includes:

1. A trusted source of subject matter experts.
2. Unique aerospace and earth science technologies.
3. Advanced modeling and simulation capabilities.
4. Testing facilities and intellectual property, which support collaborations that lead to regional economic development.
5. Core competencies in air traffic management, entry systems, advanced computing and IT systems, intelligent/adaptive systems, cost-effective space missions, aero-sciences, astrobiology and life sciences, and space and earth sciences.

NASA'S PORTAL TO SILICON VALLEY

NASA's Ames Research Center applies the spirit of Silicon Valley to NASA's mission, and there's a little bit of Ames in every launch and flight. The numerous one-of-a-kind facilities here and interconnected areas of expertise are vital elements of the nation's strategy for exploration.

Ames combines biology and space technology with two driving aims: detecting life off of our planet and understanding how Earth life is different in space, so healthy humans can explore from the Moon to Mars. Closer to home, Ames leads the national research initiative to devise the best ways for commercial drones, flying cars and aircrafts to safely share America's skies.

NASA in Silicon Valley contributes to the nation's technical prowess as only a government research organization can: when research matures to a place where others can do it, they seek out partners. NASA Ames serves as an active portal bringing together specialized NASA R&D along with a research cluster of affiliated high-tech companies, universities, and other federal laboratories. To advance both NASA's mission and the American economy, Ames shares its knowledge… and moves on to the next unknown.

BY THE NUMBERS
No. of Employees: 4,557
Annual Budget: $982 million (2022)
Annual Payroll: $271 million (2022)
Procurements to CA Businesses: $342.8 million (2022)
Spin-off Companies: 159 (since 1997)

NASA Ames has partnered with the California Department of Water Resources, the California Department of Parks, the California Natural Resources Agency, and the San Francisco Bay Conservation and Development Commission. Such collaborations offer breakthroughs each year for the benefit of the American public. NASA Ames continues to expand partnerships that can leverage taxpayer-funded NASA research and technology for the benefit of the State of California and the country.

Success Story: Setting Aircraft Efficiency Standards

While most people equate NASA with space exploration, the agency helps set standards across the general aviation industry and influences how Americans fly every day. Empirical Systems Aerospace, Inc. of San Luis Obispo, California, received SBIR awards to increase efficiency in commercial aircrafts, resulting in lower fuel costs and fewer harmful emissions. The work has led to follow-on NASA contracts, subcontracts with the Department of Defense, and increased collaboration with many of the nation's top companies.

Recent Headlines

"Traffic Jam at 400 feet – NASA and the FAA are working to revolutionize air traffic control for the drone era." – Bloomberg, July 21, 2022

"The Capstone Launch Will Kick Off NASA's Artemis Moon Program" – Wired, June 24, 2022

"NASA Needs to Find Ice on the Moon. This Rover Will Lead the Search" – New York Times, June 11, 2020

Legislators Say...

"At the Ames Research Center in Silicon Valley, NASA helps launch innovation. The discoveries made there are a benefit to all Californians.
— Assemblymember Marc Berman (D-Palo Alto)

"NASA's Ames Research Center is a tremendous source of innovation in the area."*— Senator Josh Becker (D-San Mateo)*

NASA'S JET PROPULSION LABORATORY

www.jpl.nasa.gov
Pasadena/La Cañada Flintridge, Los Angeles County (AD-41, SD-25)

Laurie Leshin, PhD, Director

Cindy Lee, Government Affairs
cindy.lee@jpl.nasa.gov

Impact to the Region and State

Home to Mars rovers, space telescopes and an array of Earth-orbiting satellites, the NASA's Jet Propulsion Laboratory (JPL) is one of NASA's premier research facilities. Beginning in the 1960s, NASA JPL made news as it created America's first satellite and sent the first robotic spacecraft to the planets. As of 2017, NASA JPL is responsible for 19 spacecraft and 10 major instruments carrying out active missions. In addition, NASA JPL developed and manages NASA's Deep Space Network, a worldwide system of antennas that communicate with interplanetary spacecraft.

As a federally funded research and development center (FFRDC), NASA JPL is staffed and managed for NASA by the California Institute of Technology (Caltech). This unique relationship creates an intellectual infusion with a university campus whose faculty and alumni have garnered 31 Nobel Prizes, 53 National Medals of Science, and 12 National Medals of Technology.

