# California's Federal Labs & Research Centers

## Toward A Resilient California:
A 2021 Impact Report for State Leaders

Prepared by the
California Council on Science and Technology

STRONGER WITH SCIENCE FOR 30 YEARS

CCST
CALIFORNIA COUNCIL ON SCIENCE & TECHNOLOGY

A nonpartisan, nonprofit organization established via the California State Legislature
— making California's policies stronger with science and technology since 1988

**Acknowldgments**

CCST would like to extend special thanks to **Rachel Silvern, PhD** and **May Dobosiewicz, PhD** for their contributions in preparing this report.

**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 CCST does not accept responsibility for any inaccuracies that may occur.

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
www.ccst.us

Layout by A Graphic Advantage, LLC
3901 Carter Street #2, Riverside, CA 92501
www.agraphicadvantage.com

# INTRODUCTION

**Dear Fellow Californians:**

As a state whose motto proclaims proudly—*Eureka!*—California's bounty of advanced research institutions is decidedly appropriate. Alongside academic powerhouses such as the University of California, Stanford, and Caltech, 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. Complex and intersecting disasters, including wildfires, climate change, and the ongoing COVID-19 pandemic, 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 an electricity grid infrastructure that is more resistant to disruptions from extreme weather events, satellite monitoring of developing wildfires to aid our first responders, or new technologies for purifying drinking water in the wake of an earthquake, 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
Executive Director

**Peter Cowhey, PhD**
CCST Board Chair
UC San Diego

**Terry Land, PhD**
CCST Federal Laboratory Partners Chair
Lawrence Livermore
National Laboratory

# 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 Partner Institutions:

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, Caltech, Stanford, 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), 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 11 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/California,** 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

**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 its Federal Laboratory Partners has resulted in several high-impact reports that have been useful to state leaders, delivering timely, nonpartisan, scientific analysis on complex issues. Examples include:

1. 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 **Lawrence Berkeley National Laboratory.**

2. Biomethane Heating Values **(2018):** At the request of the State, CCST completed a study analyzing minimum heating value and maximum siloxane concentration of biomethane injected into natural gas pipelines. Scientists from **Sandia/ California** participated in the study process.

3. Underground Natural Gas Safety **(2018):** State leaders tasked CCST with providing an independent assessment of the long-term viability of underground natural gas storage in California. The report effort was led by experts from the **Lawrence Berkeley National Laboratory** and the **Lawrence Livermore National Laboratory.**

4. Hydraulic Fracturing **(2015):** CCST and the **Lawrence Berkeley National Laboratory** partnered to author "An Independent Scientific Assessment of Well Stimulation in California," a three-volume report responding to **SB 4 (2013).**

## 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 dealing with 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. 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 Ames Research Center |
| NASA JPL | NASA 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

*Wildfire fuel reduction.* Mechanical thinning of old growth forests is an important strategy to reduce the risk of catastrophic wildfires in the wildland-urban interface. However, removal of low-value biomass is uneconomic, and most wood piles are burned. With support from CAL FIRE, **Berkeley Lab** is teaming up with other researchers to develop a mobile biorefinery that can process woody biomass and convert it into biopower, biofuels, and biochar with minimal carbon or airborne emissions. Unlike conventional biorefineries that require large-scale feedstock removal, this mobile unit can be transported by truck to regions where the biomass is located. This technology represents an important step toward a circular bioeconomy, as excess agricultural and forest residues can be converted into valuable products.

*Charging portable devices*. Building upon previous research, a team of researchers from **LLNL,** with collaborators from Sun Yat-Sen University and the University of California, Santa Cruz, has developed a novel class of 3D-printed aerogel electrodes that simultaneously boosts energy density and power density. Previous 3D-printed electrodes could achieve either high energy density or high power density but not both, but this new design boosts both parameters in the same device. The resulting supercapacitors could have major implications for ultrafast-charging power storage for a broad range of devices, including cell phones and laptops.

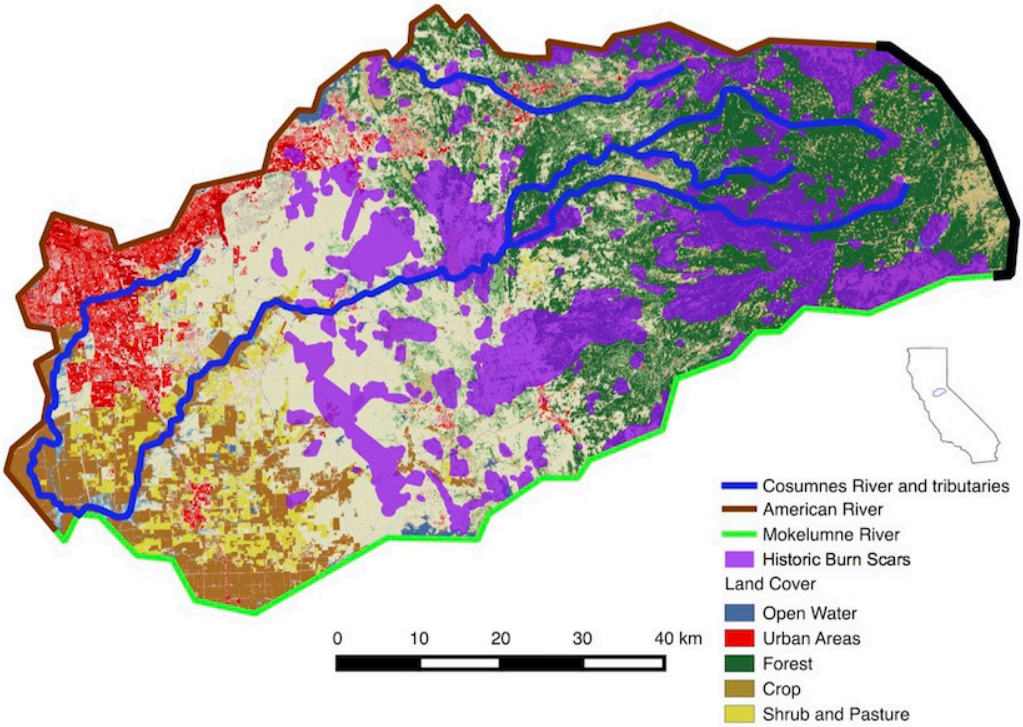
*Climate change projections*. The **NASA Earth Exchange** (NEX) is a Big Data initiative using **NASA Ames'** supercomputers to help scientists work with huge data sets from Earth-observing satellites. Among the many projects of NEX have been initiatives to understand climate projections on a finer scale and to study how climate changes might affect a single town or region, like the Bay Area. The data from NEX projects becomes available in a NASA archive, helping inform policymakers', agencies' and other stakeholders' decisions about our climate future.

