California's Federal Labs & Research Centers

2018 Impact Report for State Leaders

Prepared by the
California Council on Science and Technology

CCST
CALIFORNIA COUNCIL ON SCIENCE & TECHNOLOGY

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

INTRODUCTION

Dear Honorable and 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 campuses, Stanford, and Caltech, we also take pride in our unrivalled collection of federal laboratories and research centers.

Discoveries by California's federal labs and research centers save lives, advance technology, and inspire possibilities. They take us deep inside the genetic code, support the foundations of our energy and national security, and launch us toward the stars. When families save money on their home power bills through new technology, when a child explores the valleys of Mars from a classroom computer, and as the *Voyager* space probes sail far beyond our Solar System on thermal batteries activated in the 1970s, we have California's federal labs and research centers to thank.

Federal labs and research centers are distinguished by large-scale, mission-oriented projects and facilities designed to tackle humanity's most difficult scientific questions. These labs and centers build and operate one-of-a-kind supercomputers, lasers, particle accelerators, simulators, and engineering foundries only a federally funded institution can sustain. They represent an investment of tens of billions of federal research and development dollars — a wealth of intellectual power that businesses, universities, and agencies in California can draw from.

Of course, these mighty achievements are made possible because of a Californian workforce — world-class researchers, dedicated students, and passionate support staff, be they Golden State natives or recent residents. Across the labs and centers we highlight in this report are some 24,000 talented hires who live, raise families, and stake their future in California. This workforce brings more than four billion dollars in payroll, contracts, and procurements to California's communities, companies, and institutions — building partnerships, transferring ideas, and incubating startups in our state's economy.

As Californians confront big challenges — climate change, clean energy, cybersecurity, resource scarcity, and international competitiveness — these labs and centers stand ready to help. We invite you to find your moment of discovery as you turn these pages, and learn how our federal labs and research centers help make California stronger with science.

Sincerely,

Amber Mace, PhD
CCST Interim
Executive Director

Peter Cowhey, PhD
CCST Board Chair
UC San Diego

Terry Land, PhD
CCST Federal Lab Affiliates Chair
Lawrence Livermore
National Laboratory

Sarah Brady, PhD
CCST Interim
Deputy Director

Jim Sweeney, PhD
CCST Council Chair
Stanford University

Judith L. Swain, MD
CCST Council Vice-Chair
Singapore A*STAR

ABOUT CCST

The **California Council on Science and Technology (CCST)** is a nonpartisan, nonprofit organization established via the **California State Legislature** in 1988. CCST responds to **the Governor, the Legislature, and other state entities** who request independent assessment of public policy issues relating to science and technology that affect the State of California.

In 1988, a coalition of policymakers and institutional leaders had been seeking ways to catalyze the role of science and technology in California's future direction in research, industry, and policy. The effort resulted in **Assembly Concurrent Resolution 162** — championed by then-Assemblymember **Sam Farr** and then-Senator **John Garamendi** — calling for the creation of CCST.

California has seen great advances and new challenges since then, and CCST has been invited as a voice of counsel at each turn. Over the past decades, CCST has been asked to report on the state's R&D competitiveness, STEM education, energy production, and water future, among many other timely topics.

CCST itself has evolved as well: It added the **CCST Science & Technology Policy Fellowship** program to train more scientists for public policy careers; and it added the **Federal Laboratories** to enhance its network of in-state experts — complementing CCST's partnerships with the **University of California, California State University, California Community Colleges, Stanford,** and **Caltech.**

California's leadership in technology, environmental stewardship, biomedicine, and other critical fields relies on its policymakers having access to clearly communicated, scientifically informed advice. With this need in mind, CCST will continue to engage leading experts in science and technology to advise State policymakers — ensuring that California policies are strengthened and informed by scientific knowledge, research, and innovation.

In 2018, CCST celebrated its 30th anniversary and welcomed the 10th class of its CCST Science Fellows.

CONTENTS

Cover Photo: SLAC and Stanford scientists seek to improve the efficiency of thin-film flexible solar panels.

CCST is a nonpartisan, 501(c)(3) nonprofit organization established via the California State Legislature in 1988. We engage leading experts in science and technology to advise State policymakers — ensuring that California policy is strengthened and informed by scientific knowledge, research, and innovation. Explore how CCST is making California's policies stronger with science at www.ccst.us.

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**

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 institutions as new partners. 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.**

Connecting Federal Resources In and Beyond California

As the convenor for this California research network, CCST helps facilitate links across the capabilities and talents of these labs and centers. In turn, these ongoing relationships and dialog improve CCST's ability to fulfill its mission to the State of California: responding to requests from State leaders in providing up-to-date, evidence-based advice on policy issues related to science and technology **(see page 37)**.

The program has led to successful conversations and reports benefiting the State of California **(see next page)**.

Why CCST?

The **California Council on Science and Technology (CCST)** was 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" — and to create a council "comprised of distinguished scholars and experts, including scientists and engineers from California's academic and industrial community." Today, this Council includes many senior scientists from public and private research universities and federal labs serving the Golden State.

CCST has grown as a resource to connect decision makers with leading scientists in California and beyond. Over these 30 years, state leaders have requested CCST reports on many issues of policy importance, from natural gas storage safety to sustainable water futures.

Why Tap into Federal Science?

Uniquely Positioned: Federal departments 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 Decision Makers: 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.

How CCST Can Help

CCST can help Members and Capitol 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:

1. **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.**
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. **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:

1. During policy development, to obtain data and advice from subject area experts.
2. During the legislative process, to find experts for testimony at policy, fiscal, select committee, and other hearings.
3. During implementation and regulatory enforcement, accessing current science to review standards, technologies, efficacy, and relevance.
4. When recovering from and analyzing natural disasters and human-engineered catastrophes.

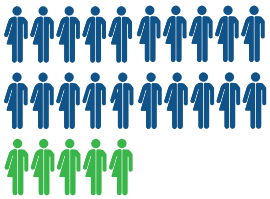
If your office is considering legislation that you believe would benefit from federal expertise, or if you are seeking data and advice to strengthen your decisions with science, **contact CCST** — and we will help you navigate the bounty of top scientific minds available to California. **(See p.36 for CCST contact information)**

CCST FEDERAL LABORATORY AFFILIATES

ECONOMIC IMPACT

$7.7 BILLION
of Federal Money

EMPLOYING CALIFORNIA TALENT



1,000 EMPLOYEES

Ph.D. SCIENTISTS and ENGINEERS

25,000
employees

1,200+
Patents Issued

*2006-2016

SPARKING INNOVATION

BOOSTING CALIFORNIA'S ECONOMY

$2.2 BILLION
Payroll

$1.5 BILLION
Procurements to California Businesses

$500 MILLION
Procurements to Small Businesses

FEDERAL LABS RESEARCH BENEFITING CALIFORNIA

In Service to the Nation and Its States

The following are 2017 highlights of research areas and programs at CCST's seven Federal Laboratory Affiliates. This overview is not an exhaustive list of all projects and research areas at these instutions, 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 decision makers 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

Public Safety

Earthquake Safety: In collaboration with **LLNL** and **UC Davis**, **Berkeley Lab** is developing next-generation simulation methods to predict earthquake ground motion at the regional scale. This research will improve our understanding of the distribution, amplitude and frequency of future earthquakes, and our insights into how these motions will impact public safety and critical infrastructure. Complementing this are **Berkeley Lab**'s investigations into solutions for distributed sensing — exploring the deployment of seismometers to electric utility meters or through existing and unused underground fiber-optic cables.

Environmental Disasters: Federal labs and research centers are routinely called upon to provide scientific expertise needed to guide responses to crises at home and abroad. Most recently, scientists from **Berkeley Lab**, **Sandia California**, and **LLNL** worked together in response to the Aliso Canyon natural gas storage leak, while **NASA Ames** collected airborne gas measures over Aliso Canyon. **Berkeley Lab** has also studied biological responses to ocean contamination associated with the Deepwater Horizon spill, and **LLNL**, **Sandia California**, and **Berkeley Lab** rendered assistance to U.S. and Japanese government responses to the Fukushima nuclear incident.

Emergency Response: **NASA JPL** developed a 3-D tracking system called **POINTER** that firefighters can use to navigate inside buildings, while helping incident commanders locate personnel in case of danger. POINTER uses electromagnetic fields instead of radio waves or GPS, which are unreliable indoors because they bounce off walls or do not work well underground. NASA JPL also developed **FINDER**, which sends a low-powered microwave signal through rubble to sense life signs such as breathing and heartbeats. FINDER can detect heartbeats through 30 feet of rubble or 20 feet of concrete, and was credited with rescuing survivors in the 2015 Nepal earthquake.

Air Travel: NASA Ames conducts commercial air travel studies, including air traffic control patterns, aircraft safety, automation, and human factors. A two-story, full-scale, 360-degree air traffic control tower at Moffett Field called **FutureFlight Central** can virtually display the airfield view from real airports, and is able to simulate and analyze operational scenarios that help make air travel safer and more reliable.

