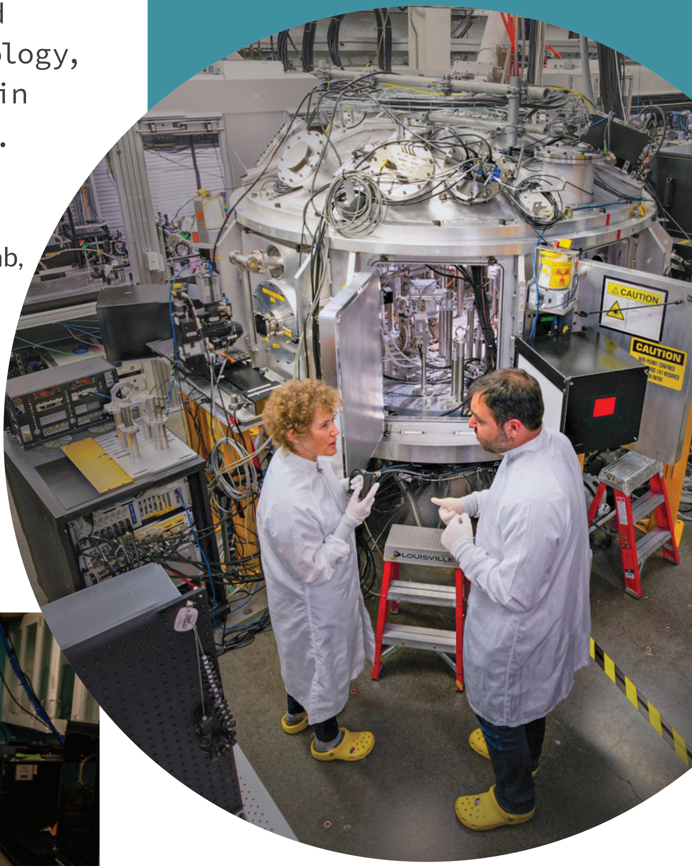
Securing our energy future

Seeing natural and industrial processes with atomic precision is a key step toward designing technology that meets society's energy needs. SLAC's advanced facilities, expertise in energy science and technology, and strong partnerships are breaking new ground in securing abundant, affordable and reliable energy.

Innovating energy storage

The SLAC-Stanford Battery Center drives collaborative R&D across the lab, university and industry to close discovery-to-deployment gaps in energy storage. By capturing atomic-scale views inside charging and discharging cells, researchers engineer better batteries for everything from phones and electric vehicles to the national grid. Studies at SLAC's X-ray facilities reveal how batteries degrade and inform safer, fast-charging designs. SLAC and Stanford are also advancing a national strategy for solid-state batteries and developing next-generation aqueous (water-based) batteries to power the grid affordably and reliably.



Advancing manufacturing

SLAC's manufacturing science research combines X-ray analysis, cross-competitor supply chain models and AI to understand materials at the atomic scale and leapfrog technology hurdles. We discover and develop scalable materials and chemical processes for energy storage and generation, microelectronics and critical minerals processing. The goal: globally competitive, next-generation manufacturing that compresses discovery-to-deployment timelines, integrates supply chains and brings smart manufacturing to gigafactory scale.