*Predicting landslides*. Slow moving landslides, in which the 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,** collaborating with scientists at University of California, Berkeley and the US Geological Survey, is developing a new 3D mapping technique to predict how these landslides suddenly transition and enable authorities to better prepare for landslide risks. The technique relies on high resolution data gathered using JPL's Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR), which makes precise measurements of the ground level it flies over. UAVSAR has also provided data for other disasters and ground deformation changes, including burn areas from the 2020 California wildfires.

*Oil refinery hazards*. For oil refineries in the US, sulfur present in the oil can react with metals in the equipment and cause corrosion, though this important safety hazard can be hard to predict. Researchers at **SLAC** are using X-rays from the lab's Stanford Synchrotron Radiation Lightsource in order to collect detailed information about the sulfur compounds in the oil. This precise experimental information can be combined with data from corrosion studies and computer modeling in order to help the oil industry more accurately predict and prevent dangerous corrosion of equipment.

*Climate change simulations*. **Berkeley Lab's** National Energy Research Scientific Computing Center (NERSC) advanced supercomputers are enabling high-resolution climate simulations that help local decision makers quantitatively understand how climate change may intensify extreme weather events and impact water availability and infrastructure. For example, the City and County of San Francisco has partnered with Berkeley lab to assess how climate change could impact San Francisco and its infrastructure, including the San Francisco Airport. Berkeley Lab scientists, in collaboration with **LLNL** and university labs, are also using NERSC to develop an advanced hydrologic model of the Consumnes watershed to study how climate change and wildfires might affect California's water availability and help resource managers develop strategies to manage the state's water resources. This model can be adapted to other California watersheds to explore future scenarios, evaluate risks, and improve planning.

*Modeling hurricanes*. A team led by **NASA JPL** scientists, in collaboration with IBM and the National Hurricane Center, is using machine learning to more accurately forecast when hurricanes will intensify suddenly, providing vital time to prepare an adequate emergency response. By analyzing historical satellite data from several NASA missions, the team identified three indicators associated with an increased chance




Berkeley Lab researchers built a numerical model of the Consumnes River watershed, to study post wildfire effects on water availability. (Credit: Berkeley Lab)

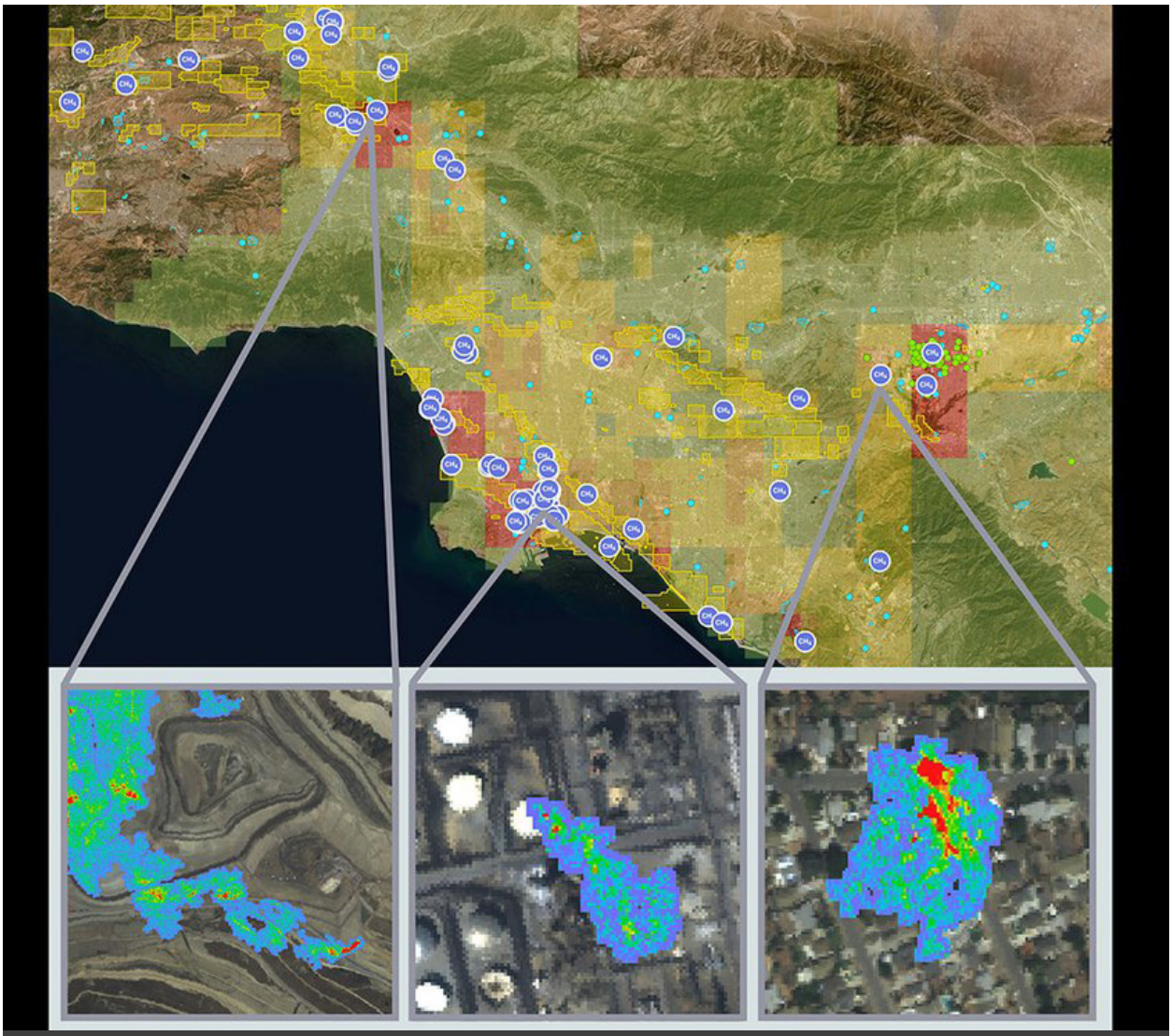
of intensification: the rainfall rate at the storm's core, the ice water content of clouds within the storm, and the temperature of air flowing away from the eye of the storm. Incorporating these indicators into forecasting models through the use of machine learning resulted in a 60% more likely chance of accurately detecting an intensification event compared to existing models.

*Sea level rise*. As we continue to grapple with the long term impacts of climate change, reliably predicting the extent and impacts of sea-level rise is a major component of climate resilience. A team of scientists at **Sandia/California** has been developing new models to predict the behavior of the Greenland and Antarctic ice sheets. As part of a five year collaboration with other labs and universities known called PISCEES (Predicting Ice Sheet and Climate Evolution at Extreme Scales), Sandia's team developed an analysis tool to simulate the flow of ice over the Greenland and Antarctic sheets. By combining the insights from these tools with data sets from glaciologists and climate scientists, PISCEES can make more efficient and reliable predictions about ice sheet behavior.