Forensic Science: The **LLNL Forensic Science Center**, which focuses on chemical, nuclear, and biological counterterrorism, developed a technique that uses protein signatures instead of DNA to identify individuals based on hair samples. Once optimized, identification may be possible using as small a sample as a single hair — providing an additional, science-based, statistically validated way to help solve crimes.

Nuclear Security: The **DOE National Nuclear Security Administration (NNSA)** is responsible for securing the nation's aging stockpile of nuclear weapons and safely dismantling retired weapons in support of nonproliferation agreements. **Sandia California** and **LLNL** are both home to NNSA research facilities, focusing on engineering, design, and testing of components related to weapons safety and assessment.

Human Health

Vector-Borne Diseases: Researchers at **Sandia California** have developed a smartphone-controlled, battery-operated diagnostic device that weighs under one pound, costs as little as $100 and can detect Zika, dengue, and chikungunya viruses within 30 minutes. The device eliminates the need to process a biological sample, such as blood or urine, before testing. Ultra-accessible and ultra-portable, the prototype could one day become a staple in point-of-care clinics worldwide.

Pharmaceutical Testing: "Human-on-a-chip" technology is an effort currently underway at **LLNL.** Dubbed **iCHIP (in-vitro Chip-based Human Investigational Platform),** the project will fit cellular components of major human organ systems on a surface smaller than a credit card. These simulated organs can then be exposed to a variety of chemicals, allowing scientists to assess potential responses in humans — a dramatic improvement over animal testing and other traditional methods for drug testing.

Paging Dr. McCoy: NASA Ames and **LLNL** have developed the **NASA Analyzer**, which would provide comprehensive medical diagnostic capabilities in a compact, hand-held device with wireless capacity, with the ability to handle multiple sample types — including breath, saliva, and blood.

Air traffic controllers test NASA-developed concepts in FutureFlight Central at the NASA Ames Research Center.

Scientist Profile: Susan Hubbard, PhD

Associate Lab Director
Earth & Environmental Sciences Area (EESA)
Lawrence Berkeley National Laboratory

PhD, Engineering, UC Berkeley
MS, Geophysics, Virginia Tech
BS, Geology, UC Santa Barbara


Berkeley Lab

Dr. Susan Hubbard leads the 500-staff EESA unit at Berkeley Lab in studies of climate science, terrestrial ecosystem, environmental and water science, and subsurface energy geoscience. With career experience spanning industry and government, Dr. Hubbard helps the U.S. Department of Energy incorporate its understanding of natural systems and global change with its research and recommendations for America's energy future. Dr. Hubbard is a current CCST Council Member.

Dr. Hubbard can speak and advise on the following technical fields:

- Water resiliency, water-energy issues, and water quality mitigation in California.
- Soil health, soil carbon, and precision agriculture in California.
- Energy geoscience, including geothermal and carbon sequestration strategies.
- Advanced approaches to monitor and predict environmental system dynamics.


U.S. Navy (photo credit)

Scientist Profile: Patricia Falcone, PhD

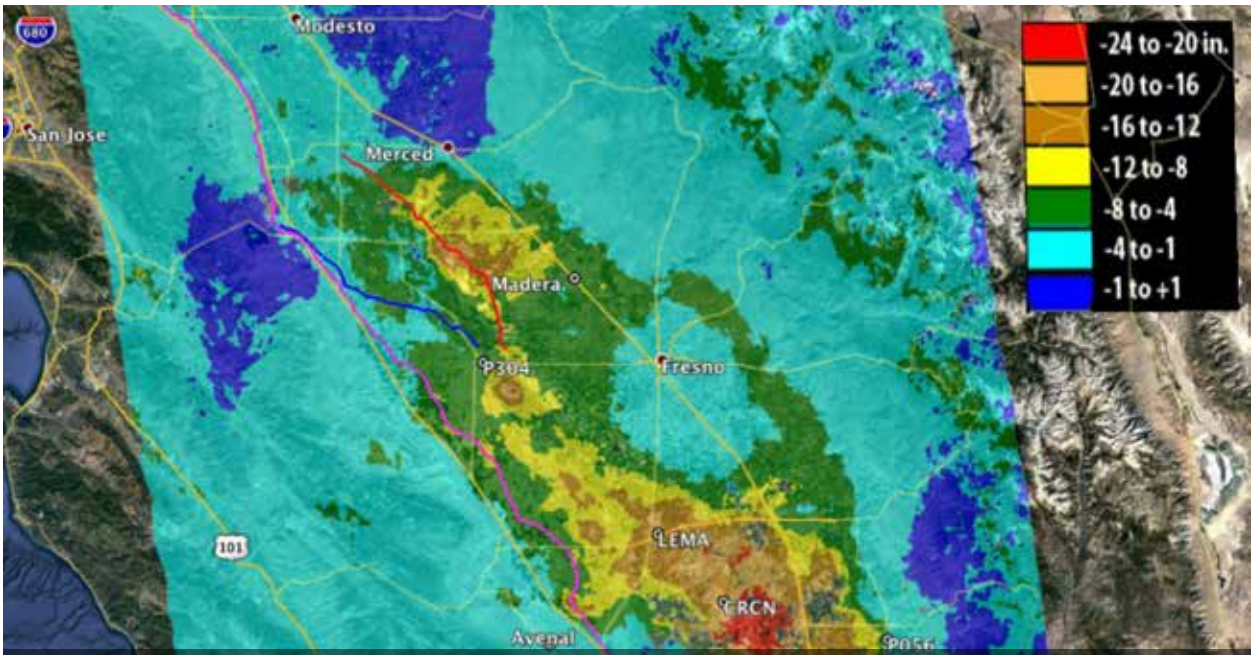
Deputy Director for Science and Technology
Lawrence Livermore National Laboratory

PhD, Mechanical Engineering, Stanford
MS, Mechanical Engineering, Stanford
BSE, Aerospace and Mechanical Sciences, Princeton

Dr. Patricia Falcone oversees the strategic development of LLNL's capabilities and is responsible for the lab's research collaborations with academia and the private sector. Dr. Falcone joined LLNL in 2015 after six years at the White House Office of Science and Technology Policy (OSTP), serving as the presidentially appointed and U.S. Senate-confirmed Associate Director of OSTP for National Security and International Affairs.

Dr. Falcone can speak and advise on the following technical fields:

- Science and technology dimensions of national security policy deliberations.
- Federal support of national security research and development.
- Assessment of new technologies for mission applications.
- Advanced energy conversion technologies.



A map layer created by NASA JPL and Caltech for DWR shows areas with extreme subsidence in red.

Disease Vaccines: A team of **LLNL** and **UC Irvine** scientists are pursuing a vaccine against chlamydia, the most commonly reported sexually transmitted infection in the U.S. and in California. With funding from the **National Institutes of Health (NIH)**, LLNL is applying its protein engineering expertise to produce a Major Outer Membrane Protein (MOMP) vaccine — a promising vaccine with a complex, difficult-to-create molecular structure.

Youth Brain Injury: NASA Ames and **San Jose State University** have developed a "brief eye-movement" test to assess brain health. NASA Ames is working to adapt and refine this technology to assess mild-to-moderate traumatic brain injury. This noninvasive technology has the potential to be deployed in schools for real-time use to assess youth athletes in the event of possible injury.

Knowledge Sharing: The **Medical Engineering Forum** at **NASA JPL** harnesses unique technologies being developed for space exploration by finding ways to apply them towards solving challenges in health and medicine. In 2017, one study generated by the forum revealed the possibility that bacteria in human breast ducts may influence breast cancer risk — by applying techniques which NASA JPL uses for screening outgoing space probes for microbe contamination.

Agriculture, Water, and Natural Resources

Subsidence Tracking: NASA JPL prepares subsidence maps for **California Department of Water Resources (DWR)** reports. These satellite and radar data show that land continues to sink in certain areas of the San Joaquin Valley, putting state and federal aqueducts and flood control structures at risk of damage. NASA JPL also tracked subsidence rates in the San Joaquin Valley during the recent historic drought, showing that two main subsidence bowls, covering hundreds of square miles, grew wider and deeper between 2015-2016.

Snowpack Measurement: The **NASA JPL Airborne Snow Observatory (ASO)** uses satellite data to estimate the amount of water accumulating each year in California's Sierra Nevada snowpack, and the rate of water melt, providing real-time, high-resolution maps to complement manual surveys. These data are used at Hetch Hetchy Reservoir and other facilities to improve modeling estimates of future water runoff — and will guide more efficient operations and water usage in California under conditions spanning flood to drought.

Water Data: Berkeley Lab, DWR, UC Water, and CCST are partners in the Open and Transparent Water Data workshops spawned by **AB 1755 (2016),** seeking to improve water data management across the state.