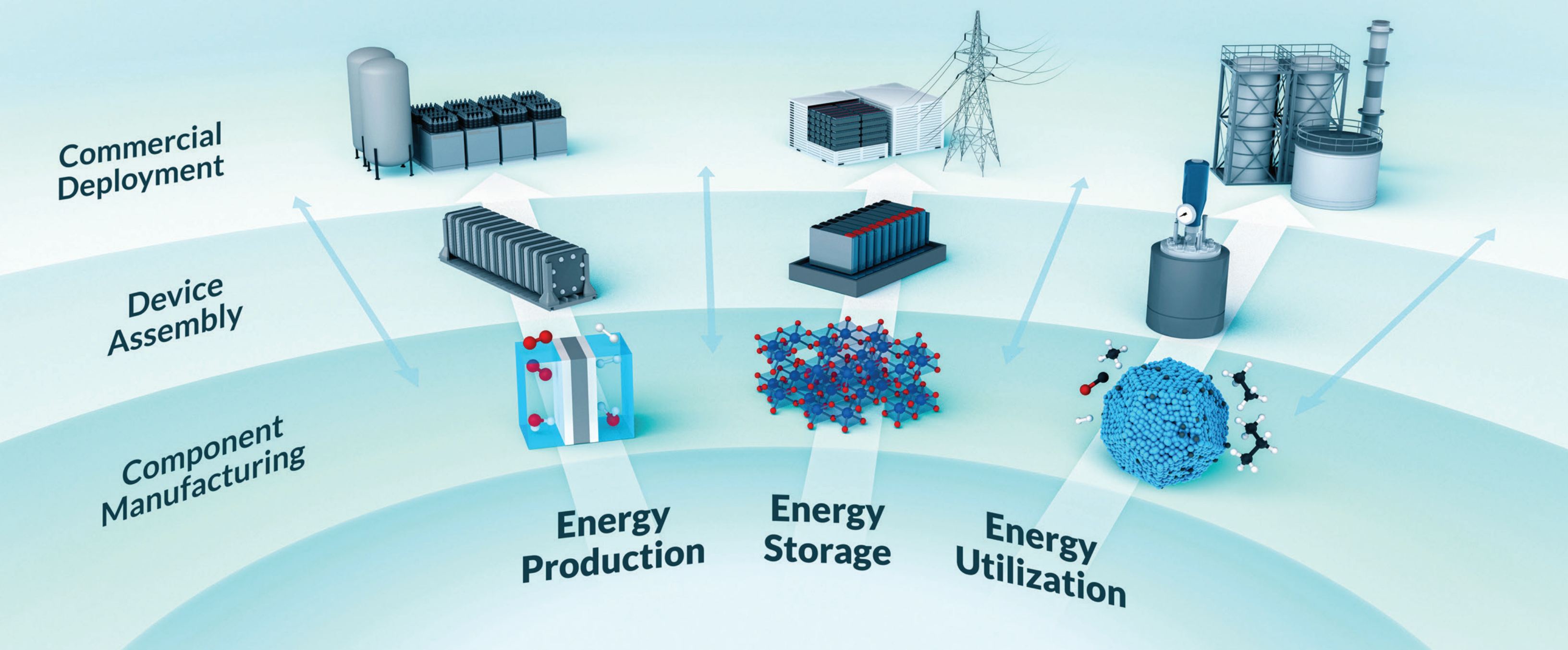
Research at SLAC

- X-ray & ultrafast science
- Physics of the universe
- Advanced accelerators
- Science of life
- New technologies
- **Energy science**

SLAC NATIONAL ACCELERATOR LABORATORY

Stanford University

U.S. DEPARTMENT of ENERGY



Developing fusion energy

As a U.S. Department of Energy (DOE) fusion hub co-lead and collaborator, SLAC is building the technologies and workforce needed to realize a fusion-powered future. Our Matter in Extreme Conditions (MEC) instrument at our X-ray free-electron laser reveals the physics that drive inertial fusion energy with unprecedented resolution in space and time. We partner with public and private institutions to advance fusion technology, address global energy needs and keep the U.S. at the forefront.

Harnessing chemistry

SLAC develops ways to reduce hydrogen production costs and transform domestically abundant chemical feedstocks, such as carbon dioxide, into the building blocks for fuels, fertilizers, antibiotics and more. We advance commercial solutions for hydrogen production in two ways: by examining chemistry-performance relationships in real time at SLAC's facilities and by developing water-splitting processes through materials discovery and engineering. These approaches show tremendous potential for producing low-cost hydrogen fuel and chemical feedstocks to address our nation's manufacturing challenges and increasing energy demands. Our partners in this work include Stanford, the Liquid Sunlight Alliance (LiSA) and the DOE's H2Nuc consortium.

Securing safe water

SLAC and Stanford leverage SLAC's X-ray sources and modeling tools to improve water treatment processes, including desalination, reuse and resource recovery. These projects, funded by National Alliance for Water Innovation, measure how the design and structure of treatment processes impact performance, tracking the efficiency of separating unwanted substances, the mass transport of water and the types and structures of contaminants. These insights help to reduce costs and energy use.

Upcycling plastic

As a member of the DOE consortium BOTTLE™ (Bio-Optimized Technologies to keep Thermoplastics out of Landfills and the Environment), SLAC is developing chemical upcycling strategies for today's plastics and new pathways to convert them into the inherently recyclable biodegradable plastics of tomorrow.

Guiding technology development

Partnering with Stanford and DOE, SLAC supports STEER, which analyzes emerging energy technologies from supply chains to deployment to inform what to build, where to innovate and how to invest. SLAC's expertise answers key questions about the most effective frontiers for batteries and nuclear energy research. Recent STEER efforts have identified conditions that would make low-cost batteries and nuclear power plants more viable.

Accelerating with AI

AI and machine learning tools mine troves of research data from SLAC's advanced facilities, helping researchers design materials for future energy applications – like catalysts, batteries, fusion energy and quantum technologies – while reducing time to market. SLAC teams also explore AI tools to secure the national supply of critical minerals for energy technologies.

Front left: SLAC scientist working on batteries at scale in the SLAC–Stanford Battery Center in the Arrillaga Science Center at SLAC. Front right: At the Matter in Extreme Conditions (MEC) instrument at SLAC's Linac Coherent Light Source, researchers study materials for fusion fuel targets and power plants. (Photos by Jacqueline Ramseyer Orrell/SLAC National Accelerator Laboratory)

Top: SLAC's applied energy program develops scalable processes and collaborates with industry on technology transfer. SLAC scientists advance technologies that transform how energy is produced, stored and used. Our research integrates the full innovation pipeline, from the chemistry and materials science of individual components to device manufacturing and bringing new energy solutions to market. (Greg Stewart/SLAC National Accelerator Laboratory)

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