This Caltech-JPL synergy is boosted by cooperative initiatives, dedicated research seed funding, and joint-faculty appointments. Furthermore NASA JPL's research is conducted in 1,138 laboratory or technical rooms in 76 buildings on the main campus and extends into space with 29 currently active missions.

Resources and Expertise

NASA JPL's expertise is of particular potential benefit to California in two broad areas: 1) regional decision support systems based on Earth observations and models, and 2) advanced technology and earth science. Resources include airborne and spaceborne instruments that remotely:

1. Measure ground subsidence due to aquifer discharge and recharge or natural events.
2. Provide multi-decade observations of sea level rise.
3. Measure changes in coastal regions due to erosion and changes in plant health.
4. Detect and help quantify greenhouse gas emissions and characterize ozone sources.
5. Quantify with high accuracy water stored as snow.

FROM DEFENSE TO DISCOVERY

NASA JPL's roots date to the 1930s, when students at Caltech — collectively known as the "Suicide Squad" — gathered to test rocket engines near Pasadena, California.

During the 1940s and 1950s, JPL grew as it developed rockets and other technologies for the U.S. Army. JPL designed, built, and operated America's first satellite, Explorer 1, launched in 1958. Explorer 1 also delivered the first science finding from space — the discovery of Earth's Van Allen radiation belts. Later that year, Congress established NASA, and JPL was transferred to the space agency.

Since then, NASA JPL has sent robotic spacecraft to all of the planets in the Solar System, and is responsible for all four rovers that have explored the surface of Mars. In addition, NASA JPL conducts significant programs in earth sciences, spacebased astronomy, and technology research and development.

BY THE NUMBERS

No. of Employees: 6,912
PhD Scientists and Engineers: 1,175
Annual Budget: $2.26 billion
Procurements to CA Businesses: $387 million (2021)
Contracts to Small Businesses: $169 million (2021)
No. of Patents Registered: 340 (since 2007)

6. Assess the health of forest ecosystems for post-fire land management restoration decisions.
7. Detect changes and threats to critical infrastructure such as the Bay-Delta levees.
8. Provide information on damage extent for emergency response teams following natural disasters.

NASA JPL is advancing technology in the areas of energy systems, robotics, miniaturized sensors, artificial intelligence, autonomy and remote sensing. These advances in natural hazards, climate change and ecosystems science will offer deep insights for California policymakers.

Recent Headlines

"NASA's Perseverance rover makes safe landing on Mars" – *Los Angeles Times*, February 18, 2021

Governor Newsom congratulates NASA JPL's Mars 2020 Perseverance team on their successful landing in his 2021 "State of the State" address.

Legislators Say...

"Technology deployed on JPL space missions is applied here on Earth, benefiting the lives of everyday Americans. I'm proud that these innovations are made possible by the thousands of JPL employees and contractors in the 25th Senate District."— *Senator Anthony Portantino (D-La Canada Flintridge)*

LAWRENCE BERKELEY NATIONAL LABORATORY

www.lbl.gov
Berkeley, Alameda County
(AD-14, SD-09)

Michael Witherell, PhD, Director

Jim Hawley, State and External Relations
jchawley@lbl.gov

Dan Krotz, Strategic Communications
dakrotz@lbl.gov

Impact to the Region and State

At the forefront of science, Lawrence Berkeley National Laboratory (Berkeley Lab) is committed to nonclassified research. Berkeley Lab scientists search for cleaner, more reliable sources of energy while making innovations in energy efficiency, green building design, and electric grid modernization. They study the Earth to understand why the climate is changing and how that impacts sectors such as agriculture.

Berkeley Lab also designs, builds, and houses some of the world's most powerful microscopes, x-ray beams, and supercomputers. Berkeley Lab researchers aim to coax more power from solar cells, build better batteries, and develop clean biofuels for the future. They study questions as awe-inspiring as the formation of the universe, as relevant as water production and desalination, and as important as cybersecurity. They also can provide expertise on oil and gas geosciences, genetic analysis, and chemical and materials sciences.

Berkeley Lab partners with a number of California agencies — including the California Energy Commission, the California Geologic Energy Management Division, the Department of Water Resources, California Public Utilities Commission, and the California Air Resources Board — to support our state's ambitious clean energy and environmental goals.

Resources and Expertise

Berkeley Lab houses many "user facilities": state-of-the art lasers, instruments, and computers available for industry and university use. In 2022, more than 14,000 researchers (approximately 40 percent from California institutions) accessed these facilities, representing nearly one third of the total for all DOE user facility traffic nationwide. Work conducted at Berkeley Lab user facilities has led to the development of better medicines, new materials, and more efficient solar cells and batteries.