Home to sea level height satellites since 1978, **NASA JPL** measures and predicts sea level rise. A recently published study, led by JPL scientists, provides valuable insight into the processes that have driven historical global sea level rise, since 1900. The team tracked and accounted for the effects of a number of global factors, including melting glaciers and ice sheets, land bound water storage, and thermal expansion, to not only understand the past but also to improve predictions of future sea level rise and its impacts. This study used data from JPL's suite of sea level height missions, as well as its pair of gravity-measuring satellites, Gravity Recovery and Climate Experiment (GRACE) and its Follow-On (GRACE-FO), which have also been used to provide data on drought and groundwater, including in the Central Valley in the context of the Sustainable Groundwater Management Act.

*Protecting our water supply.* With snowmelt projected to decline by two-thirds by 2100, California will need new treatment and recycling technologies to meets its needs for climate-resilient water supplies. **Berkeley Lab** is leading the National Alliance for Water Innovation, a $130 million, five year initiative aimed at reducing the energy use and cost of desalination by 75%, paving the way for a circular water economy in which inland brackish and waste waters and other non-traditional water sources can be productively used and re-used. The initiative focuses on developing distributed technologies that can be used locally to reduce transportation costs and increase resilience during water delivery disruptions.

*Water quality and drought.* As California and the western US are expected to face threats of drought and flooding in the coming years, researchers are using **SLAC's** Synchrotron Radiation Lightsource to study and anticipate how these hydrological changes will impact water quality. As water levels ebb and flow, nutrients, contaminants, and chemical reactions may all impact surface water quality. This SLAC research is centered in the Colorado River Basin, an important water source for Southern California.



Outputs from NASA JPL's Methane Source Finder tool, derived from airborne and surface monitoring networks. (Credit: NASA/JPL-Caltech)

## Building Resilient Infrastructure

Greenhouse gas emissions. Methane is one of the most potent greenhouse gases contributing to climate change, resulting from human activity. **NASA JPL**'s Next Generation Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-NG) has been flown across the state to identify fugitive methane emissions, as part of its California Methane Survey. Monitoring methane plumes, JPL researchers were able to detect leaks in infrastructure from agriculture, landfills, and oil and gas utilities. By sharing the data with facility operators to aid in repairing these leaks, this campaign has driven significant voluntary mitigation of methane emissions.

*Developing a resilient grid*. **Sandia/California** recently launched a new, multiyear research portfolio to fund exploratory research to combat evolving threats to the U.S. utility systems and electrical grid. The Research Energy Systems Mission campaign is focused on defending the grid from disasters, both natural, such as hurricanes or solar flares, and man-made, such as hostile cyberattacks. Much of the grid is reliant on antiquated technologies that were not designed to be able to withstand modern threats. Additional benefits from the technology developed as part of the campaign include more efficient electricity generation, more accurate data collection, and better grid management.

**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.

*Protecting the grid*. The U.S. electricity grid is a vital part of the nation's infrastructure and ensuring that it is resilient to both natural and man-made threats is critical to the nation's security and economy. **Sandia National Laboratories'** Grid Modernization Program is developing technological solutions to address emerging issues to our electricity distribution system. The program works closely with grid operators and local stakeholders to identify and model the most crucial potential threats and consequences in their regions. Major areas of research focus within the program include: integration of solar and wind power, resilience to geomagnetic disturbances, and the development of agile and resilient control systems for large-scale interconnected power systems.

*Building for extreme heat*. With heat waves likely to increase by as much as ten-fold by mid-century, extreme heat represents the most costly, deadly threat to Californians. **Berkeley Lab** has pioneered the use of solar-reflective surfaces – "cool" roofs, walls, and pavements – to significantly reduce neighborhood temperatures, air conditioning costs, and water consumption in urban areas. Cool roofs could reduce urban heat impacts by almost half of their projected levels by 2050. Berkeley Lab is developing a heat-resilience toolkit with community input for underserved neighborhoods in Fresno for the Strategic Growth Council, leveraging its expertise in cool surfaces and neighborhood-scale modeling using CityBES.lbl.gov.

## Event Spotlight: COVID-19

In December 2019, the novel viral respiratory illness, coronavirus disease 19 (COVID-19), quickly spread from China across the globe. The World Health Organization declared COVID-19 a pandemic in March 2020, and since then, all six federal laboratories have rapidly deployed their resources and research capacities to respond to the multifaceted public health crisis. These are just a small sample of the ways in which the labs and research centers stepped up to respond to the disaster.

*International collaboration:* Scientists at **NASA Ames, LLNL** and **Berkeley Lab** are contributing to the COVID-19 International Research Team (COV-IRT), an international community of scientists using public data to rapidly understand the virus and develop a vaccine and therapeutics.

*Real-time health response:* In just 37 days, scientists at **NASA JPL** developed a ventilator, Ventilator Intervention Technology Accessible Locally (VITAL), that received Emergency Use Authorization from the Food and Drug Administration (FDA). Designed specifically for COVID-19 patients, VITAL requires fewer parts than traditional ventilators, and its design makes it ideal for use in nontraditional settings.

*Providing the tools for research:* As part of the COVID-19 High Performance Computing (HPC) Consortium, **NASA, LLNL, Berkeley Lab**, and **Sandia/California** are contributing to the public-private partnership between industry, academia, federal agencies, and national laboratories, bringing together computation resources and technical expertise to help meet the needs of COVID-19 researchers.

**Berkeley Lab's** Advanced Light Source (ALS) rapidly shifted operations initially to run a limited number of beamlines to support structural biology research on therapeutics. Similarly, the Stanford Synchrotron Radiation Lightsource (SSRL) at **SLAC** dedicated a subset of stations to provide its powerful X-rays to examine the biomolecules crucial to understanding how the virus replicates in the body, and produce detailed images that can be used in the design of targeted therapeutic interventions.

*Advancing diagnostic testing:* **LLNL** is spearheading several research efforts on diagnostic testing, including adapting their genetic diagnostic system to provide an inexpensive, sensitive method for rapid detection, and updating their diagnostics system to detect co-infection with other viruses and bacteria to better inform clinical care.

Leaning on previous testing methods developed for portable, rapid detection of Zika virus, researchers at **Sandia California** developed a novel approach for viral detection focused on low-cost portable instrumentation that could be controlled by smartphone.

