slac.stanford.edu

Creating a sustainable future

Two of the most urgent challenges of our time – clean energy and sustainability – require investigation at the atomic level. Seeing natural and industrial processes with atomic precision is a key step toward designing technology that meets society's energy needs without depleting limited resources or accelerating climate change.

Facts

- State-of-the-art scientific tools
- Atomic-level details of natural and industrial proceesses
- DOE and Stanford partnerships accelerate progress

Researchers at SLAC use an array of advanced tools to study complex energy-related questions, from improving battery and solar cell performance to making the electric grid more resilient and investigating state-of-the-art quantum materials for future energy technologies.

Transforming CO_2 and H_2O

Alongside collaborators at Stanford and around the world, SLAC is developing ways to transform carbon dioxide into the basic building blocks for fuels, fertilizers, antibiotics and more, thus turning a potent greenhouse gas into a valuable chemical feedstock.

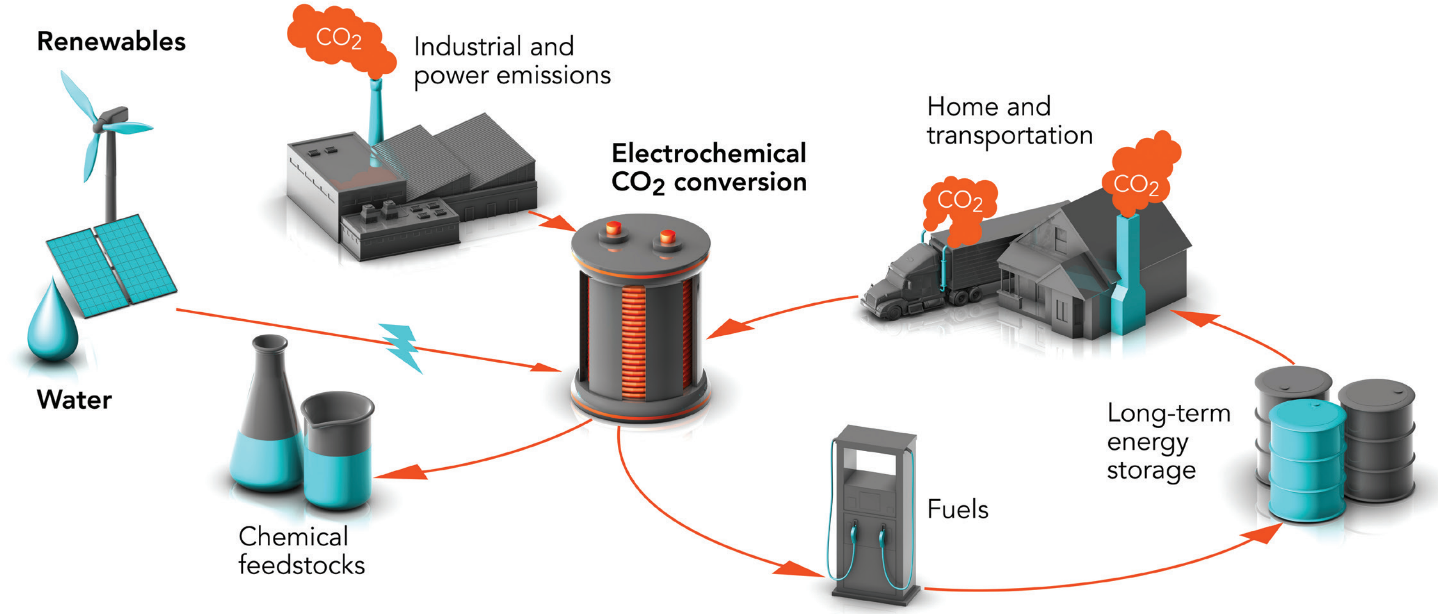
For example, an international team of scientists used advanced X-ray sources at SLAC and Argonne National Laboratory to discover how a bacterial enzyme converts carbon dioxide into other compounds 20 times faster than plants do during photosynthesis.

We're also finding ways to split water to release hydrogen gas with reactions powered by solar, wind or other renewable energy sources. This has tremendous potential for producing clean hydrogen fuel in a sustainable way from the Earth's most abundant and accessible starting material.

Stanford graduate student McKenzie Hubert watches hydrogen bubbles form in an electrolyzer, which uses a catalyst to split water into hydrogen and oxygen. Finding catalysts that can propel this reaction on a commercial scale to generate sustainable hydrogen fuel is a major goal of SUNCAT research at SLAC and Stanford.

Battery research

To engineer better batteries for electric vehicles, electronics and the grid, researchers need to look deep inside working batteries as they charge and discharge and see what's going on at an atomic scale. One recent study at SLAC suggested a way to revitalize rechargeable lithium



Researchers at Stanford and SLAC are working on ways to convert waste carbon dioxide (CO_2) into chemical feedstocks and fuels, turning a potent greenhouse gas into valuable products. The process is called electrochemical conversion. When powered by renewable energy sources (far left), it could reduce levels of carbon dioxide in the air and store energy from these intermittent sources in a form that can be used any time.

batteries by bringing "dead" lithium back to life. Another, carried out at SLAC's cryogenic electron microscopy facilities, generated the first high-resolution images of a squishy layer on lithium-ion battery electrodes that's key to their performance.

The new SLAC-Stanford Battery Center will spur collaborative R&D between the lab, the university and industry to bridge the gap between discovering and deploying sustainable energy storage solutions.

Modernizing the grid

The grid of the future will have to seamlessly absorb power fluctuations and quickly respond to major storms and other disruptions. SLAC's Grid Integration, Systems, and Mobility (GISMo) lab is developing tools and control systems to make that a reality, including artificial intelligence to prevent or minimize electric grid failures.

These advanced technologies can seamlessly integrate energy flowing into the grid from intermittent sources, like solar and wind. They can also help the grid meet spikes in energy demand when large numbers of people crank up their air conditioners during a heat wave or plug their electric vehicles into chargers when they get home from work, for instance. Other tools help consumers and businesses monitor their energy use to lower their energy bills.

Water desalination

SLAC is collaborating with Stanford on a research project aimed at developing energy-efficient technologies for decontaminating water sources so they can be safely used for drinking water, agriculture and other purposes.

Solar fuels

As a part of the Liquid Sunlight Alliance (LiSA), SLAC is helping design materials and chemical processes that can convert sunlight into chemical energy.

Advanced manufacturing

Understanding the manufacturing process at a very small scale is crucial for improving things like 3D printing of metals, production of thin films, precision manufacturing of semiconductor chips and novel heat engines that use waste heat to generate electricity and drive chemical processes used in industry.

Staff engineer Bruis van Vlijmen sets up cell cooling plates in the Battery Informatics Lab at SLAC.

Plastic upcycling

SLAC is also a member of a U.S. Department of Energy consortium called Bio-Optimized Technologies to Keep Thermoplastics out of Landfills and the Environment, or BOTTLE. The consortium is looking for ways to break down and upcycle plastics more efficiently and design future plastics so they're easier to recycle and reuse.