The user facilities at the Berkeley Lab include:

1. The Advanced Light Source produces extremely bright x-ray beams for examining the atomic and electronic structure of materials. Applications range from environmental, material science, and biology.

A BEACON OVER BERKELEY

Lawrence Berkeley National Laboratory (Berkeley Lab) was founded in 1931 by Ernest Orlando Lawrence. Considered the father of multidisciplinary team science, Lawrence was a University of California (UC) Berkeley physicist who won the 1939 Nobel Prize in physics for his invention of the cyclotron, a circular particle accelerator that opened the door to high-energy physics and the foundation of today's Nobel Prize-winning accelerators such as the Large Hadron Collider.

Today, Berkeley Lab is managed and operated by the University of California system for the Department of Energy (DOE). Berkeley Lab's close relationship with UC Berkeley brings the intellectual capital of the university's faculty, postdocs and students to bear on the nation's great scientific questions, a partnership that underpins the lab's extraordinary scientific productivity.

BY THE NUMBERS
No. of Employees: 3,663
PhD Scientists and Engineers: 1,781
Annual Budget: $1.167 billion (2022)
Annual Payroll: $481.8 million (2022)
Procurements to CA Businesses: $250 million (2022)
Contracts to Small Businesses: $292 million (2022)
No. of Patents Issued (last 10 years): 775
IP Licenses (last 10 years): 978
No. of Startups Based on Tech: 71

2. Molecular Foundry is the DOE's largest nanoscience center, allowing researchers to engineer new materials from fuel cell components to proteins.
3. The National Energy Research Scientific Computing Center (NERSC) includes one of the world's most powerful supercomputers.
4. Energy Sciences Network (ESnet) provides reliable, high-bandwidth connections that link scientists at federal labs, universities, and other institutions.
5. The Joint Genome Institute helps researchers solve energy and environmental challenges with high throughput genomic capabilities and data analysis.

Too numerous to detail, other notable user facilities include the FLEXLAB, the Advanced Biofuels Process Demonstration Unit, and other assets available to government, university, and corporate users.

Recent Headlines

"Here's where experts say California's historic snowpack presents the greatest flood risks."– SF Chronicle, April 5, 2023

"How climate change will make atmospheric rivers even worse" – The Washington Post, January 12, 2023

"Solar + batteries at home can provide backup power during disasters" – Ars Technica, September 29, 2022

Legislators Say...

Berkeley Lab is home to world-renowned scientific leaders. These brilliant minds are crafting the technology we need — today and tomorrow — to advance our lives, protect our planet, and enhance our economy. Berkeley Lab researchers are on the cutting edge of technological transformation, for California and the world."— *Senator Nancy Skinner (D-Berkeley)*

"Berkeley Lab is a world leading scientific institution. Its facilities are used by researchers across the state. Its scientists are helping lead the way on new technologies and innovations to tackle big challenges—from climate change, to energy storage and clean water, creating jobs for our state."— *Assemblymember Buffy Wicks (D-Oakland)*

LLNL

LAWRENCE LIVERMORE NATIONAL LABORATORY

www.llnl.gov
Livermore, Alameda County
(AD-16, SD-07)

Kim Budil, PhD, Director

Steven R. Bohlen, Senior Director, Government and External Affairs, Bohlen1@llnl.gov

Scott F. Wilson, State Government Liaison
wilson101@llnl.gov

Impact to the Region and State

Since its founding in 1952, the Lawrence Livermore National Laboratory (LLNL) has been an icon in northern California, applying cutting-edge technology to enhance our nation's security and solve some of the most pressing challenges of our time.

Those goals are met, in part, through strategic partnerships with California industry and academia. LLNL currently has active commercial licenses with more than 75 companies (34 in California) as well as dozens of active cooperative research and development agreements. Licensing and royalty income in recent years has topped $8 million annually representing more than $300 million in annual sales of products based on LLNL technologies. LLNL licensed technologies have enabled the launch of numerous new businesses that are helping drive economic growth locally, regionally and beyond.

LLNL's procurements through California businesses ($509 million) and annual payroll ($1.19 billion) directly contribute to the regional economy. Additionally, LLNL has deep and longstanding relationships with the University of California and California State University systems, which serve as workforce pipelines for many of its most sought after positions.