**SLAC** led the development of the Coronavirus Standards Working Group, convening experts across sectors to establish an open source repository for testing methods and data, and producing reference materials, samples, and methods, critical for accurate and reliable testing.

*Developing medical countermeasures:* In collaboration with other federal agencies, **LLNL** is supporting rapid identification of countermeasures using an artificial intelligence computational platform to optimize antibody designs for a vaccine, as well as computationally screening commercially available compounds to identify candidates for the development of antiviral drugs.

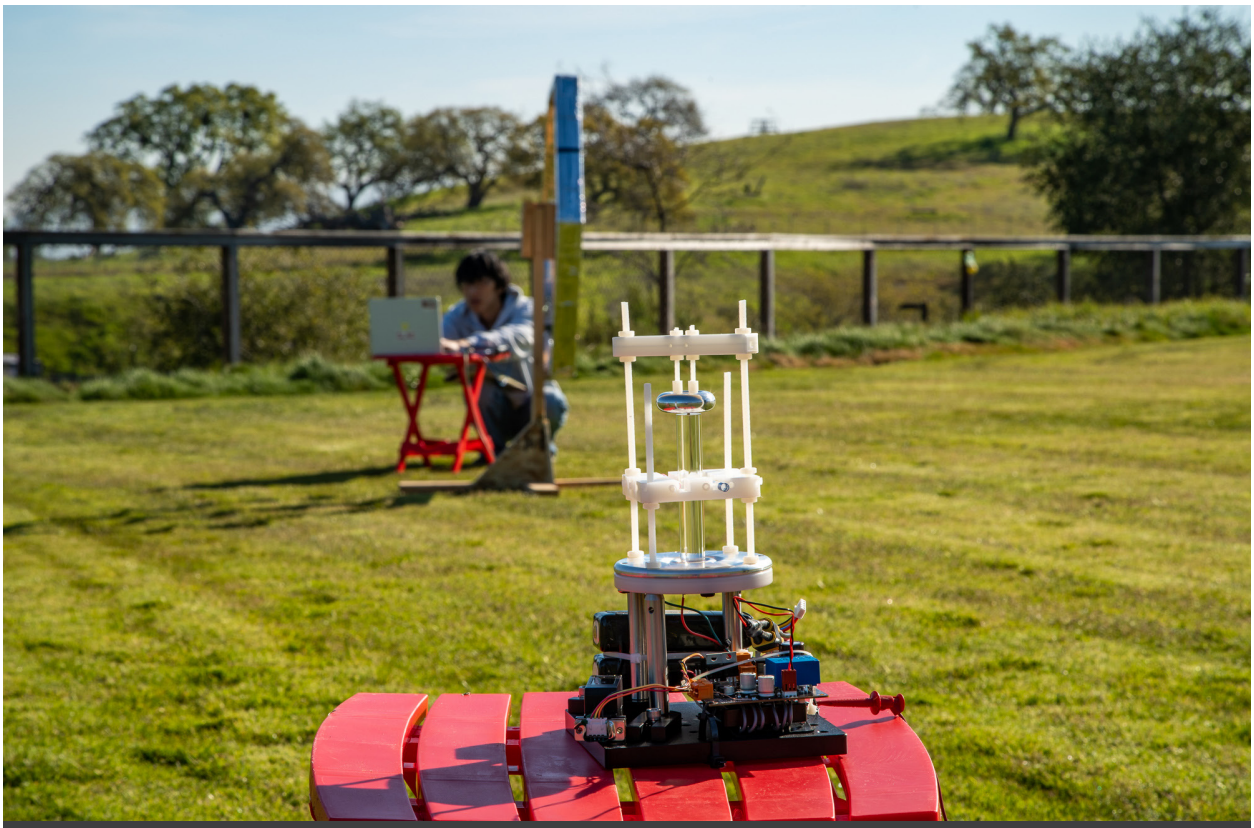
*Studying impacts to inform decision-making:* Researchers at **Berkeley Lab** conducted a study of the risk of airborne transmission of viruses within buildings and how to mitigate those risks. Using computer modeling and physical experiments, researchers hope to provide a set of recommendations for building operation that can decrease virus transmission risk.

A **NASA Ames** project is using satellite thermal infrared sensor brightness temperatures to examine how the entire Bay Area's urban heat flux has changed during the pandemic, and how that change has contributed to a more or less healthy environment for the millions of people living in it. **NASA JPL** is using satellite-derived synthetic aperture radar data to map changes in activity levels in cities around the world to understand how activity reductions correspond to different cities' levels of success in controlling virus outbreaks and how those reductions correspond to observed changes in environmental conditions.

## Real Time Response and Monitoring

*Real-time disaster monitoring*. **NASA JPL's** Advanced Rapid Imaging and Analysis (ARIA) project, a partnership with the California Institute of Technology, delivers timely data products for disaster response. ARIA combines near real-time GPS, radar, optical, and seismic observation with state-of-the-art processing to produce damage and flood maps. With satellite data that can see through clouds, ARIA has helped organizations like the UN World Food Programme monitor events, like flooding from the 2020 tropical cyclones in Bangladesh and India. From local California wildfires to the massive explosion in Beirut, ARIA's openly-accessible maps, produced in collaboration with the Earth Observatory of Singapore, have been used to help identify severely damaged areas where assistance may be required. ARIA's ground deformation maps have also been used to identify a complex web of fault ruptures and damage from the 2019 Ridgecrest, CA earthquakes.

Through **NASA's Small Business Innovation Research program**, California's Swift Engineering, with support from **NASA Ames**, has developed a high-altitude, long-endurance uncrewed aircraft to carry science instruments and other small payloads. It is designed to stay aloft for 30 days at 65,000 feet, and its recent 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. 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.



A SLAC researcher working on a compact, low-frequency antenna, for communicating over long distances and through potential obstructions. (Credit: Dawn Harmer/SLAC National Accelerator Laboratory)

*Communication during disasters*. Scientists at **SLAC** National Accelerator Laboratory are developing a new type of pocket-sized antenna, that could enable communication in situations where traditional radios do not work, such as rescue missions that require high mobility. The 4-inch-tall device is capable of emitting radio waves with wavelengths as large as tens to hundreds of miles. In contrast to traditional shorter wavelength radio waves, these waves can maintain their strength over longer distances or travel through obstructions such as water or layers of rock.

*Microgrids*. **Sandia/California's** microgrid team is helping communities hit by natural disasters to recover and rebuild with resilience in mind. A microgrid is a decentralized system of electricity generators that can provide power to buildings and infrastructure even if the power grid goes down. They are a powerful tool in responding to natural disasters, particularly in the critical days after a disaster strikes, when access to power is vital to emergency response. In the wake of Hurricane Maria's devastating impacts in Puerto Rico, Sandia's team worked alongside local groups to deploy six microgrid demo sites across the island, generating power to key buildings, such as hospitals. Additionally, the team worked with local communities on capacity building and workforce development, paving the way for the deployment of more microgrids across Puerto Rico, increasing the island's resilience to future events.

