JCAP
JOINT CENTER FOR ARTIFICIAL PHOTOSYNTHESIS

U.S. DEPARTMENT OF ENERGY
Office of Science

Joint Center for Artificial Photosynthesis

The Joint Center for Artificial Photosynthesis (JCAP) is the Fuels from Sunlight Energy Innovation Hub established by the US Department of Energy in 2010 to advance research and development on systems that convert sunlight, water and carbon dioxide into a range of commercially useful fuels. JCAP has adopted an approach in which robust concepts for complete solar-fuels generators motivate basic scientific research targeting the accelerated discovery and integration of necessary components.

JCAP is led by the California Institute of Technology in primary partnership with Lawrence Berkeley National Laboratory. Other key partners include SLAC National Accelerator Laboratory, the University of California at Irvine, and the University of California at San Diego.

JCAP Achievements (2010-2015)

The ability to generate energy-rich fuels directly from sunlight holds great promise as a new innovation in energy production, potentially enabling fossil fuels to be replaced with solar fuels. Through a combination of scientific, engineering, and theoretical modeling approaches, JCAP has discovered novel materials and developed solar water-splitting prototypes that exhibit performance characteristics which were inconceivable just five years ago.

JCAP is on track to produce full-system hydrogen-generating solar-fuels prototypes by the end of its initial funding period that meet all of the requirements set out in its original 5-year goal. To reach this target, JCAP has addressed critical needs by conducting basic scientific research and systems engineering. Selected accomplishments include:

- Discovery of new methods to protect light-absorbing semiconductors from corrosion in aqueous solutions while still maintaining excellent electrical charge conduction to the surface, enabling the use of photovoltaic materials like silicon in solar fuels generators that split water.
- Creation of an innovative high-throughput experimentation facility with a coordinated pipeline for the rapid preparation, processing, screening, characterization, and data analysis of light absorbers and electrocatalysts.
- Discovery of new mechanisms and materials for electrocatalytic water splitting reactions, including earth-abundant catalysts with activity as good as those based on rare-earth metals.
- Design, construction and testing of versatile, fully integrated test-beds to facilitate the evaluation and optimization of new components and assemblies for solar fuels generators.

JCAP Phase-II

During the second five-year term of the Fuels from Sunlight Hub, JCAP will capitalize on its scientific achievements and sophisticated technology development during the initial funding period by focusing on artificial photosynthetic systems that produce carbon-based fuels by consuming CO_2. In contrast to hydrogen, these products could be utilized by existing technologies to fuel transportation. However, the scientific barriers to reducing CO_2 are even greater than those addressed by JCAP during its first five years: there is no currently known catalyst that can reduce carbon dioxide with high energy efficiency and selectivity.

Mission

JCAP will create the scientific foundation for a scalable technology that converts carbon dioxide into renewable transportation fuels, under mild conditions, with only sunlight to provide energy.

Objectives

Mechanisms: Discovery and understanding of highly selective catalytic mechanisms for carbon dioxide reduction and oxygen evolution operative at mild conditions of temperature and pressure.

Materials: Accelerated discovery of electrocatalytic and photoelectrocatalytic materials and useful light-absorber photoelectrodes for the selective, efficient CO_2 reduction into hydrocarbon fuels.

Prototypes: Demonstration, in JCAP test-bed prototypes, of artificial photosynthetic carbon dioxide reduction components and oxygen evolution components that exceed natural photosynthesis in efficiency and rival it in selectivity.

Thrust Areas provide R&D for an Integrated CO_2 Reduction Solar-Fuels Generator