Resources and Expertise

LLNL has missions in biosecurity, counterterrorism, defense, energy, intelligence, nonproliferation, science, and weapons. LLNL's fundamental work in science, technology, and engineering — such as basic research and development to achieve the breakthroughs applied directly by LLNL programs– is spread across three disciplinary organizations: Computation, Engineering, and Physical and Life Sciences:

1. In addition to designing, developing, and deploying high-performance computing capabilities, the Computations Directorate assures that mission and program goals are attained by delivering outstanding computer science expertise and creative technology and software solutions. Computation also possesses technical expertise in information technology services and solutions that help missions.

SCIENCE AND SECURITY IN THE ATOMIC AGE

Originally established by Edward Teller and Ernest Lawrence as a branch of the UC Radiation Laboratory, the Lawrence Livermore National Laboratory (LLNL) has been a pillar of the Tri-Valley community since 1952.

Today, LLNL is a Federally Funded Research and Development Center (FFRDC) primarily funded by the U.S. Department of Energy. It is operated by Lawrence Livermore National Security, LLC — a partnership of Bechtel National, the University of California, BWX Technologies, Amentum, the Texas A&M University System, and Battelle Memorial Institute. LLNL's defining responsibility is ensuring the safety, security, and reliability of the nation's nuclear deterrent — yet its responsibilities have evolved with America's changing needs.

The LLNL mission of making the world a safer place now aligns with our nation's most challenging security problems — terrorism, energy security, climate and environmental change — through R&D investments in computing, engineering, and life and physical sciences. California can only stand to benefit, as LLNL cultivates partnerships with industry innovators regionally and statewide.

BY THE NUMBERS
No. of Employees: 8,380 (2022)
PhD Scientists and Engineers: 1,300
Annual Budget: $2.9 billion (2022)
Annual Payroll: $1.19 billion (2022)
Procurements to CA Businesses: $509 million

2. The Engineering Directorate undertakes projects with high technical risk, integrates and extends technologies, and uses the extremes of both ultrascale and microscale to achieve results. LLNL engineers develop systems that push technologies to their extremes.

3. The Physical and Life Sciences Directorate delivers science that ensures the success of LLNL's national security programs, anticipates their future needs, and provides innovative solutions to the hardest scientific problems facing the nation and our state.

Recent Headlines

"Scientists Achieve Nuclear Fusion Breakthrough with Blast of 192 Lasers" – New York Times, Dec. 13, 2022

"Speeding up detection of climate change response to emission reductions" – LLNL, April 14, 2022

"California Can Be Carbon Neutral in 25 years—with Drastic Action" – Scientific American, February 1, 2020

Legislators Say...

"LLNL is a huge contributor to California's economy, providing high-end jobs, bringing in federal research dollars, and forming academic and industrial partnerships. I never hesitate to hold up LLNL as a shining example of the technological and entrepreneurial excellence that the Bay Area can offer." — *Senator Steve Glazer (D-Orinda)*

"LLNL has been a leader in national security and fundamental science for generations, and its many contributions, inventive technologies, and passion for STEM education have helped shape California's and the East Bay region's thriving innovation ecosystems. We're proud to have such an important institution as part of our community."— *Assemblymember Rebecca Bauer-Kahan (D-Orinda)*

SANDIA NATIONAL LABORATORIES-CALIFORNIA

www.sandia.gov
Livermore, Alameda County
(AD-16, SD-07)

Andy McIlroy, PhD, Associate Labs Director for California

Patrick Sullivan, Government Relations
pmsulli@sandia.gov

Michael Ellis Langley, Corp. Comms. Specialist
mlangle@sandia.gov

Impact to the Region and State

The California campus of Sandia National Laboratories (Sandia/California) has delivered essential science and technology to resolve the nation's most challenging issues for more than 55 years.

Many of these nationwide security challenges — like energy resources, transportation, immigration, ports, and more — surfaced early for the State of California, providing this Sandia campus with a special opportunity to contribute to the first wave of science and technology solutions serving the United States.

Sandia/California boosts the state's regional and statewide economy, with contracts totaling more than $92 million directed to small businesses and $146 million total in contracts across all California businesses.

Sandia/California is located in the Livermore Valley Open Campus, a 110-acre campus that brings academia and businesses together with researchers from Sandia and its Department of Energy sibling, Lawrence Livermore National Laboratory.

Resources and Expertise for California Governance

Sandia/California researchers pursue a variety of security and resource management research.

