



DOE Energy Innovation Hubs



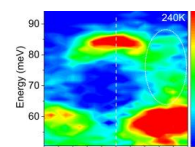
The Basic Energy Sciences (BES) program of the Office of Science (SC) manages DOE Energy Innovation Hubs that focus on collaborative research to overcome key scientific barriers for major energy challenges. The research activities are centered on fundamental science whose impact is demonstrated by development and evaluation of integrated energy systems, a critical step toward implementation of scientific innovation in transformative energy technologies. The Hubs funded and managed by SC/BES bring together teams of experts from multiple disciplines to focus on two grand challenges in energy: (1) Fuels from Sunlight and (2) Batteries and Energy Storage.

The **Fuels from Sunlight Hub** program currently consists of two multidisciplinary research centers that address emerging new directions as well as long-standing challenges in liquid solar fuels generation via artificial photosynthesis approaches. Scientists in each center are employing new approaches to understand, design, and develop chemical processes and new materials for directly converting sunlight into storable fuels using only water and carbon dioxide.

The Liquid Sunlight Alliance (LiSA), established in 2020 and led by the California Institute of Technology in close partnership with Lawrence Berkeley National Laboratory, is pursuing a “co-design” strategy to make the many complex steps in solar fuels generation work more efficiently both individually and in concert with each other. Enhanced understanding of these processes at the molecular-level are targeted through a combination of advanced computational methods and sophisticated characterization tools such as ultrafast x-ray and optical spectroscopy. LiSA partner institutions also include the National Renewable Energy Laboratory, SLAC National Accelerator Laboratory, the University of California Irvine, the University of California San Diego, and the University of Oregon.

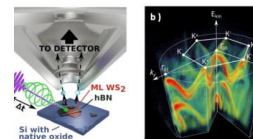
The Center for Hybrid Approaches in Solar Energy to Liquid Fuels (CHASE), established in 2020 and led by the University of North

Highlights



Thanks to Trapped Electrons, a Material Expected to be a Conducting Metal Remains an Insulator

Trapping electrons with atomic vibrations has the potential to tune behavior in a quantum material.



Directly Imaging Quantum States in Two-Dimensional Materials

Carolina at Chapel Hill, seeks to develop hybrid photoelectrodes for fuel production that combine semiconductors for light absorption with molecular catalysts for selective chemical conversion. CHASE is blending experiment with theory to understand and establish new design principles that can enable the integrated light-driven synthesis of liquid fuels through multi-catalyst cascades. CHASE partner institutions are Brookhaven National Laboratory, Yale University, the University of Pennsylvania, North Carolina State University, and Emory University.

Both centers build on important scientific understandings of natural photosynthesis and related chemical processes that have been achieved through decades of fundamental research by single principal investigators, small groups, and large multi-institutional teams, including the first Fuels from Sunlight Hub, the Joint Center for Artificial Photosynthesis (JCAP) that was established in 2010. Significant JCAP accomplishments include the discovery of new ways to protect light-absorbing semiconductors from corrosion; creation of innovative high throughput capabilities for synthesis, characterization, and data analysis of light absorbers and electrocatalysts; discovery of new earth-abundant catalysts with performance comparable to those based on rare-earth metals; discovery of mechanistic aspects of key factors important for tuning activity and selectivity of carbon dioxide reduction to specific carbon-based products; and implementation of fully integrated test-beds to evaluate new components and assemblies for solar fuels generators including the design and demonstration of prototypes with highly efficient solar-to-hydrogen conversion.

More information on LiSA, CHASE, and JCAP is available at the links below.

[LiSA Web Site](#)  | [CHASE Web Site](#)  | [JCAP Web Site](#)  | [Selected JCAP Tools](#)  | [Selected JCAP Science Advances](#) 

The **Batteries and Energy Storage Hub** is the Joint Center for Energy Storage Research (JCESR), which was established in FY 2013 and renewed in FY 2018 for five years through peer-review processes. JCESR brings together world leading battery researchers to focus on a common objective to overcome fundamental scientific challenges to enable transformational energy storage systems beyond today's lithium-ion batteries. JCESR is led by Argonne National Laboratory in collaboration with four other national laboratories, eleven universities, the Army Research Laboratory, and industry. Joining Argonne on the JCESR team are Lawrence Berkeley National Laboratory, Pacific Northwest National Laboratory, Sandia National Laboratories, and

Scientists image the complete set of light-induced quantum states in 2-D crystals of tungsten disulfide and reveal the mechanisms coupling these states.

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SLAC National Accelerator Laboratory. Participating universities include Northwestern University, University of Chicago, University of Illinois at Urbana-Champaign, University of Illinois at Chicago, University of Kentucky, University of Waterloo, Notre Dame, Cornell University, Massachusetts Institute of Technology and the University of Michigan. The Army Research Laboratory and United Technologies are also research partners.

In the initial five-year award (2013-2018), JCESR created a library of fundamental scientific knowledge including: demonstration of a new class of membranes for anode protection and flow batteries; elucidation of the characteristics required for multi-valent intercalation electrodes; understanding the chemical and physical processes that must be controlled in lithium-sulfur batteries to greatly improve cycle life; and computational screening of over 16,000 potential electrolyte compounds using the Electrolyte Genome protocols.

In the 2018 renewal, JCESR extended its scientific emphasis to understanding and identifying transformational materials that can be mixed and matched to build a diversity of next-generation batteries purpose-designed to specific applications. To achieve these objectives JCESR is organized around five research Thrusts: Liquid Solvation Science, Solid Solvation Science, Flowable Redoxmer Science, Charge Transfer at Dynamic Interfaces, and Science of Material Complexity. As an integrator for the scientific and engineering communities pursuing next-generation energy storage, JCESR is coordinating its efforts with the DOE Energy Frontier Research Centers and other programs in the DOE technology offices and in ARPA-E.

[JCESR Website](#) 