Tapping Into the Water Cycle: Berkeley Lab has developed advanced models for resource managers to predict the timing and location of rainfall and snowpack, and how California's watersheds distribute this water, including prediction of watershed responses to extreme events such as droughts and floods. Berkeley Lab also is partnering with universities and the agricultural sector to develop ways of optimizing groundwater storage, withdrawal, and pumping, based on where and when it is needed by cities and farms.

Desalination for Remediation: Berkeley Lab is developing low-cost desalination technologies capable of stripping the salt out of brackish groundwater in the Central Valley, leaving farmers with a more reliable source of irrigation water while lowering the rate of salt buildup in the soil.

Contaminated Water Treatment: NASA Ames has developed a portable, low-cost method that recycles liquids by processing and removing contaminants. Their system can process urine into an emergency supply of drinking water.

Improving Crop Yields and Carbon Storage: In seeking to understand microbe-soil-plant interactions in natural and working lands, **Berkeley Lab** is using electrical currents to noninvasively image the structure, size, and distribution of plant roots within the soil. The technology lets scientists observe nutrient absorption by crop roots, revealing ways to increase soil health for agricultural and natural resource managers. Another technology uses radiation detection to measure soil carbon content at the scale of mere inches. This technology was inspired by sensors used in homeland security for detecting explosives in cargo. Combined, these innovations will provide growers and researchers a "window into the soil" to understand how crops access carbon and other nutrients, leading to enhancements in crop yields and soil carbon storage.

Algal Fuel Farming: Seeking to improve yields of algal crops for biofuel and bioplastics production, researchers at **LLNL, Sandia California,** the **Berkeley Lab's Joint Genome Institute,** and **UC Davis** are developing "probiotic" treatments to control the levels of algae-destroying microorganisms in algal farm ponds. These miniature pests can cause as much as a 30 percent drop in algal yield, adding to production costs and increasing biofuel prices. The team believes that these treatments — which will need to be tailored and tested for full-scale farm operations — can lead to a 10 percent increase in annual productivity for algal farms.

Under a Microscope: SLAC is using its **Stanford Synchrotron Radiation Lightsource (SSRL)** to study how chemicals used in hydraulic fracturing interact with shale to form precipitates that can clog pores, ultimately shutting down natural gas production. They are also investigating how contaminants such as uranium and radium are released from the rock. With the SSRL, scientists can examine pore structure down to very small scales, and analyze the chemical composition of these precipitates and contaminants.

Climate Change

Measuring City-Level Greenhouse Gas Emissions: Los Angeles is one of the pilot cities in the **Megacities Carbon Project,** led by **NASA JPL** in partnership with the **California Air Resources Board, UC Irvine,** and others. A sensor network sited around the L.A. Basin continuously measures three key chemicals: carbon dioxide, methane, and carbon monoxide. The multi-year data will give managers a way to see how local emissions trends match changes in policies, regulations, and human activity — offering never-before-available insight on how major cities "exhale" greenhouse gases.

AmeriFlux Network: Berkeley Lab leads the **DOE AmeriFlux** project — a network of hundreds of atmospheric instrument towers distributed across the Americas that provide continuous measurements of carbon, water, and other parameters. The twenty-some California AmeriFlux sites provide a foundation to quantify changes in greenhouse gas fluxes across a range of the state's landscapes.

Affordable Sensors: Berkeley Lab developed a black carbon monitor costing less than one-tenth of those now on the market — paving the way for communities and air quality districts to collect better data about local air pollution, as directed by **AB 617 (2017)**.

High-Performance Computing: One of the world's leading supercomputers, **Berkeley Lab's National Energy Research Scientific Computing Center (NERSC)** is the primary scientific computing facility for the **DOE's Office of Science.** NERSC offers tremendous advances in computing speed, allowing researchers to run high-resolution models like the Community Atmospheric Model, which offers details about how climate change will affect specific locations and agricultural regions within California at an increasingly granular level. Using NERSC supercomputers, updated models will help researchers predict climate change impacts at the city level.

Scientist Profile: Bob Hwang, PhD

Director, Transportation Energy Center
Sandia National Laboratories

PhD, Physics, University of Maryland
BS, Physics, UCLA


Sandia

Dr. Bob Hwang leads Sandia's transportation energy division, which includes the world-renowned Combustion Research Facility, recognized for its collaborations with industry and academia. With an objective of creating a carbon-neutral vehicle fleet, the Transportation Energy Center also studies the co-development of biofuels and engine design, safe and reliable energy storage components, and systems to enable a hydrogen vehicle infrastructure.

Dr. Hwang and his team can speak and advise on the following technical fields:

- Combustion science and the predictive simulation of engines.
- Hydrogen science and engineering for vehicle and stationary sources.
- Biofuels and drop-in replacement fuels.
- Assessment of new transportation energy technologies and trends.


SLAC/Stanford

Scientist Profile: David Chassin

Staff Scientist
GISMo Laboratory
SLAC National Accelerator Laboratory

PhD/MASc, Mechanical Engineering, University of Victoria
BS, Building Sciences, Rensselaer Polytechnic Institute

Dr. David Chassin leads GISMo R&D on modeling, simulation and analysis of power systems. He managed the development of the DOEs GridLAB-D simulation system, which is widely used to study smart-grid and renewable energy technology integration in electricity distribution systems. He led the design of the transactive control systems for DOE's smart-grid demonstrations, and serves on the North American Electricity Reliability Corporation Load Modeling Task Force.

Dr. Chassin can speak and advise on the following technical fields:

- Demand response and building system performance.
- Agent-based energy system modeling and simulation.
- Data-driven distributed energy resource integration.
- Flexible load-to-grid services.

Statewide Greenhouse Gas Inventory: Both **LLNL** and **Berkeley Lab** are collaborators in the **Air Resources Board**'s **Statewide Greenhouse Gas Monitoring Network**, established via **AB 1803 (2006).** This network of sensor stations spread around California tracks carbon dioxide, methane, nitrous oxide, and black carbon — collecting critical data to verify the statewide greenhouse gas inventory and help inform carbon policy decisions.

Satellite Technology for Air Monitoring: Managed by researchers at **NASA JPL, AIRS (Atmospheric Infrared Sounder)** supports climate research and improves weather forecasting. AIRS is one of six instruments aboard the **Aqua Satellite,** a **NASA Earth Observing System** of satellites. It is the most advanced water vapor sensor ever built, and also measures all other primary greenhouse gases including carbon dioxide, carbon monoxide, methane, and ozone.

Changing Oceans: For the last 25 years, the **Topex-Poseidon** satellite has revolutionized ocean research. Led by **NASA JPL** and the French space agency **CNES**, the mission provides highly accurate, global measurements of sea levels. The program continuously mapped global ocean currents and tides; illuminated the global reach of El Niño and other climate events; created a quarter-century-long, extraordinarily precise record of global and regional sea level rise; and enabled improved forecasts of extreme weather events such as hurricanes, floods, and droughts.

Transparency in Engine Systems: Sandia California uses its **Combustion Research Facility** to investigate renewable fuels and advanced combustion strategies. Equipped with a modified diesel engine, the lab allows researchers to see into a combustion chamber, conduct experiments, and generate data critical to achieving legislated targets, such as the low-carbon fuel standard.

Energy Efficiency and Renewables

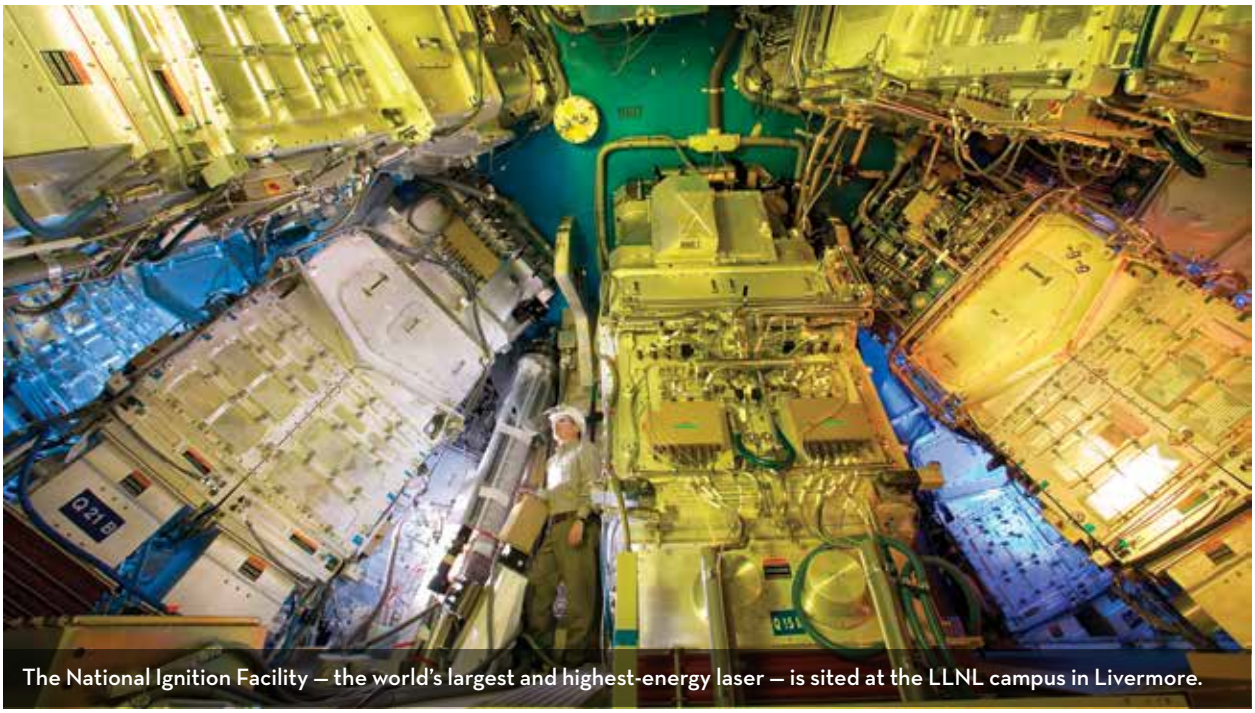
Electrical Grid Infrastructure and Management: Solving the technological, data, and software hurdles of solar generation integration, vehicle charging infrastructure design, and managing the distributed grid are the goals of the **Grid Integration Systems and Mobility (GISMo) Lab** at **SLAC.** Projects like **VADER** seek to improve real-time data integration and analysis from power generators and users, while **SCRIPT** seeks to forecast and compare future travel scenarios of electric vehicle drivers and grid conditions.

