Researchers develop software for complex CO2 capture, transport and storage infrastructure

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Watch a video about SimCCS$^{2.0}$, the open-source software package for designing CO_2 capture, transport and storage infrastructure

Billions of tonnes of industrially produced carbon dioxide (CO_2) are emitted globally to the atmosphere every year. Capturing, transporting and storing these CO_2 emissions could provide important benefits in the areas of energy, the economy and the environment. But that process involves building pipelines and other infrastructure on a massive scale to collect and store the CO_2.

In a solution to this challenge, Los Alamos researchers and collaborators have developed an open-source software package, called *SimCCS$^{2.0}$*, to help industry and government make the complex, expensive infrastructure decisions needed to capture, transport and store CO_2.

"*SimCCS$^{2.0}$* is the only tool to simultaneously consider where, how much and when to capture, transport and store CO_2. It can identify effective energy, economic and environmental solutions that no other tool can find," said Richard Middleton of Computational Earth Science group, lead developer of the software.

To help research, industry and government personnel design infrastructure for CO_2 capture and storage (CCS), the software optimally links CO_2 sources, such as power plants, with CO_2 sinks, such as saline aquifers and depleted oil fields. The CO_2 could be reused in CO_2-enhanced oil and gas production. The software accesses public- or user-provided CO_2 source, sink and transportation data to create an optimization problem that, when solved, determines the most cost-effective CCS infrastructure design, while minimizing costs, reducing industry's carbon footprint and enhancing oil production and carbon tax credits.

This optimization problem is solved either through a high-performance computing (HPC) interface, called the *SimCCS$^{2.0}$* Science Gateway version—or through third-party software on a local desktop computing platform, called the *SimCCS$^{2.0}$* Desktop version. Both the desktop and HPC versions provide identical functionality, including the flexibility to adjust designs for changes in tax credits and CO_2 price and to address

uncertainties associated with emission rates at sources and injection rates and capacities at sinks.

For its infrastructure designs, the software identifies real-world routes for CO_2 pipeline networks and trunk links. It estimates the costs of pipeline construction based on an extensive list of factors, including topography, water bodies, land cover, existing rights of way and social constraints such as population density, federal lands and environmental impact.

“Our software addresses all critical parts of the CCS supply chain simultaneously, allowing us to identify key cost savings, revenue streams and risks,” Middleton said. “In this way, it can help reduce industry carbon footprints and maximize revenue.”

The Los Alamos team collaborated with Montana State University and Indiana University to develop the software package. The software is already being widely used by a variety of industry, government and research projects after being released in January 2018. Major U.S. energy companies that have used or are using *SimCCS*$^{2.0}$ include Southern Company, BP, Duke Energy, Jupiter Oxygen, Archer Daniels Midland and Advanced Resources International.

SimCCS$^{2.0}$ is supporting nine different projects as part of two DOE initiatives: CarbonSAFE, which focuses on storage in saline aquifers, and Associated Storage, which is concerned with storage in both saline aquifers and oil fields. Each project represents investments between industry, government and academia and has the goal of understanding how to cost-effectively and safely implement CCS across the United States. Key projects have focused on Illinois, Indiana, Michigan, Nebraska, Ohio, Utah, Wyoming and the southeast United States.

Major U.S. and international academic institutions, including Arizona State University, Montana State University, Stanford University, Ohio State University, the University of Texas-Austin, the University of Virginia, the University of Wyoming and West Virginia University, are using *SimCCS*$^{2.0}$. It has been applied in numerous academic studies, taught in classes, and made part of class projects and has had a role in research dissertations.

The Los Alamos developers include Richard Middleton, Bailian Chen, Dylan Harp and Brendan Hoover, all of the Computational Earth Science group. The Department of Energy’s Office of Fossil Energy funded the research, which supports the Laboratory’s Energy Security mission area.

This video is the third in a series of eight videos showcasing 2019 R&D 100 Award technologies. See more LANL science videos here.