

## THREE GRAND CHALLENGES FOR ENERGY NANOSCIENCE AND SUSTAINABILITY

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**Abstract:** Addressing the very sustainability of the earth system, global climate, and our energy use has now become a leading area of scientific research. The sciences of light-matter interactions and electrochemistry are yielding advances that are opening paths for conceptually new sustainable energy technologies that have not previously been achievable. I will discuss three such “grand challenge” examples. A first is space solar power – enabling the generation of dispatchable, baseload solar electricity that doesn’t exhibit the intermittency of conventional solar photovoltaic systems, enabling solar power generation during both daytime and nighttime. A challenge is that of sustainable, carbon-net-zero chemical fuels from sunlight, suitable for aviation and heavy transport use, from advances in photoelectrochemical water splitting and carbon dioxide reduction. This requires new approaches to designing solar fuels systems with unprecedented efficiency, durability, and chemical selectivity. The third challenge focuses on realization globally scalable carbon dioxide capture and removal, using sunlight, electrochemical synthesis, and the world’s oceans.

**Bio:** Harry Atwater is the Otis Booth Leadership Chair of the Division of Engineering and Applied Science, and the Howard Hughes Professor of Applied Physics and Materials Science at the California Institute of Technology. Currently he is the Director for the Liquid Sunlight Alliance (LiSA), a Department of Energy Hub program for solar fuels. Atwater’s scientific effort focuses on nanophotonic light-matter interactions and solar energy conversion. His current research in energy centers on high efficiency photovoltaics, carbon capture and removal, and photoelectrochemical processes for generation of solar fuels. His research has resulted in world records for solar photovoltaic conversion and photoelectrochemical water splitting. His work also spans fundamental

nanophotonic phenomena, in plasmonics and 2D materials, and also applications including active metasurfaces and optical propulsion.

From 2014-2020, Atwater served as Director of the Joint Center for Artificial Photosynthesis (JCAP), the DOE Energy Innovation Hub for solar fuels. Atwater was an early pioneer in nanophotonics and plasmonics; he gave the name to the field of plasmonics in 2001. Atwater is a Member of US National Academy of Engineering, and a Web of Science Highly Cited Researcher. He is also founder of 5 early-stage companies, including Captura, which is developing scalable approaches to carbon dioxide removal from oceanwater, and Alta Devices, which set world records for photovoltaic cell and module efficiency. He is also a Fellow of the SPIE as well as APS, MRS, Optica, and the National Academy of Inventors. He is also the founding Editor in Chief of the journal ACS Photonics, and Chair of the LightSail Committee for the Breakthrough Starshot program. He is the recipient of numerous awards, including the 2021 von Hippel Award of the Materials Research Society.

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