Battery Technology: Berkeley Lab, SLAC, and **LLNL** are members of **CalCharge**, a public-private consortium of companies, research institutions, government programs, and other stakeholders in battery and electrochemical energy storage technology. CalCharge is intended to invigorate the energy storage sector and speed up commercialization of technologies. Businesses can take advantage of federal lab resources in developing and commercializing energy storage technologies for markets at the grid, vehicle, and consumer electronics scales.

Hydrogen Highways: Developed by **Sandia California** and the **National Renewable Energy Laboratory**, the **Hydrogen Station Equipment Performance (HyStEP)** device measures the performance of hydrogen dispensers at new fueling stations, drastically reducing the time to commission new hydrogen vehicle fueling stations. This streamlines how California certifies retail hydrogen stations to meet customer demands for fueling, helping to pave the hydrogen highway future.

Subsurface Energy Management: Underground or "subsurface" energy resources includes renewable sources like geothermal. California produces more geothermal power than any other state, and alone accounts for more than 20 percent of total geothermal energy production worldwide, with potential for more. The subsurface can also serve as a vast reservoir for energy storage and geologic carbon sequestration. **Berkeley Lab** and **Sandia California** are co-leads on **DOE SubTER Crosscut,** a program integrating expertise and resources across DOE labs, universities, and industry to quantify, predict, and safely use subsurface resources. Berkeley Lab also has additional geothermal resources research, with a focus of adding more flexible-load energy to California's grid.

Oil and Gas Production: Federal scientists are developing technologies to assess and reduce the environmental impact of California's oil and gas production. Examples include **NASA JPL**'s work on repurposing the excess heat or gas generated by mechanical systems as electrical power. In partnership with the Gas Technology Institute, Southwestern Energy, and Chevron, NASA JPL is developing high-efficiency thermoelectric generator (TEG) systems for oil and gas facilities, potentially giving industries and utilities new ways to capture energy waste while reducing greenhouse gas emissions. Other examples include **Berkeley Lab**, **LLNL**, and **Sandia California** research on capturing greenhouse gas emissions from large stationary emitters, and safely disposing emissions deep underground.



The National Ignition Facility — the world's largest and highest-energy laser — is sited at the LLNL campus in Livermore.

Solar Energy for Space and Earth: Solar energy is the primary source of power for today's NASA missions. Researchers at **NASA Ames** are creating new materials that push the limits of solar panel efficiency and weight to enhance solar energy system performance. These technologies for space-based applications also provide Earth-based benefits, helping to drive down the cost of solar energy with more efficient systems. New technologies are essential for California to reach the goal of deriving 50 percent of electricity from renewable energy by 2030.

From Bio-concept to Bioproduct: Harnessing biological systems can produce sustainable fuels, chemicals, therapeutics, food and feed. **Berkeley Lab** offers integrated bioengineering capabilities — including the **Joint Genome Institute**, the **Agile BioFoundry**, and the **Advanced Biofuels/Bioproducts Process Development Unit (ABPDU)** — to California researchers. For example, the ABPDU to date has worked with more than 20 California companies and startups to optimize production of next-generation biofuels, low-carbon, and carbon-negative bioproducts. This commercial processing of animal waste, woody biomass, municipal solid waste, and other materials for fuel and bioproducts has huge potential in diverting the more than 40 million tons of waste that is disposed in California landfills each year.

Innovation, Incubation and Entrepreneurship

Entrepreneurship Training: Named after its famed address, the **Cyclotron Road** business incubator program at the **Berkeley Lab** is currently hosting its third cohort of innovators. The program embeds talented researchers at the Berkeley Lab for up to two years in a mentored technology entrepreneurship program, where they receive guidance to quickly and strategically transition new applications from lab to market. The program offers unique access to Berkeley Lab facilities and instruments, typically unavailable to early-stage tech startups. Several early teams have already received follow-on funding from private investors and **DOE** programs, and two other national labs have adopted similar programs.

Leveraging Federal Resources: The **DOE Small Business Innovation Research (SBIR)** and **Small Business Technology Transfer (SBTT)** programs ask select DOE National Labs to pool a portion of their R&D funding. Small businesses compete for these funds, and winners retain the rights to any technology developed and are encouraged to commercialize the technology.

Scientist Profile: Meyya Meyyappan, PhD

Chief Scientist for Exploration Technology
NASA Ames Research Center

PhD, Chemical Engineering, Clarkson University
MS, Chemical Engineering, Ashton University
BS, Chemical Engineering, Madras University


NASA Ames

Dr. Meyya Meyyappan is a founding member of the Interagency Working Group on Nanotechnology established by the White House Office of Science and Technology Policy. This working group was responsible for putting together the National Nanotechnology Initiative. For his contributions to the field, he was inducted into the Silicon Valley Engineering Council Hall of Fame in 2009. Dr. Meyyappan was inducted as a CCST Senior Fellow in 2006.

Dr. Meyyappan can speak and advise on the following technical fields:

- Applied usage of nanotechnologies.
- Developing gas sensors and bio-sensors.
- Development and construction of flexible electronics.
- Health, safety, and public security issues regarding nanotechnologies and nanoparticles.


NASA JPL

Scientist Profile: Riley Duren

Principal Engineer and Chief Systems Engineer
Earth Science Directorate
NASA Jet Propulsion Laboratory

BS, Electrical Engineering, Auburn University

Mr. Riley Duren is a NASA veteran of nearly 30 years who works at the intersection of engineering and science to deliver complex systems, including seven space missions spanning earth science and astrophysics. Since 2008, Mr. Duren has applied the discipline of systems engineering to supporting societal decision-making about climate change and energy with a particular research focus on carbon monitoring.

Mr. Duren can speak and advise on the following technical fields:

- Surface and satellite observations, high resolution CO_2 and methane emissions data sets, and tracer transport modeling to monitor carbon fluxes in megacities, such as Los Angeles.
- Airborne surveys of methane point sources across California.

Patents and Agreements Dashboard: NASA's Technology Transfer Program's motto is "Bringing NASA Technology Down to Earth." The program takes the entirety of NASA's patent portfolio and software collection, sorted into 15 categories spanning robotics to manufacturing, and assesses each for maturity and commercial potential. Each technology is available for licensing by businesses towards creating solutions for health, communications, transportation, public safety, and more. Its **Analytics Dashboard** shows the patents and software user agreements arising from each NASA field center, and its **Spinoff** website highlights examples of successful tech transfers.

UC Business Education: Both **LLNL** and **Sandia California** are partners in the **National Labs Entrepreneurship Academy** hosted by the **UC Davis School of Management.** The Academy is intended for employees of DOE National Labs, to train them in the entrepreneurial process and provide a springboard for moving technologies out of federal labs and into the world. The Academy is taught by industry investors and entrepreneurs, UC Davis faculty, and research and innovation directors from National Labs.

Driverless Cars: NASA Ames and **Nissan North America** have partnered to research and test self-driving capabilities for automobiles. NASA Ames will assist in design, development, testing and assessment of Nissan autonomous vehicles, including utilizing the NASA Ames campus for testing. Lessons learned from integration, testing, and demonstrations will enable better planning for the development and commercialization of autonomous vehicles.

Tri-Valley Catalysts: A nonprofit organization created to strengthen the startup community in the Tri-Valley, **i-GATE** is supported by **LLNL** and **Sandia California**. Located in Livermore, i-GATE serves as a gathering place for tech startups, innovators, and investors to brainstorm technology development, commercialization, and new research.