*Screening for infections*. 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

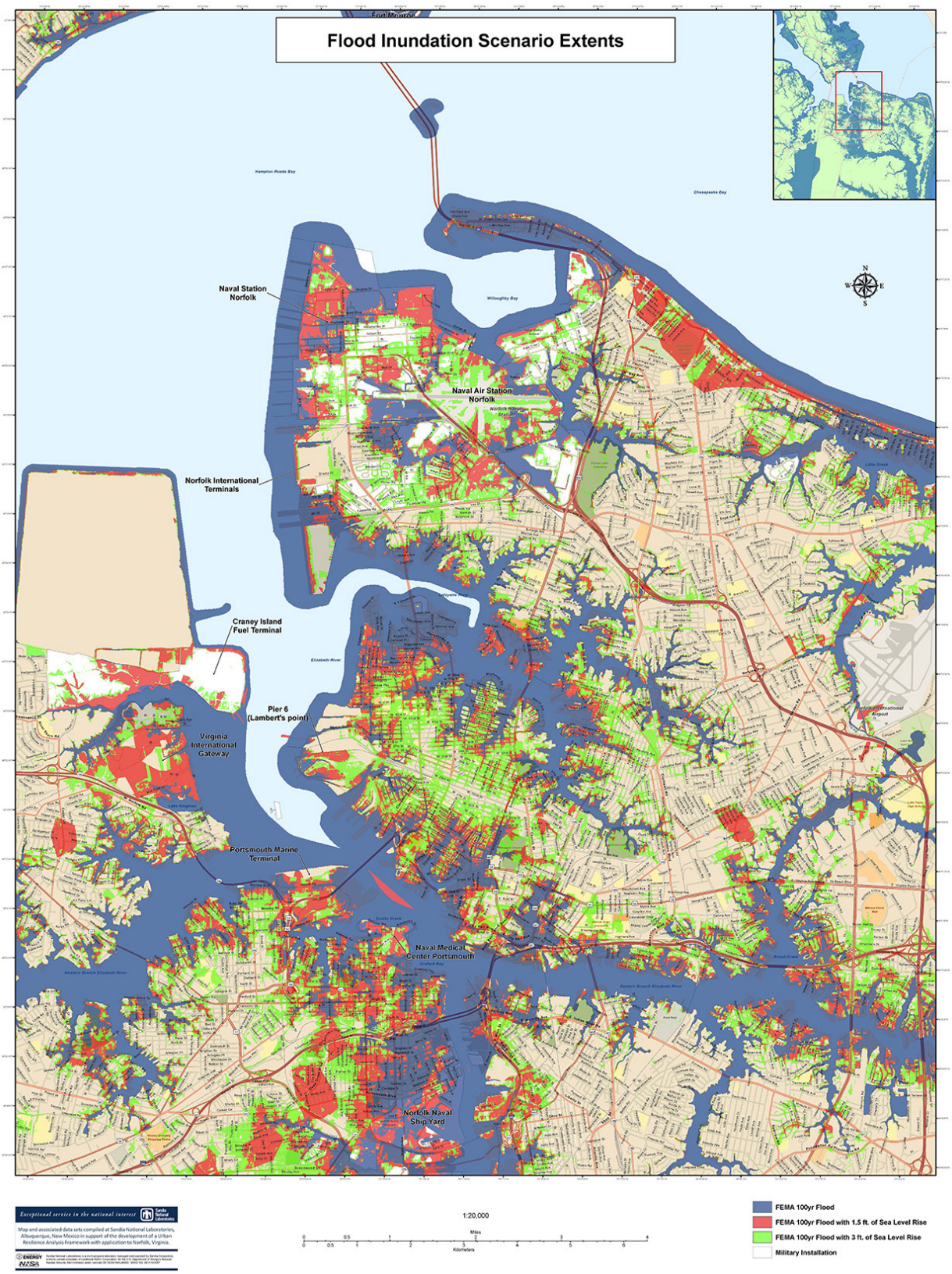
breath analysis. Using an instrument attached to a smartphone – and NASA expertise in advanced machine-learning methods – the results from the E-Nose will combine with body temperature and other non-invasive symptom screening to provide more accurate on-the-spot answers. The screening results can then be transmitted via cellphone or WiFi networks.

*Assessing biohazards*. A multidisciplinary team of biologists and engineers at **LLNL** has developed a 3D "brain-on-a-chip" device capable of sustain and record activity from hundreds of thousands of interconnected, human-derived neurons as they communicate with each other. These devices can potentially be used to study how healthy or sick networks of neurons change in response to disease or infection, toxins, or drugs, without using animal models. The team has recently developed computational tools to analyze the data coming from the devices, bringing brain-on-a-chip devices another large step closer to widescale use.

*Protection from chemical threats*. When faced with a chemical or biological threat, the safety of soldiers and first responders depends on protective equipment. Unfortunately, the existing materials that provide protection from these threats also inhibit breathability. A **LLNL**-led team of scientists have developed a smart fabric that breathes, blocks all biological threats, and dynamically blocks chemical threats by closing its pores only in the presence of organophosphate threats. The team is improving the new fabric by incorporating stretch and protection from additional chemical threats.

*First responder support*. Drones could help reduce the impacts of natural disasters by assisting emergency responders: they can make interventions faster, more targeted, and better able to adapt to changing circumstances. They can also multitask in unique ways, for instance making logistics deliveries during a wildfire (of water, radio batteries, first aid, etc.) while using onboard sensors to scan the terrain for hotspots and provide near-real-time information to firefighters. **NASA Ames'** Scalable Traffic Management for Emergency Response Operations (STEReO) project builds on the center's expertise integrating these vehicles into the airspace to develop the tools and systems to make this a reality.

