

Carbon

Preparing solutions for the next major phase of climate change mitigation by creating the S&T and collaborations to support global-scale CO₂ removal.

Climate scientists predict that even after we achieve carbon-free electricity, and most industry and transportation is emission-free, the world will still be about 25 percent short of the carbon dioxide (CO₂) reductions necessary to limit the global mean temperature increase to no more than 2°C. The remaining gap is caused by agriculture, other transportation such as airplanes and ships, and the fact that the transition to a carbon-free energy system will not be fast enough. We will have no option but to remove CO₂ from the air. To create a stable “2°C world”, most models predict that by later in this century we will need to remove ten gigatons of CO₂ per year. For scale, the world currently harvests about a gigaton of grain, and moves about two gigatons of oil per year. An endeavor of this magnitude is unprecedented, and requires new technology, new collaborations, and ultimately new companies that are engaged in the business of cleaning the atmosphere. The LLNL Carbon Initiative will help create the science, technology, and collaborations to support global-scale CO₂ removal. The timeline for this next phase of climate technology brings it to full scale after carbon-free energy is widely available, but LLNL is acting now because the enormous size of the activity requires that we begin the technology development today.

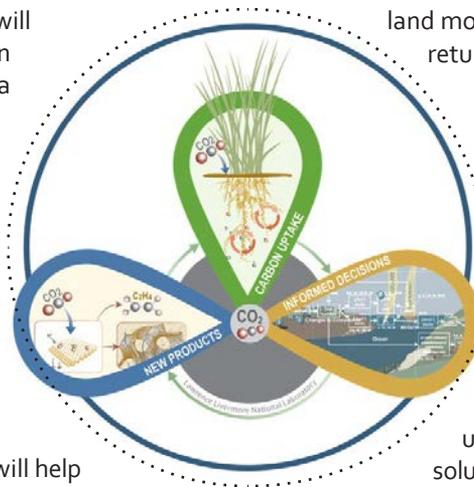
A New Carbon-Recycling Economy: Industrial Chemicals from CO₂

Carbon-free electricity is an important tool for achieving dramatic carbon reductions. It will permit us to make many carbon-based products not from fossil carbon, but from CO₂ that we have harvested from the atmosphere, either using plants or by direct engineered extraction. LLNL is developing new electro-chemical approaches for making industrial chemicals such as ethylene (C₂H₄), lubricants, and polymers directly from CO₂ and water.

Enhancing Our Soil by Returning Carbon to the Earth

The majority of the carbon dioxide removed from the

atmosphere will ultimately be stored in the Earth. Soil carbon is a huge sink for atmospheric CO₂ that modern agriculture has depleted. By understanding the science that caused the highly productive carbon-rich soils of the central US plains to form originally, we hope to be able to engineer agricultural and agronomic approaches that will return carbon to soil in long-lived forms. This can improve the atmosphere, and make land more productive, allowing marginal land to be returned to a natural condition.



Prioritizing Investments

The choices that must be made in our complex energy and agriculture system require thoughtful evaluation of the best ways to combine and prioritize our approaches. How can we achieve our climate goals, while encouraging new jobs and industries, building better farms, and while keeping the cost manageable? The Carbon Initiative is using system analysis to lead us to win-win solutions.

LLNL will Work with Partners to Shape a New Carbon Future

Defining the research and development pathway to reach optimal real-world solutions is an LLNL strength, and we are applying it to understand solutions like:

- Carbon capture from biofuel production to enable negative emissions fuels—fuels that when burned, emit less carbon than was permanently stored during their production.
- Storing carbon dioxide in existing California oil reservoirs, utilizing the infrastructure and expertise resident in Central California.

LLNL will work with industry, academia, and other national resources to develop visions like this and turn them into reality in time to meet climate goals. Technology will come from many sources, and will help create the partnerships and industries required to implement these new technologies.