Cybersecurity

The Grid Modernization Laboratory Consortium: This **DOE**-led collaboration is addressing national grid modernization goals. Researchers from **Berkeley Lab, LLNL, Sandia California, SLAC,** and the **National Renewable Energy Laboratory** are focusing on technical areas including security and resilience, sensing and measurements, and systems operations. The consortium will deliver new tools to better measure, analyze, and control the grid of the future.

Energy Grid Security: The **California Energy Systems for the 21st Century (CES-21)** is a public-private collaborative that includes **San Diego Gas and Electric, Southern California Edison, Pacific Gas and Electric,** the **California Public Utilities Commission,** and **LLNL.** One of CES-21's two major missions is to improve cybersecurity for Industrial Control Systems (ICS). There are three focal areas: developing a **Simulation Engine** to model possible threat and response scenarios in virtual settings; establishing a **Physical Test Bed** to evaluate threats on actual, physical substation equipment; and compiling an **Automated Response Research Package** software system, keeping pace with the industry's movement towards machine-to-machine automated threat response (MMATR) and other next-generation security techniques.

Ferreting Out Cyber Threats: Researchers at **Sandia California** have developed new ways to detect and respond against potential attacks, not only for nuclear security but for critical infrastructure across a broad range of industries. **WeaselBoard** is a small card that plugs into industrial controllers to detect illicit traffic. Currently in pilot phase, WeaselBoard technology allows operators to see compromises as they happen in real time, and respond quickly to prevent damage.

Recruitment Pipeline: Sandia California runs the **Center for Cyber Defenders (CCD)**, which gives high school, undergraduate, and graduate student interns hands-on, practical experience with computer systems, network operations, and information protection. The year-round program combines research with education, and aims to matriculate graduates who can move into computer security jobs at Sandia California, or into the private sector. CCD is one of three technical tracks in Sandia's **Technical Internships to Advance National Security (TITANS)** program.

Sensitive Data Networks: As manager of **ESNet**, the high-bandwidth network connecting national labs, **Berkeley Lab** enables scientific computing that is currently hindered without security or privacy controls. ESNet enables extremely large, high-throughput data transfers while still providing protection of sensitive data categories, such as those subject to the HIPAA Security and Privacy rules. Partners who leverage ESNet include the **U.S. Department of Veterans Affairs**. Researchers can safely access electronic records and other health data, and tap into DOE's high-performance computer processing to study priority topics such as suicide prevention, prostate cancer, and cardiovascular disease.

Nestled in the hills of Menlo Park is the SLAC LCLS facility — a first-of-its-kind X-Ray laser that observes atoms in motion.

STEM Education

Research Immersion Program for Teacher Trainees: Operated by **Cal Poly San Luis Obispo**, the **STEM Teacher and Researcher (STAR)** program is a summer research experience for students currently training to be K-12 STEM teachers. Once selected, STAR Fellows spend nine weeks conducting research at federal labs such as **LLNL, SLAC,** and **NASA JPL**, working alongside mentors to get hands-on experience in advanced instruments and methods. STAR Fellows help federal labs answer pressing questions and, more importantly, bring real-world research experience with them to their future careers as STEM educators.

LLNL operates the **Teacher Research Academy (TRA),** which offers middle and high school science teachers and community college faculty a summer experience at LLNL in specific technical tracks such as biotechnology, computational modeling, 3D printing and design, fusion and astrophysics, and technical writing. **Berkeley Lab** also hosts an **Undergraduate Faculty Fellowship (BLUFF)** for college faculty who primarily teach undergraduates.

Encouraging Underrepresented Students: NASA's Minority University Research and Education Project (MUREP) awarded multimillion dollar grants to create several California programs that recruit underrepresented students for internships with researchers at **NASA Ames, NASA JPL,** and elsewhere. Awarded programs include the **NASA DIRECT-STEM** program at **Cal State Los Angeles;** the **NASA MIRO Center for Applied Atmospheric Research and Education (CAARE)** at **San Jose State;** the **Fellowships and Internships in Extremely Large Data Sets (FIELDS)** program at **UC Riverside;** and the **Merced nAnomaterials Center for Energy and Sensing (MACES)** program at **UC Merced.**

The **DOE Student Undergraduate Lab Internship (SULI)** program also provides undergraduates from two- and four-year colleges with research internships at DOE National Laboratories, including **Berkeley Lab**, **LLNL**, **Sandia California**, **SLAC**, and **NREL**. Other DOE internship programs for undergraduates include the **Mickey Leland Energy Fellowship (MLEF)**, the **Community College Internship (CCI)**, and the **Minority Educational Institution Student Partnership Program (MEISPP)** programs.

Berkeley Lab also hosts the **Undergraduate Research (BLUR)** program for student researchers, and partners with community organizations such as the **Rising Sun Energy Center** in Berkeley, California, which provides job opportunities in the residential clean energy services sector for young people predominantly from disadvantaged communities.

Inspiration for All

Beyond research in areas of public safety, human health, natural resources, climate change, and renewable energy, federal labs perform **"basic science"** research that allows us to understand fundamentals of subatomic particles, matter, life, and the universe.

Basic science research may have no apparent application at first. However, many modern-day conveniences — televisions, computers, and mobile phones — all owe their existence to earlier victories in our understanding of physics and mathematics. The basic science research of today advances the technologies of tomorrow.

The World's Highest Energy Laser: Operated by LLNL in Livermore, the **National Ignition Facility (NIF)** is larger than three football fields and focuses the power of 192 laser beams to achieve temperatures of 180 million degrees Fahrenheit. Experiments at the NIF examine questions spanning nuclear fusion to clean energy. Bridging science fact with fiction, the NIF even once served as a set for the film *Star Trek Into Darkness.*

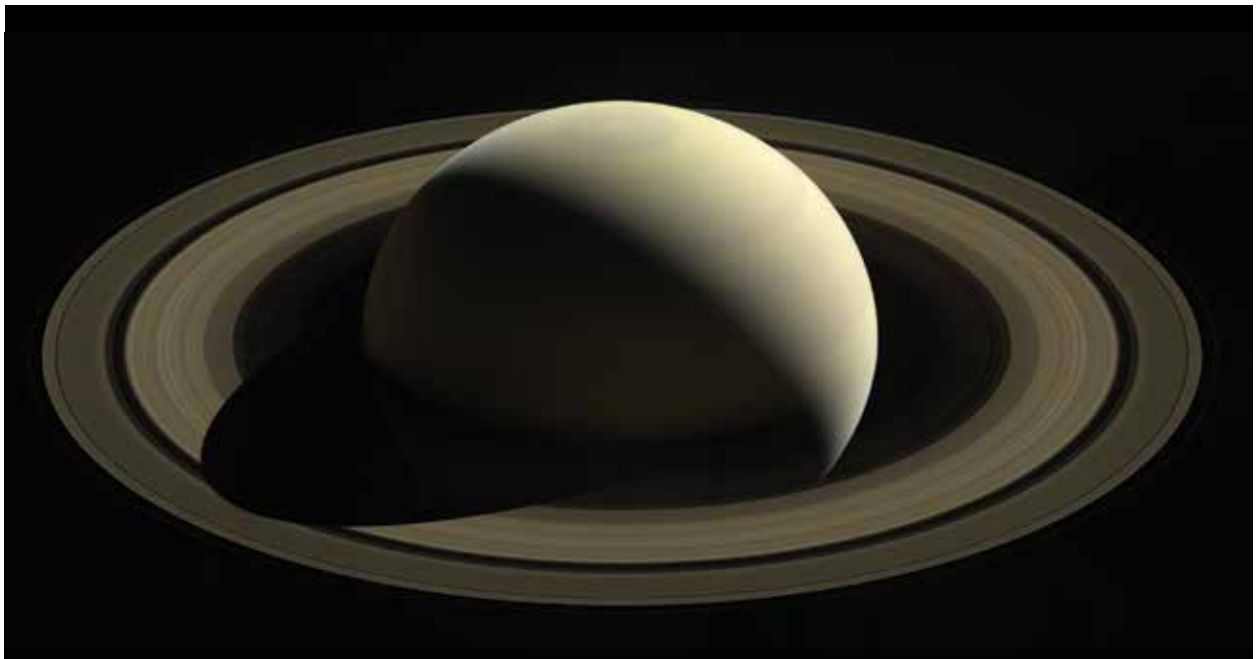
Matter and the Universe: SLAC and the **Berkeley Lab** build and operate components for **ATLAS,** one of two detectors at the **Large Hadron Collider (LHC).** ATLAS investigations include the **Higgs boson,** extra dimensions, and evidence of **dark matter**.

Solar System Exploration: NASA JPL's Cassini Spacecraft captivated the public from its launch in 1997 to its destruction in 2017, collecting new data and sending back astounding photos of Saturn and its moons. Cassini traveled more than 2 billion miles to reach Saturn, and its data gives humanity a new understanding of where water — and possibly life — might be found elsewhere in our own Solar System.

