Blog Post

ARPA-E: Innovating Through Unconventional Ideas

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In 2019, ARPA-E announced an ongoing funding opportunity for a range of the most innovative and unconventional ideas across the energy technology spectrum, exploring high-risk R&D that could lead to the development of disruptive technologies. The topics explored under this opportunity are not part of existing ARPA-E programs, but if successful could establish new program areas for ARPA-E to further explore.

Take a look at specific projects ARPA-E has funded under this opportunity across the broad range of technical areas outlined below.

▶ Mining Incinerated Disposal Ash Streams (MIDAS)
▶ Waste into X (WiX)
▼ Direct Removal of Carbon Dioxide from Oceanwater (DOC)

This topic seeks to develop technologies to focus on the capture process of removing carbon dioxide from oceanwater. Direct ocean capture (DOC) technologies are a promising option for servicing a very large and diverse carbon removal industry needed to mitigate legacy carbon dioxide emissions that are exacerbating anthropogenic climate change. Projects will focus on the development of robust, energy efficient, and low-cost strategies for direct removal of carbon dioxide from oceanwater and other natural waters by addressing challenges and opportunities specifically found in operation in an oceanic environment.

The removal of CO_2 from oceanwater and other natural waters, or direct ocean capture (DOC), is one method of capturing dispersed CO_2. DOC also has the potential for offshore deployment that offers a variety of useful potential benefits such as reducing competition for useful land, allowing access to oceanic CO_2 storage sites currently only reachable by pipeline, and producing valuable CO_2 streams offshore for a number of potential uses, including as a feedstock for fuel and chemical synthesis. Finally, DOC represents a direct reversal of ocean acidification caused by anthropogenic CO_2 emissions. Teams will focus on de-risking technologies that can capitalize on the unique benefits of ocean-based systems to help meet the promise of energy-efficient, low-cost, scalable CO_2 capture.

California Institute of Technology – Pasadena, CA

DEVELOPMENT OF AN OFF-SHORE, STAND-ALONE SYSTEM FOR EFFICIENT CO2 REMOVAL FROM OCEANWATER - $850,000

California Institute of Technology aims to develop an off-shore, stand-alone system for low-cost, efficient CO2 removal from ocean water. The project's main objectives are to demonstrate a (1) high operating current density and low power electrodialyzer stack and (2) membrane contactor to facilitate unprecedented rapid removal of CO2 from ocean water. These combined innovations will significantly reduce the volume of ocean water that needs to be processed. They will also significantly reduce the capital and associated system costs. The proposed system aims to provide a viable pathway to achieve CO2 removal from ocean water at <$100/ton and could be potentially scaled up to multi-gigaton CO2/year capacities.

University of North Dakota Energy & Environmental Research Center – Grand Forks, ND

HYDROLYTIC SOFTENING OF OCEAN WATER FOR CARBON DIOXIDE REMOVAL - $500,000

Hydrolytic softening is a lower-cost process to remove CO_2 from the oceans. It has similarities to processes at conventional water treatment facilities, which mix hydrated lime to "soften" water by precipitating dissolved inorganic carbon as calcium carbonate. In hydrolytic softening, however, instead of a consumptive use of lime, the calcium carbonate is decomposed. This releases CO_2 gas for sequestration or industrial use and regenerates the lime for continued cycles of carbon removal. Hydrolytic softening can reduce energy input costs for CO_2 removal by 77% compared to state-of-the-art methods based on sodium chloride salt splitting using bipolar membrane electrodialysis.

Massachusetts Institute of Technology – Cambridge, MA

ELECTROCHEMICALLY MODULATED CO_2 REMOVAL FROM OCEAN WATERS - $650,000

The Massachusetts Institute of Technology proposes to use electrochemical modulation of a proton gradient within electrochemical cells to initially release the CO_2 in seawater, and then to alkalize the water before it is returned to the ocean. This battery-like electro-swing approach does not require expensive membranes or addition of chemicals, is easy to deploy, and does not lead to formation of byproducts. Innovative electrode configurations will be employed to reduce overall transport and electrical resistances while still enabling large quantities of water to be treated efficiently. Relatively compact CO_2 capture processes with promising low energetics, powered by renewable solar or wind resources, could be assembled for deployment on platforms or cargo ships.

▶ Direct Removal of Carbon Dioxide from Ambient Air (DAC)
▶ Insulating Nanofluids and Solids to Upgrade our Large Aging Transformer Equipment (INSULATE)
▶ Recycle Underutilized Solids to Energy
▶ Biotechnologies to Ensure a Robust Supply of Critical Materials for Clean Energy
▶ Supporting Entrepreneurial Energy Discoveries
▶ Electricity System Models for Carbon Capture Resources
▶ Establishing Validation Sites for Field-Level Emissions Quantification of Agricultural Bioenergy Feedstock Production
▶ High Value Methane Pyrolysis
▶ Diagnostic Resource Teams to Support the Validation of Potentially Transformative Fusion-Energy Concepts
▶ Leveraging Innovations Supporting Nuclear Energy
▶ Downhole Tools to Enable Enhanced Geothermal Systems
▶ Extremely Durable Concretes and Cementitious Materials