NASA Ames traffic drones in flight in Reno, Nevada undergoing flight tests. (Credits: NASA/Dominic Hart)




As part of its work in developing local urban resilience in Norfolk, VA, Sandia National Laboratories developed maps showing varying levels of potential flooding. (Credit: Sandia National Laboratories)

## Rebuilding with Resilience

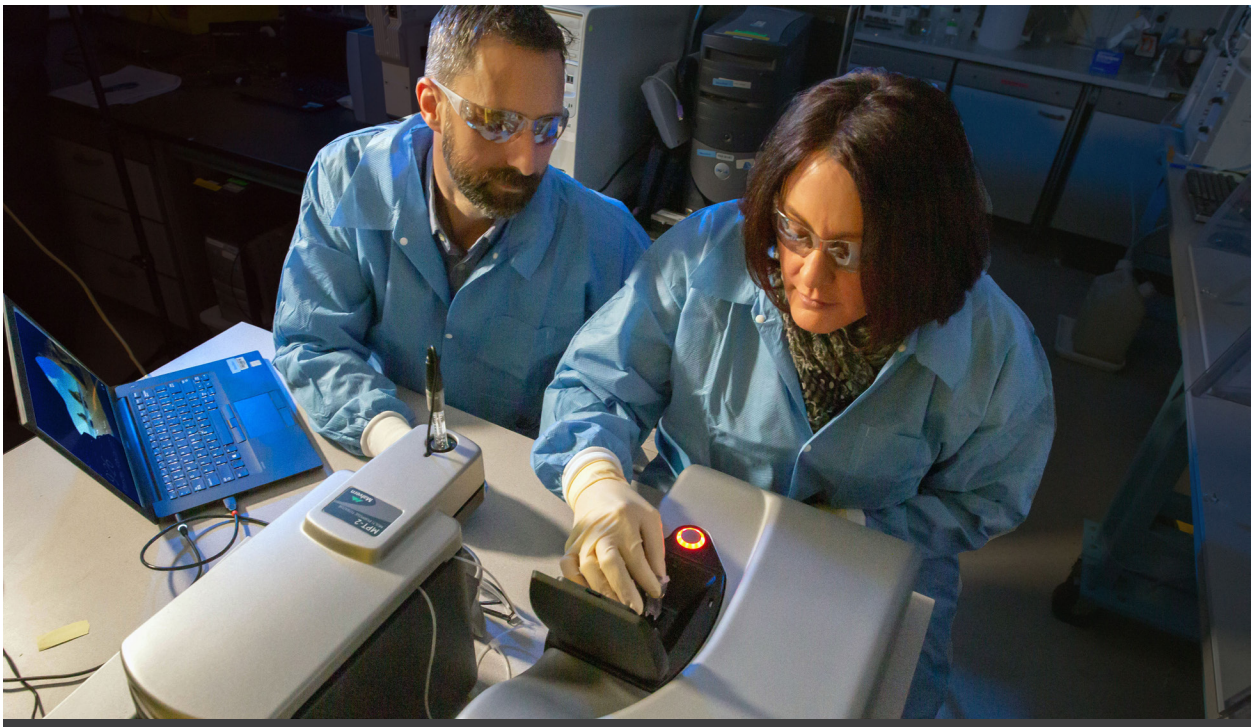
*Planning for carbon neutrality*. As part of **LLNL's** Engineering the Carbon Economy Initiative and other energy programming, LLNL scientists have conducted a study to identify solutions to remove carbon from the atmosphere and help California meet its goal of achieving carbon neutrality by 2045. This comprehensive analysis outlines the costs, carbon removal potential, and important co-benefits of a suite of natural carbon removal strategies, biomass conversion technologies, and negative emissions technologies such as direct air capture. This report concludes that carbon neutrality is achievable, and can guide the State as it makes the required investments and policies.

*Social Welfare and Urban Resilience*. A core aspect of building a resilient community is understanding their unique needs during a disaster event. **Sandia National Laboratories'** Urban Resilience planning team centers the social welfare of communities and has been used in several places such as Norfolk, VA and New Orleans, LA to build more resilient communities. The process is built around two core tenets: engaging community stakeholders at the outset to provide community-specific insights into community needs, and measuring resilience through the consequences to these specific communities. By engaging the community early and gaining a thorough understanding of its needs, Sandia can help design tailored resilient solutions.

*Earthquake recovery*. Major earthquakes in California can destroy or damage many thousands of structures and critical 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 infrastructure throughout the entire Bay Area. After a major earthquake occurs, safety assessments and repairs can take many months, disrupting critical operations and delaying economic recovery. To dramatically speed up the recovery process, Berkeley Lab has developed, extensively tested, and deployed a new optical sensor that building managers can use to quickly pinpoint likely damage for assessment.

*Purifying contaminated water.* A personal water-treatment bag developed at **NASA Ames** can purify contaminated water without power and with minimal interaction. Developed as an emergency technology for astronauts, it has now been used by a group of Antarctic explorers to recycle urine for drinking water. One version containing a powdered supplement can provide all the nutrients and water needed to keep a person alive; another can safely hydrate baby formula with contaminated water. Used in the days following a disaster, the Personal Water Recycling System could save lives until help arrives.

As part of federal efforts to safely handle the legacy of former uranium mines in the west, scientists at **SLAC** are showing how the radioactive element can continue to cycle through the environment and pose challenges for remediation. While former mines and waste piles were capped decades ago and the remaining uranium was expected to naturally leave the sites as part of groundwater flow, uranium has persisted in nearby groundwater for longer than expected. Researchers have found that the dominant form of uranium in sediments can bind to organic matter and persist in the environment. This work has challenged previous assumptions made in modeling, and will improve the understanding of the dynamics involved in the system in order to enhance groundwater remediation efforts around these former mines.



LLNL researchers working on the development of a tularemia vaccine. (Credit: Julie Russell/LLNL)

*Developing new vaccines*. *Francisella tularensis,* the bacteria responsible for tularemia, is a potential biothreat agent and is classified as a high-priority priority pathogen by the Centers for Disease Control and Prevention. Current tularemia vaccines use live, attenuated strains of *F. tularensis,* a strategy associated with high risk profiles, and are not generally available in the US. A team of researchers from **LLNL** and two other research institutes is developing a vaccine that uses a LLNL-developed nanotechnology to co-deliver *F. tularensis* antigens, rather than live pathogens, and an additional immunostimulant. This vaccine candidate is expected to be significantly safer than current vaccines without sacrificing efficacy. The LLNL-developed delivery system can used to develop vaccines for additional pathogens.

# CALIFORNIA'S FEDERAL LABS: 2020 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 Ames Research Center
- NASA 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 26,000 |
| PhD Scientists and Engineers: | More than 5,000 |
| Procurement to California Businesses: | Over $1.3 billion |
| Procurement to Small Businesses: | Over $500 million |

# NASA AMES RESEARCH CENTER

www.nasa.gov/ames
Moffett Field, Santa Clara County
(AD-24, SD-13)

Eugene L. Tu, PhD, Center Director

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

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



## 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.

NASA Ames generates quantifiable financial benefits in California as a result of its activities. Operating activities at NASA Ames provide our state with $1.65 billion in annual economic benefits and support approximately 9,400 permanent jobs.

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. The NASA Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) programs provided more than $40 million in Phase I and Phase II awards to California firms, resulting in an estimated economic impact of more than $83 million and 378 jobs in 2015.