Extreme Environments: SLAC is a leader in studies of how matter behaves in extreme conditions, such as in planet cores or exploding stars — where matter can enter into exotic phases beyond the solid, liquid, gas, and plasma phases familiar to us on Earth. SLAC facilities allow scientists to study these phases and qualities under conditions never previously achieved.

Planet Hunting: NASA Ames is the lead facility for the **Kepler space telescope**. Kepler's mission is to look for signs of Earth-sized planets associated with stars similar to our Sun. More than 1,200 planets are now known, thanks to Kepler.

Life Beyond Earth: NASA Ames hosts the **NASA Astrobiology Institute,** which explores the myriad possibilities for lifeforms in extreme environments on Earth and on other worlds. It builds on decades of NASA research on the origin, evolution, and possible distribution of life in the universe — informing future missions in the search for life on other planets.



Close-up photos of the famed rings of Saturn — mesmerizing art made of cosmic dust — were not possible until Cassini.

LLNL collaborations assisted Sunnyvale-based Cepheid Inc. in advancing an Ebola virus detection test for emergency use.

SLAC's Matter in Extreme Conditions (MEC) facility allows scientists to study extremely hot, dense materials.

CALIFORNIA'S FEDERAL LABS: 2018 IMPACT REPORTS

Six federal laboratories and science centers in California have formal partnerships with CCST as Federal Laboratory Affiliates.

The following reports offer a glimpse of the resources and expertise that each lab can offer to California's decision makers. Look up examples of ongoing collaboration 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

The NASA JPL Megacities Project is a prime example of federal and state partners solving grand challanges in California.

NASA AMES RESEARCH CENTER

NASA

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 | (650) 604-3009

Matt Buffington, Public Affairs
matthew.c.buffington@nasa.gov | (650) 604-3448

Impact to the Region and State

NASA Ames provides expertise to California through a highly talented cadre of scientists and engineers experienced in leveraging their unique capabilities with renowned research universities, social entrepreneurs, and top business executives. The Ames presence in Silicon Valley offers California easy access to NASA technologies, facilities, and expertise. NASA Ames and its partners provide California with the opportunity to quickly gain access 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 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.

NASA'S PORTAL TO SILICON VALLEY

NASA Ames Research Center (NASA Ames) was established in 1939 as the second laboratory of the National Advisory Committee for Aeronautics (NACA) and named for the chair of NACA, Joseph S. Ames. With the formation of NASA in 1958, the Laboratory was renamed the NASA Ames Research Center. It is located at Moffett Field in Sunnyvale, California, now the heart of Silicon Valley.

Originally, NASA Ames research focused on construction of increasingly sophisticated wind tunnels, research aircraft, and theoretical aerodynamics. Today NASA Ames is a leader in nanotechnology, information technology, fundamental space biology, biotechnology, thermal protection systems, and human factors research.

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.

BY THE NUMBERS

No. of Employees:	4,557
Annual Budget:	$1.03 billion (2017)
Annual Payroll:	$212 million (2017)
Procurements to CA Businesses:	$499 million (2017)
Contracts to Small Businesses:	$143 million (2017)
Spin-off Companies:	135 (since 1997)

Success Story: Small Business Goes to Mars

The Mars 2020 Rover is one of the mostly highly anticipated robotic missions in NASA's history. Specialized ultraviolet lasers developed by **Photon Systems** of Covina, California, under the **NASA Small Business Innovation Research (SBIR)** program, will help the Mars Rover trace miniscule amounts of chemicals such as amino acids — the building blocks of life. Back here on Earth, Photon Systems is working with both **Pfizer** and **DuPont** to repurpose this technology for quality-control checks of manufacturing equipment, and to look for trace amounts of contaminants in manufactured pills and food products. Commercial revenue stemming from this SBIR-funded technology has exceeded $8 million.

Success Story: Setting Aircraft Efficiency Standards

While most people equate NASA with space exploration, the agency also 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

"So Long, Kepler, And Thanks For All The Planets" — *SF Gate*, Oct. 31, 2018

"Can Research On Astronauts Lead to a Good Night's Sleep On Earth?" — *Wall Street Journal*, June 4, 2018

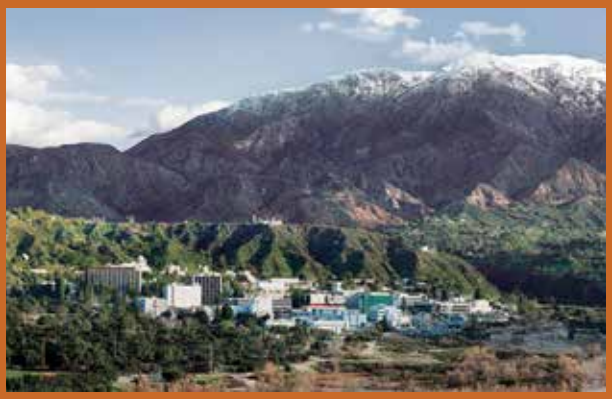
"Kilauea Volcano's Lava Fields Offer Scientists A Portal To Mars" — *New York Times*, May 28, 2018

Legislators Say...

"At the Ames Research Center in Silicon Valley, NASA helps launch innovation." — *Assemblymember Marc Berman (D-Palo Alto)*

"NASA Ames Research Center is a tremendous source of innovation in the area." — *Senator Jerry Hill (D-San Mateo and Santa Clara Counties)*

NASA JET PROPULSION LABORATORY



NASA

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 | (818) 393-4585

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 1950s, JPL made news as it created America's first satellite and sent the first robotic spacecraft to other planets. As of 2017, JPL is responsible for 19 spacecraft and 10 major instruments carrying out active missions. In addition, 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), JPL is staffed and managed for NASA by the **California Institute of Technology (Caltech).** This unique relationship creates an intellectual fusion 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 JPL's research is conducted in 1,138 laboratory or technical rooms in 76 buildings on the main campus and extends into outer space with 29 currently active missions.

Resources and Expertise for California Governance

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.
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.

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.

FROM DEFENSE TO DISCOVERY

The NASA Jet Propulsion Laboratory (NASA JPL) traces its roots 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, 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, JPL conducts significant programs in earth sciences, space-based astronomy, and technology research and development.

BY THE NUMBERS

No. of Employees:	6,769
PhD Scientists and Engineers:	1,052
Annual Budget:	$2.75 billion (2017)
Annual Payroll:	$652 million (2017)
Procurements to CA Businesses:	$317 million (2017)
Contracts to Small Businesses:	$115 million (2017)
No. of Patents Registered:	141 (since 2007)

NASA

Success Story: ArterioVision

Initially developed at JPL, the **FDA**-approved **ArterioVision** software is helping doctors diagnose and monitor treatments for hardening of the arteries in its early stages, before it causes heart attacks and strokes. ArterioVision software converts standard ultrasound data of blood flow and plaque within the carotid artery into a measure of arterial thickness — an early indicator of atherosclerosis. ArterioVision has been licensed by Caltech to **Medical Technologies International, Inc.** of Palm Desert, California, via **JPL's Innovative Partnership Program.**

Success Story: Drought Monitoring

The **California Department of Water Resources (DWR)** named three scientists at JPL as recipients of its **Remote Sensing and Drought Science Service award.** The award recognizes ongoing assistance provided by researchers who have been working closely with the department on drought or climate science projects. The researchers used remote sensing data to map the ongoing sinking of land in California's San Joaquin Valley caused by groundwater extraction. The scientists found that some parts of the valley sank more than a foot during the 2014 irrigation season alone.

"DWR is pleased to recognize the work that these scientists have performed in developing new methodologies for monitoring land subsidence in response to our multi-year drought," said then **DWR Director Mark Cowin.**

Recent Headlines

"NASA Is Going To Play The Classic Arcade 'Claw Game' On Mars" — *Fox News*, Oct. 19, 2018

"Rain Falls From Saturn's Rings—And a Dying Spacecraft Tasted It" — *National Geographic*, Oct. 4, 2018

"Will Robots Save Us From Natural Disasters?" — *KQED*, April 9, 2018

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 Cañada 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

U.S. DEPARTMENT OF ENERGY

www.lbl.gov
Berkeley, Alameda County
(AD-15, SD-09)

Michael Witherell, PhD, Director

Jim Hawley, State and External Relations
jchawley@lbl.gov | (916) 747-7912

Dan Krotz, Strategic Communications
dakrotz@lbl.gov | (510) 486-4019

Impact to the Region and State

The **Lawrence Berkeley National Laboratory (Berkeley Lab)** ranks among DOE's most productive "multipurpose" labs for nonclassified research. Its scientists have won 13 Nobel Prizes and 13 National Medals of Science, and its nearly 900 post-docs and graduate/undergraduate students make it the largest STEM pipeline in the national lab system.