Teams of researchers on the Sandia/California campus are engaged in work that will advance climate change security, which Labs Director James S. Peery has described as an existential threat. Sandia/California researchers work on a host of other projects to tackle the scientific and engineering challenges of the 21st century.

Sandia's famed Combustion Research Facility focuses on improving energy efficiency and reducing emissions. The Labs' robust solar, wind, and geothermal research and development programs have contributed to widespread deployment of renewable energy technologies. Sandia's energy storage and grid integration programs also help California's efforts to meet requirements for its renewable energy portfolio.

NATIONAL SECURITY FROM "A" TO "Z"

From its origins as a single-mission engineering organization for nonnuclear components of nuclear weapons, the Sandia National Laboratories now has multiple programs involved in a broad spectrum of national security issues. One of three National Nuclear Security Administration research and development laboratories, Sandia's underlying mission is to develop advanced technologies to ensure global peace.

Sandia began in 1945 as the "Z-Division" — the weapons design, testing, and assembly branch of Los Alamos National Laboratory in New Mexico. It officially became Sandia Laboratory in 1948, and in 1956 a second site was opened in California's Livermore Valley. In 1979, Congress made Sandia a Department of Energy National Laboratory. In 1993, Sandia became a government-owned, contractor-operated (GOCO) laboratory under Lockheed Martin Corporation. Today Honeywell, International, Inc. manages and operates Sandia.

BY THE NUMBERS

No. of Employees: 2.150
Percent of Technical Staff w/ PhD or Masters: 80
Annual Budget: $585 million
Procurements to CA Businesses: $221 million
Contracts to Small Businesses: $132 million

The SUMMIT tool, developed at Sandia/California, aids in preparing for human-caused or natural disasters by improving the cycle of activities that emergency response teams undertake. SUMMIT was included as part of a memorandum of agreement with the California Fire and Rescue Training Authority to deliver an emergency response framework to the California Exercise Simulation Center. The enhanced, 3-D virtual view of hazard damage creates a new level of realism and a common operating picture for members in exercises at national, regional, and local levels.

Recent Headlines

"How the U.S. is Planning to Boost Floating Wind Power" – Scientific American, February 23, 2023

The people who imagine disasters" – BBC, 7th July 2020

"HPE, AMD win deal for U.S. supercomputer to model nuclear weapons" – Reuters, March 4, 2020

Legislators Say...

"Sandia has been an integral part of the East Bay for over 60 years. It engineers solutions for our country's national security challenges, advances low-carbon energy technologies, and develops clean transportation systems. Sandia's contributions are felt across California and the country." — *Senator Steve Glazer (D-Orinda)*

"For more than 60 years in California, Sandia National Laboratories has built on its reputation for delivering results to address our nation's most complex national security challenges and developing innovative energy solutions to advance next generation energy technologies." — *Assemblymember Rebecca Bauer-Kahan (D-Orinda)*

SLAC NATIONAL ACCELERATOR LABORATORY

www.slac.stanford.edu
Menlo Park, San Mateo County
(AD-23, SD-13)

Stephen Streiffer, PhD, Interim Director

Erika Bustamante, State Government Relations
erikab@stanford.edu

Melinda Lee, Communications
Melinda.lee@slac.stanford.edu

Impact to the Region and State

The SLAC National Accelerator Laboratory (SLAC) contributes to California's global reputation as a hub of innovation. SLAC invents, develops, and operates sophisticated particle accelerator and X-ray technology and other scientific tools, including sensors, detectors, controllers, lasers, and systems for working with torrents of data and images. SLAC also develops novel laser architectures for our own research and work with local laser firms, further securing California as a hub of the optical laser industry. Through CalCharge, SLAC supports California energy storage firms.

Each year, SLAC hosts thousands of researchers who come here to use its sophisticated X-ray facilities for a wide range of basic and applied science — including California companies developing new pharmaceuticals, improving chip manufacturing and developing sensor technology for self-driving cars.

SLAC has deep ties to a major university — their employees are Stanford University employees, and the SLAC director is a dean of Stanford. SLAC's expertise and ties with Stanford are a powerful combination, and allow them to provide unique educational experiences and serve as a vital training ground for the nation's future scientific workforce. SLAC educates the public through tours, lectures, and outreach programs, and it also provides internships and fellowships to students and early career professionals.

Resources and Expertise

SLAC has world-leading expertise in the design, engineering, and fabrication of advanced electronics, sensors, detectors, instrumentation — in addition to largescale data handling and computing systems, and associated facilities that help advance real-world applications. These include:

1. Structural biology research aimed at understanding disease and developing and improving treatment.
2. Next-generation batteries, improved manufacturing techniques for semiconductors, solar cells and other products.