## Resources and Expertise for California Governance

NASA Ames' service to both the state and region includes:

1. Being 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 today's aircraft 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.

## BY THE NUMBERS

No. of Employees: 4,557
Annual Budget: $1.027 billion (2020)
Annual Payroll: $240 million (2020)
Procurements to CA Businesses: $195 million (2020)
Contracts to Small Businesses: $102 million (2020)
Spin-off Companies: 135 (since 1997)



NASA Ames develops groundbreaking technologies for NASA missions, while seeking to promote collaboration with U.S. industry. 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.

## Recent Headlines

"The NASA Engineers Stuggling to Build a Better Heat Shield" –*MIT Technoology Review,*June 26, 2019

"How NASA Ames Is Helping the FAA Brace for the Rise of Delivery Drones" – *KQED*, July 8, 2019

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

## Legislators Say...

"NASA Ames is a vital source of innovation in the Silicon Valley region. The scientific breakthroughs developed there are a great boon to all Californians."
— *Assemblymember Marc Berman (D-Palo Alto)*

"Thanks to the ingenuity of NASA Ames' research and development, the technology pioneered for exploration of space also has important applications in meeting the challenges we face on Earth. From COVID to climate change, and water treatment to disaster response, NASA Ames offers solutions that can help us battle the emergencies that confront us today and aid us in building resilience for our future."— *Senator Josh Becker (D-San Mateo)*

# NASA JET PROPULSION LABORATORY

www.jpl.nasa.gov
Pasadena/La Cañada Flintridge, Los Angeles County
(AD-43, SD-25)

Michael Watkins, PhD, Director

Patty Rhee, Government Affairs
patty.m.rhee@jpl.nasa.gov



## Impact to the Region and State

Home to Mars rovers, space telescopes and an array of Earth-orbiting satellites, the NASA 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 for California Governance

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.
6. Assess the health of forest ecosystems for post-fire land management restoration decisions.

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

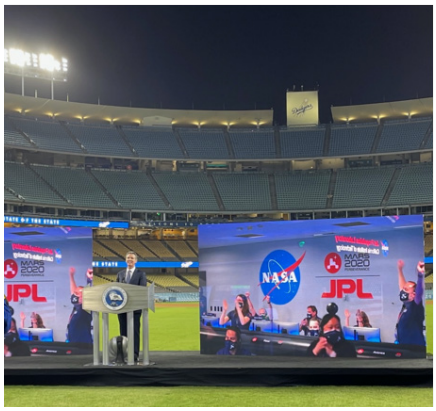
No. of Employees: 6,912
PhD Scientists and Engineers: 1,175
Annual Budget: $2.66 billion
Procurements to CA Businesses: $387 million
Contracts to Small Businesses: $169 million
No. of Patents Registered: 340 (since 2007)



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




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

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

## Legislators Say...

"The dedicated scientists at NASA/JPL are continuously pushing the boundaries of human discovery, from a mission to Mars to new insights into how Earth's lands, oceans, and climate are evolving. The discoveries and technologies made there improve the lives of all Californians and make us more resilient when confronting natural disasters and climate change. And, how about the amazing Perseverance and its helicopter!"— *Senator Anthony Portantino (D-La Canada Flintridge)*

"In meeting the challenges of robotic space exploration, JPL brings new knowledge to California that keeps our state a world leader in science and technology. JPL's research and talented workforce are an asset to the 43rd Assembly District and greatly enhance our economic vitality."— *Assemblymember Laura Friedman (D-Glendale)*

# LAWRENCE BERKELEY NATIONAL LABORATORY

www.lbl.gov
Berkeley, Alameda County
(AD-15, 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

Managed by the University of California for the Department of Energy's Office of Science, Berkeley Lab conducts a broad array of basic and applied unclassified 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.

The 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.

The 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 for California Governance

Berkeley Lab houses many "user facilities" — state-of-the art lasers, instruments, and computers available for industry and university use. In 2020, more than 14,000 researchers (40 percent from California research institutions) accessed these facilities, representing nearly forty percent 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.

Notable 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.

Managed by the University of California, Berkeley Lab collaborates closely with UC campuses across the state, bringing 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: 3,565
PhD Scientists and Engineers: 1,702
Students & Postdocs: 1,467
Annual Budget: $1 billion (2020)
Annual Payroll: $417 million (2020)
Procurements to CA Businesses: $224 million
Contracts to Small Businesses: $68 million
No. of Patents Issued (last 10 years): 678
IP Licenses (last 10 years): 913
No. of Startups Based on Tech: 60



2. Molecular Foundry is the DOE's largest nanoscience center, allowing researchers to engineer new materials from fuel cell components to proteins.
3. National Energy Research Scientific Computing Center (NERSC) is the world's sixth most powerful supercomputer.
4. The DOE Joint Genome Institute (JGI) is a world leader in generating the genetic blueprints of plants, fungi, algae, and environmental microbes to characterize the roles these organisms have in sustaining our planet.

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

## Recent Headlines

"The Superpowers of Super-thin Materials"
– *The New York Times*, January 7, 2020

"Kill Your Gas Stove"
– *The Atlantic*, October 15, 2020

"Schools (and Children) Need a Fresh Air Fix" – *Wired*, October 14, 2020

## 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)*

# LAWRENCE LIVERMORE NATIONAL LABORATORY

LLNL

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

Kim Budil, PhD, Director

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

Lynda Seaver, Public Affairs
seaver1@llnl.gov

## Impact to the Region and State

LLNL has a robust technology transfer program built on successful, mutually beneficial relationships with private industry. Access to Laboratory technologies, capabilities and intellectual property enables our industry partners to accelerate commercialization of technologies and products that strengthen regional and U.S. competitiveness and innovation. In return, research and development partnerships with industry enable LLNL to develop and sustain capabilities that support its national security mission

LLNL has deep and longstanding relationships with leading academic institutions, notably the University of California, which serve as research partners and workforce pipelines for many of its most sought-after positions. We in turn seek to inspire the next generation of researchers by providing opportunities for teachers and students to develop new skills and gain experience by participating in our various education and internship programs

## Resources and Expertise for California Governance

Our strong science and technology foundation developed for national security missions is applicable to solving many of the challenges we face in California. A sampling of these research areas are listed below, and additional competencies can be found here.

1. **Energy Security and Climate Resilience** - Secure and expand the supply and delivery of affordable, clean energy with technologies resilient to evolving natural and adversarial risks:

2. **Advanced Materials and Manufacturing** - With a key focus on additive manufacturing, which is transforming manufacturing by producing novel materials with new structural, thermal, electrical, chemical, and photonic properties with an added goal of revolutionizing the design-build-test cycle. Examples include high-performance optics, biocompatible devices, advanced battery components, and radiation detection materials.