Berkeley Lab houses many **"user facilities"** — state-of-the art lasers, instruments, and computers available for industry and university use. In 2016, more than 11,700 researchers (40 percent from California research institutions) accessed Berkeley Lab user facilities. Work conducted at these facilities has led to better medicines, new materials, and more efficient solar cells and batteries. Notable user facilities include the **Advanced Light Source**, **Molecular Foundry**, **National Energy Research Scientific Computing Center (NERSC), Energy Sciences Network (ESnet)**, **FLEXLAB**, and the **Joint Genome Institute**.

Berkeley Lab also drives industrial innovation, with 48 startups founded on Lab-developed technology, creating more than 2,000 new jobs in those companies alone. Berkeley Lab technologies have been licensed in fields including biotechnology, energy efficiency, nanotechnology, IT, materials discovery, semiconductor manufacturing, subsurface modeling, and health.

Resources and Expertise for California Governance

Berkeley Lab partners with a number of California agencies — including the **Energy Commission**; the **Division of Oil, Gas, and Geothermal Resources**, and the **Department of Water Resources** under the **Natural Resources Agency**; the **Public Utilities Commission**; and the **Air Resources Board** — to support the state's ambitious clean energy, water and environmental goals. Berkeley Lab designs, builds and houses some of the world's most powerful microscopes, X-ray beams, and supercomputers. Its researchers use these and other tools to tackle major challenges: coaxing more power from solar cells, building better batteries, and developing clean biofuels and bioproducts for the future.

These resources give the Berkeley Lab deep expertise in energy efficiency and renewable energy research and development, earth and environmental systems, air pollution monitoring, climate modeling, water management, geosciences, biosciences, physics, high-performance computing, and nanotechnology — all with potential benefits for Californians. A great example is the legacy of Berkeley Lab physicist Art Rosenfeld, which led to the the Lab's pioneering results in energy-efficient windows, cool roofs, applicance standards, and other technologies that helped eliminate growth in per-capita electricity use in California — saving the state's consumers more than $900 billion in avoided energy costs.

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 by the University of California for 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:	3,155
No. of Postdocs and Students:	870
PhD Scientists and Engineers:	1,460
Annual Budget:	$858 million (2017)
Annual Payroll:	$353 million (2017)
Procurements to CA Businesses:	$133 million (2017)
Contracts to Small Businesses:	$76 million (2017)
No. of Patents (last 10 years):	678
IP Licenses (last 10 years):	913
No. of Startups Based on Tech:	48

Success Story: Smart Windows

Imagine a window shade with a brain. Researchers at the **Molecular Foundry** designed a thin coating of nanocrystals, embeddable in glass, that can dynamically modify sunlight as it passes through a window. Unlike existing technologies, the coating provides selective control over visible light and heat-producing near infrared (NIR) light, so windows can maximize both energy savings and occupant comfort in a wide range of climates. These smart windows use small jolts of electricity to switch the material between NIR-transmitting and NIR-blocking states, and can independently control blocking of visible versus NIR light. This innovation led to the creation of **Heliotrope Technologies,** based in Alameda, CA.

Success Story: Building California's BioEconomy

The **DOE Joint BioEnergy Institute (JBEI)** in Emeryville is led by the Berkeley Lab. Researchers there had discovered a new, environmentally-benign way to manufacture malonic acid, a high-value chemical used in manufacturing. Until recently, malonic acid production required toxic chemicals such as cyanide. Working with experts at **Berkeley Lab's Advanced Biofuels/Bioproducts Process Demonstration Unit (ABPDU),** the local biotech startup **Lygos** demonstrated the scalability of the new biomanufacturing process at production costs competitive with conventional technologies. To date, JBEI has generated more than 160 patent applications, 90 licenses, and six startup companies — five of which are located in California.

Recent Headlines

"Ancient Egyptian Blue Pigment Could Significantly Boost Energy Efficiency of Buildings" — *Newsweek*, Oct. 12, 2018

"Creating More Sustainable Water Systems With Lessons From the Energy Industry" — *R&D Magazine*, Oct. 9, 2018

"Genetically Engineered Beers Could Make Hoppy IPAs Tastier And Cheaper"— *Forbes*, March 20, 2018

Legislators Say...

"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)*

"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)*

U.S. DEPARTMENT OF ENERGY

LAWRENCE LIVERMORE NATIONAL LABORATORY

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

Bill Goldstein, PhD, Director

Scott F. Wilson, State Government Liaison
wilson101@llnl.gov | (925) 423-3125

Lynda Seaver, Public Affairs
seaver1@llnl.gov | (925) 423-3103

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 100 companies (51 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 licenses have enabled the launch of new businesses that are helping drive economic growth locally, regionally, and beyond.

LLNL's procurements through California businesses ($234 million) and annual state payroll ($818 million) directly contribute to the regional economy. LLNL also has deep and longstanding relationships with the **UC** and **California State University** systems, which serve as important workforce pipelines. Finally, investments such as the Livermore Valley Open Campus — an innovation hub developed by LLNL and Sandia — creates a novel venue where researchers from industry and academia can collaborate with Lab personnel, contributing to the next generation of big ideas.

Resources and Expertise for California Governance

LLNL has missions in biosecurity, counterterrorism, defense, energy, intelligence, nonproliferation, science, and weapons. LLNL's fundamental work in science, technology, and engineering — the research and development leading to LLNL breakthroughs — 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 **Computation 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.
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 additively manufacture and 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.

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 (LLNS), LLC — a partnership of Bechtel National, the University of California, BWX Technologies, and AECOM. LLNS is also affiliated with 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 — tackling them 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:	7,300
PhD Scientists and Engineers:	1,300
Annual Budget:	$1.9 billion (2017)
Annual Payroll:	$837 million (2017)
Procurements to CA Businesses:	$234 million (2017)
Active Commercial Licenses:	104 (since 2017)

Success Story: Laser Power

LLNL is home to one of **DOE**'s flagship user facilities, the **National Ignition Facility (NIF).** The world's largest and most energetic laser, NIF surpassed expectations to fire a record-breaking 417 experiments in 2016, including shots that safely used minute amounts of plutonium to generate data relevant to understanding nuclear weapon performance — information critical to DOE's stockpile stewardship mission. NIF is also used to study fundamental properties of matter at high energies and densities, such as astrophysical plasmas and planetary cores. NIF will soon begin using complex new diagnostic capabilities to directly observe nuclear fusion experiments. LLNL's long-standing leadership in high-performance computing is indispensable for effectual design and interpretation of these complex NIF experiments.

Success Story: Radiation Security

A public-private partnership between LLNL and Tennessee-based **ORTEC** helped speed critical homeland-security technology to the marketplace. **Radscout** is a portable radiation detector developed by LLNL's weapons program for emergency first responders and inspection personnel who need rapid detection and identification of material to determine the nature and scope of a threat. The product, now under the names of **Detective** and **DetectiveEX,** has been used to screen for dangerous radioisotopes in luggage or shipping containers and rapidly reports its results on-the-spot. The detector also is being used at border crossings, cargo ship docks, and transportation terminals.

Recent Headlines

"Ice VII: Scientists Discover How Extraordinary Ice Found Deep Below The Earth Grows at Over 1,000 m.ph." — *Newsweek*, Nov. 2, 2018

"Black Holes Could Be Creating 'Zombie Stars'" — *Popular Mechanics*, Oct. 31, 2018

"Meet Sierra: Livermore's Powerful New Supercomputer" — *Mercury News*, Oct. 27, 2018

Legislators Say...

"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)*

"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)*

U.S. DEPARTMENT OF ENERGY

SANDIA NATIONAL LABORATORIES CALIFORNIA

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

Dori Ellis, Associate Labs Director for California

Patrick Sullivan, Government Relations
pmsulli@sandia.gov | (925) 294-3243

Michael Padilla, Media Relations
mjpadil@sandia.gov | (925) 294-2447

Impact to the Region and State

Sandia National Laboratories is the largest of the Department of Energy national labs with more than 13,000 staff spread across its two main campuses in New Mexico and California. For more than 60 years, the **Sandia National Laboratories campus in Livermore, California** has delivered cutting-edge science and technology solutions to resolve the nation's most challenging and complex problems.

As a multidisciplinary laboratory, Sandia draws from virtually every science and engineering discipline to address challenges in energy, homeland security, cybersecurity, climate, and biosecurity. Today, collaboration is vital to ensuring that the Lab stays at the forefront of science and technology innovation. Partnerships with industry, state and local governments, and California universities help drive innovation and economic growth in the region.

Sandia contributes to California's regional and statewide economy — with more than $145 million in contracts to California companies in 2016, $92 million of which went to California small businesses. In addition, Sandia also engages the community directly by running robust STEM education programs for local schools and administering community giving programs. Meanwhile, investments like the Livermore Valley Open Campus (LVOC), an innovation hub supported by LLNL and Sandia, help catalyze the local economy.