ACCELERATING PARTICLES AND THE FUTURE

The people, expertise and facilities at SLAC National Accelerator Laboratory (SLAC) offer potential to transform nearly every sector of our economy.

These include studies of the very small, fundamental processes of chemistry, to the very large exploration and understanding of the cosmos, dark matter, and dark energy. SLAC experts have a long record of developing novel instruments and technologies to provide unparalleled insight into the natural world — and they lead and participate in many large-scale national and international scientific collaborations.

Stanford University operates SLAC for the Department of Energy's (DOE) Office of Science. Located in Menlo Park, SLAC is home to the world's premier ultrafast X-ray science center. Extremely bright and fast X-ray pulses are used to create movies of atomic and molecular structures and interactions with unprecedented precision — driving advances in energy science, human health, industrial chemistry, novel materials, information technology, and more.

BY THE NUMBERS

No. of Employees: 1,600
PhD Scientists and Engineers: 557
Annual Budget: $508 million
Annual Payroll: $250 million
Procurements to CA Businesses: $53.2 million
Contracts to Small Businesses: $60.3 million

3. Scientific computing, AI/machine learning and control system hardware and software.
4. Electric grid modernization and more efficient catalysts for energy and industry.
5. Fusion energy science.
6. Next-generation particle accelerator technology for medicine, industry and discovery.
7. Quantum information science.

On the ground, SLAC has the ability and knowledge to manage major, complex scientific infrastructure projects that require the development of entirely new technologies. And at the edge of human exploration, SLAC's experts can guide us in understanding the context and importance of dark matter, dark energy, particle physics — and the evolution of the cosmos itself.

Recent Headlines

"New charging technique puts crumbling batteries back together" – Scientific American, Feb. 4, 2022

"Can a particle accelerator trace the origins of printing?" – Wired, Aug 29, 2022

"Scientists make nanodiamonds out of plastic bottles" – BBC Science Focus, September 2, 2022

Legislators Say...

"SLAC and Stanford University have played a major part in the creation of Silicon Valley and continue to make enormous contributions in pushing the frontiers of science and technology."— *Senator Josh Becker (D-San Mateo)*

"SLAC is a unique hub for scientific talent and opportunity. The lab's distinctive tools and capabilities will continue to enable groundbreaking discoveries, ensuring U.S. leadership in key scientific areas."— *Assemblymember Marc Berman (D-Palo Alto)*

RESOURCE

FEDERAL LABS QUICK REFERENCE

CCST can assist California Legislative and Executive offices in navigating federal research resources in the State of California.

For assistance, please contact:

Sarah Brady, PhD
CCST Deputy Director
sarah.brady@ccst.us
(916)492-0996

Access this handbook and other information about California's Federal labs online at:

www.ccst.us/federal

NASA's Ames Research Center
www.nasa.gov/ames

Lisa Lockyer, Government Affairs
lisa.l.lockyer@nasa.gov

Michele Johnson, Office of Communications
michele.johnson@nasa.gov

NASA's Jet Propulsion Laboratory
www.jpl.nasa.gov

Cindy Lee, Government Affairs
cindy.lee@jpl.nasa.gov

Lawrence Berkeley National Laboratory
www.lbl.gov

Jim Hawley, State and External Relations jchawley@lbl.gov

Dan Krotz, Strategic Communications
dakrotz@lbl.gov

Lawrence Livermore National Laboratory
www.llnl.gov

Steven R. Bohlen, Senior Director, Government and External Affairs
Bohlen1@llnl.gov

Scott F. Wilson, State Government Liaison wilson101@llnl.gov

Sandia National Laboratory, California
www.sandia.gov

Patrick Sullivan, Government Relations pmsulli@sandia.gov

Michael Ellis Langley, Corporate Communications Specialist
mlangle@sandia.gov

SLAC National Accelerator Laboratory
www.slac.stanford.edu

Erika Bustamante, PhD, State Government Relations erikab@stanford.edu

Melinda Lee, Communications
melinda.lee@slac.stanford.edu

2023 Impact Report

California's Federal Labs & Research Centers

Stories of Economic Impact, Cutting-Edge Research, and Community Engagement across California

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CCST
1017 L St, #438
Sacramento, California 95814
(916) 492-0996 • ccst@ccst.us • ccst.us • @CCSTorg

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