## SCIENCE AND SECURITY IN THE ATOMIC AGE

Our founders created Lawrence Livermore National Laboratory (LLNL) in 1952 as a "new ideas" lab, a place where innovative science and technical solutions to the nation's most difficult security challenges and human progress are created. We continue this tradition, living our motto, "Science and Technology on a Mission," by pushing the frontiers of what is or might be scientifically and technically possible.

Team science is a hallmark of LLNL. Effective team science is enabled through a healthy research culture of respect, openness, workforce diversity and interdisciplinary collaboration. Mission delivery requires talented and committed staff, state-of-the-art facilities and equipment, and robust partnerships with colleagues at other national laboratories, and in government, universities and industry. These factors have been essential to the LLNL's many achievements, and continue to be indispensable for the Laboratory's vital missions and the advancement of science and technology.

## BY THE NUMBERS

No. of Employees: 8,200
PhD Scientists and Engineers: 1,764
Post-docs: 300
University-level Students: 1,200
Annual Budget: $2.5 billion
Annual Payroll: $1 billion
Procurements to CA Businesses: $240 million
Active Commercial Licenses: 79



3. High Performance Computing for Manufacturing/Innovation/Energy (HPC4Mfg) Program - Unites the world-class computing resources and expertise of Department of Energy national laboratories with U.S. manufacturers to deliver solutions that could revolutionize U.S.

4. Laser and Optical technologies - Discovering industrial applications that strengthen U.S. economic security, including laser melting, precise material removal, precision heat treatment, mechanical strengthening such as laser peening, and heat-resistant optics

5. Forensic Science Center - One of only two U.S. laboratories to be internationally certified for identifying chemical warfare agents. The center also develops new tools for intelligence, law enforcement, homeland security, and healthcare

## Recent Headlines

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

"El Capitan supercomputer to blow past rivals, with 2 quintillion calculations per second" – *CNET*, March 4, 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

Florencia Prada, Communications Manager
fprada@sandia.gov

## Impact to the Region and State

For more than 50 years, the California campus of Sandia National Laboratories (Sandia/California) has delivered essential science and technology to resolve the nation's most challenging security issues.

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.

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

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

## Resources and Expertise for California Governance

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

The lab's transportation programs are delivering new technologies designed to reduce greenhouse gas emissions, improve air quality, and reduce petroleum use. And its Combustion Research Facility focuses on improving energy efficiency and reducing emissions. Its robust solar, wind, and geothermal research and development programs have contributed to a widespread deployment of renewable energy technology. The lab's energy storage and grid integration programs also help address California's efforts to meet requirements for its renewable portfolio.

Sandia/California also develops and prepares mitigations plans and technical solutions for natural and man-made disasters. For example, the lab signed a memorandum of agreement

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: 1,608
Percent Techincal Staff w/ PhD or Masters: 81%
Annual Budget: $551 million (2020)
Procurements to CA Businesses: $210 million (2020)
Contracts to Small Businesses: $127 million (2020)



with the California Fire and Rescue Training Authority to deliver an emergency response framework to the California Exercise Simulation Center. Their SUMMIT tool aids in preparing for man-made or natural disasters by improving the cycle of activities that emergency response teams undertake. 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 nation, regional, and local levels.

## Recent Headlines

"Can Diesel Finally Come Clean?" – *Scientific American*, December 19, 2019

"The kill-switch for CRISPR that could make gene-editing safer" – *Nature*, January 15, 2020

"Rooftop Wind Power Might Take Off by Using Key Principle of Flight"" – *Scientific American*, April 21, 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

SLAC

www.slac.stanford.edu
Menlo Park, San Mateo County
(AD-24, SD-13)

Chi-Chang Kao, PhD, 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 for California Governance

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: 579
Graduate & Undergraduate students: 330 (2019)
Annual Budget: $553 million (2019)
Annual Payroll: $229 million (2019)
Procurements to CA Businesses: $90 million (2019)
Contracts to Small Businesses: $52 million (2019)



3. Scientific computing, and control system hardware and software.
4. Improved medical imaging.
5. Electric grid modernization and more efficient catalysts for energy and industry.
6. Tracing and mitigating environmental contamination.
7. Next-generation particle accelerator technology.

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

"Silicon Valley X-ray Laser Used To See Attosecond Electron Movement" – *Forbes*, Dec 2, 2019

"New Particle Accelerator Fits on a Silicon Chip" –*Scientific American*, January 4, 2020

"California Scientists Build A Camera To Take Pictures Of Huge Swath Of Sky" – *NPR*, September 8, 2020

## Legislators Say...

"SLAC has long been in the forefront of innovation, pushing the merely imaginable into the realm of reality. SLAC continues to break new ground across its research portfolio. Ranging from preparation and early action solutions to real-time monitoring and response, as well as recovery, the work of SLAC scientists today in disaster resilience research resonates particularly strongly."— *Senator Josh Becker (D-San Mateo)*

"SLAC National Accelerator Lab continues to push the frontiers of our fundamental scientific knowledge. Their unique capabilities play a key role in establishing our scientific leadership and laying the groundwork for our progress toward a clean, sustainable energy future."— *Assemblymember Marc Berman (D-Palo Alto)*

# 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

John Thompson, PhD
Senior Science Officer,
john.thompson@ccst.us
(916)492-0996

Find us online at www.ccst.us

**NASA 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 Jet Propulsion Laboratory**
**www.jpl.nasa.gov**

Patty Rhee, Government Affairs
patty.m.rhee@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**

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

Lynda Seaver, Director of Public
Affairs seaver1@llnl.gov

**Sandia National Laboratory/California**
**www.sandia.gov**

Patrick Sullivan, Government Relations
pmsulli@sandia.gov

Florencia Prada, Communications Manager
fprada@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

CCST is a nonpartisan, nonprofit organization established via the California State Legislature — making California's policies stronger with science and technology since 1988. We engage leading experts in science and technology to advise State decision makers — ensuring that California policy is strengthened and informed by scientific knowledge, research, and innovation.

CCST operates in partnership with, as well as receives financial and mission support, from a network of public and private higher-education institutions and federally funded laboratories and science centers:

The University of California System
California State University System
California Community Colleges
California Institute of Technology
Stanford University
NASA Ames Research Center
NASA Jet Propulsion Laboratory
Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
Sandia National Laboratories-California
SLAC National Accelerator Laboratory

To request additional copies of this publication, please contact:

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

CALIFORNIA'S FEDERAL LABS & RESEARCH CENTERS
Toward A Resilient California:
A 2021 Impact Report for State Leaders

California Council on Science and Technology • Spring 2021