Resources and Expertise for California Governance

Meeting California's robust environmental policies, clean energy goals, and homeland security challenges will require readiness, excellence in engineering, and rapid innovation. Sandia researchers and engineers can help California navigate these complex challenges, including:

Transportation Energy: Since the 1980s, **Sandia's Combustion Research Facility** has delivered new vehicle technologies that reduce tailpipe emissions and improve fuel economy, and more recently it has been developing sustainable biofuels. Working with the **Air Resources Board**, Sandia research also has helped advance the deployment of California's hydrogen fueling network.

Renewable Energy and Resilience: Sandia's robust solar, wind, and geothermal programs have contributed to a widespread deployment of renewable energy technology. The **California Energy Commission** has used Sandia's energy storage and grid integration programs to help validate new technologies.

Disaster Preparedness: Sandia develops mitigation plans and solutions for natural and manmade disasters, including cybersecurity. Sandia has worked with the **California Fire and Rescue Training Authority** at the **California Exercise Simulation Center**. Sandia's **SUMMIT** tool reduces costs in developing disaster training scenarios, offering a common computing platform for exercises and drills.

NATIONAL SECURITY FROM "A" TO "Z"

Throughout its history, Sandia has been guided by the core principle of — in the words of President Harry Truman — providing "exceptional service in the national interest." The Lab 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 in 1948, and in 1956, a second site was opened in California's Livermore Valley.

Today, Sandia is operated and managed by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International. One of the three National Nuclear Security Administration research and development laboratories, Sandia's underlying mission is to develop advanced technologies to ensure global peace.

From its origins as an engineering organization for nonnuclear components of nuclear weapons, Sandia now has multiple programs involved in a broad spectrum of national security issues. As a Federally Funded Research and Development Center (FFRDC), Sandia is an objective, independent, and trusted advisor, drawing from its deep science and engineering experience to anticipate, innovate, create, and inform the policy discussion for decision makers.

BY THE NUMBERS

No. of Employees:	1,254
PhD Scientists and Engineers:	290
Annual Budget:	$585 million (2017)
Procurements to CA Businesses:	$173 million (2017)
Contracts to Small Businesses:	$99 million (2017)

Success Story: Zero-Emission Hydrogen Passenger Ferry

Sandia is partnering with the San Francisco-based **Red and White Fleet** to design a hydrogen-fueled ferry, called San Francisco Bay Renewable Energy Electric Vessel with Zero Emissions, or **SF-BREEZE.** A feasibility study, initiated two years ago, looked at the possibility of a large, fast vessel that would meet maritime regulations and be economically competitive. With the recent success of the initial proof of concept, this public-private partnership is moving forward with optimization of design studies and is one step closer to creating large, high-speed, pollution-free ferries.

Success Story: Algal Biofuels and Water Remediation

Sandia is testing to see if one of California's largest and most polluted lakes can transform into one of its most productive and profitable. Inland Empire's 350-square-mile **Salton Sea** has well-documented problems related to elevated levels of nitrogen and phosphorus from agricultural runoff. Algae thrives on these elements, and Sandia intends to harness algae's penchant for prolific growth to clean up these pollutants and stop harmful algae blooms while creating a renewable, domestic source of fuel. Algae can be easily converted to fuels and chemicals using a Sandia-patented fermentation process. This could make a significant impact on efforts to revitalize and restore the Salton Sea while bringing economic opportunity to the region.

Recent Headlines

"Sandia Labs Help Impact Future STEM Leaders" — *Livermore Independent*, Nov. 15, 2018

"Soot Formation: A New Mechanism For An Old Problem" — *Physics Today*, Nov. 1, 2018

"California's Scum Ranchers Are Working On A Fuel To Replace Oil" — *Vice News*, March 28, 2018

Legislators Say...

"Sandia has been an integral part of the East Bay for 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)*

U.S. DEPARTMENT OF ENERGY

SLAC NATIONAL ACCELERATOR LABORATORY

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

Chi-Chang Kao, PhD, Director

Erika Bustamante, PhD, State Government Relations
erikab@stanford.edu | (650) 725-3324

Melinda Lee, Communications
melinda.lee@slac.stanford.edu | (650) 926-8547

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.

Each year, SLAC hosts thousands of researchers who come to use its 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 also develops novel laser architectures for their own research and for their work with local laser firms, further securing California as a hub of the optical laser industry. And through **CalCharge,** SLAC also supports California energy storage firms.

SLAC has deep ties to **Stanford University —** its employees are Stanford employees, and the SLAC director is a Stanford dean. SLAC and Stanford are a powerful combination, providing unique educational experiences and serving as a vital training ground for the nation's future scientific workforce. SLAC provides internships and fellowships to students and early-career professionals, and educates the public through tours, lectures, and outreach programs.

Resources and Expertise for California Governance

SLAC has world-leading expertise in the design, engineering, and fabrication of advanced electronics, sensors, detectors, and instrumentation — in addition to large-scale 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 and improved manufacturing techniques for semiconductors, solar cells, and other products.
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.

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.

SLAC research spans the smallest and largest scales, from fundamental processes of chemistry to the 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 DOE's 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:	1,500
PhD Scientists and Engineers:	386
Annual Budget:	$598 million (2017)
Annual Payroll:	$195 million (2017)
Procurements to CA Businesses:	$140 million (2017)
Contracts to Small Businesses:	$72 million (2017)

Success Story: Guiding Lights

SLAC has initiated construction on a major upgrade to the world's brightest X-ray laser, the **Linac Coherent Light Source (LCLS).** The **LCLS-II** will add a second X-ray laser beam that is 10,000 times brighter and fires 8,000 times faster, up to a million times per second. This will greatly increase the power and capacity of the X-ray laser for experiments that sharpen our view of how nature works on the atomic level and on ultrafast timescales. SLAC is also leading construction of a 3.2-gigapixel digital camera — the largest digital camera ever built for ground-based optical astronomy — for the **Large Synoptic Survey Telescope (LSST)** in Chile. The LSST will provide a definitive wide-field, ultradeep survey of galaxies for precision measurement of dark energy properties.

Success Story: Electric Dreams

SLAC's new **Grid Integration, Systems and Mobility lab (GISMo)** is developing ways to collect data from power systems and grid-connected devices — and to help managers use that data to better manage the electrical grid as we incorporate more sources of renewable energy (*see p.11*). GISMo works closely with California utilities and the **California Energy Commission** to develop and test new tools for managing a renewable grid and on planning for future electric vehicle charging loads. As an unbiased, highly technical partner, GISMo can test, benchmark, and evaluate emerging technologies that await the 21st Century power grid.

Recent Headlines

"Zapping Tumours In Less Than A Second" — *Forbes*, Nov. 28, 2018

"CERN's Pioneering Mini-Accelerator Passes First Test" — *Scientific American*, Sep. 2, 2018

"Scientists Use Artificial Intelligence To Discover New Materials" — *Forbes*, April 22, 2018

Legislators Say...

"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)*

"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 Jerry Hill (D-San Mateo and Santa Clara Counties)*

FEDERAL LABS EXPERTISE QUICK INDEX

The Joint BioEnergy Institute in Emeryville unites research from Sandia, Berkeley Lab, LLNL, UC Davis, and UC Berkeley.

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 Interim 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 Ames Research Center
www.nasa.gov/ames

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

Matt Buffington, Public Affairs
matthew.c.buffington@nasa.gov | (650) 604-3448

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 | (916) 747-7912

Dan Krotz, Strategic Communications
dakrotz@lbl.gov | (510) 486-4019

Lawrence Livermore National Laboratory
www.llnl.gov

Scott F. Wilson, State Government Liaison
wilson101@llnl.gov | (925) 423-3125

Lynda Seaver, Director of Public Affairs
seaver1@llnl.gov | (925) 423-3103

Sandia National Laboratory, California
www.sandia.gov

Patrick Sullivan, Government Relations
pmsulli@sandia.gov | (925) 294-3243

Michael Padilla, Media Relations
mjpadil@sandia.gov | (925) 294-2447

SLAC National Accelerator Laboratory
www.slac.stanford.edu

Erika Bustamante, PhD, State Government Relations
erikab@stanford.edu | (650) 725-3324

Melinda Lee, Communications
melinda.lee@slac.stanford.edu | (650) 926-8547

CCST
CALIFORNIA COUNCIL ON SCIENCE & TECHNOLOGY

CCST is a nonpartisan, nonprofit organization established via the California State Legislature — making California's policies stronger with science since 1988. We engage leading experts in science and technology to advise State policymakers — 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
Stanford University
California Institute of Technology
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
1130 K Street, Suite 280
Sacramento, California 95814
(916) 492-0996 • ccst@ccst.us
www.ccst.us • facebook.com/ccstorg • @CCSTorg

CALIFORNIA'S FEDERAL LABS & RESEARCH CENTERS
2018 IMPACT REPORT FOR STATE LEADERS
California Council on Science and Technology • February 2019