

# Lawrence Berkeley National Laboratory

## LBL Publications

### Title

Bringing research findings to the real world is an essential and rewarding experience

### Permalink

<https://escholarship.org/uc/item/2b13w677>

### Journal

Greenhouse Gases Science and Technology, 7(1)

### ISSN

2152-3878

### Author

Oldenburg, Curtis M

### Publication Date

2017-02-01

### DOI

10.1002/ghg.1667

Peer reviewed

# Bringing research findings to the real world is an essential and rewarding experience

[Curtis M. Oldenburg](#)

First published: 01 February 2017

<https://doi.org/10.1002/ghg.1667>

[UC-eLinks](#)



## **Curtis M. Oldenburg**

The pending changes in the U.S. presidential administration and Congress threaten the ongoing progress being made in lowering U.S. greenhouse gas (GHG) emissions. Yet the need for reducing emissions and directly addressing the energy-climate crisis has never been greater. I define the energy-climate crisis as the situation created by reliance on fossil fuels for 80% of global energy supply, the combustion of which releases CO<sub>2</sub>, the main greenhouse gas causing global warming. Instead of allowing the U.S. national political situation to be a distraction, scientists, engineers, and policy experts need to push even harder to turn research findings into practical applications so those findings can contribute to actually reducing emissions. In addition, scientists and engineers need to communicate research results to lawmakers and the public to reinforce the urgency of directly addressing the energy-climate crisis. As I will describe below, without giving away still-developing conclusions of the ongoing project, facilitating practical application of research results can be a very rewarding and satisfying experience.

Recently my colleagues and I have been working on developing recommendations for site-selection and monitoring protocols for the state of California to develop a quantification methodology (QM) for geologic carbon sequestration (GCS). GCS is planned to be one of the approaches allowed for use in California's cap-and-trade and low-carbon fuel standard programs to provide valuable emissions credits to projects that effectively reduce GHG emissions.

Emissions credits need to be certifiable, i.e., credits must represent emissions reductions that are real, permanent, quantifiable, and verifiable.

For background, the California Air Resources Board administers a cap-and-trade program pursuant to the state's 2006 Global Warming Solutions Act (Assembly Bill 32, or AB 32), a law that mandates the state to reduce its greenhouse gas emissions to 1990 levels by the year 2020. The state also administers a low-carbon fuel standard (LCFS) program mandated by Executive Order S-01-07 issued in accordance with AB 32. The workings of cap-and-trade should be familiar to readers of this journal. The LCFS program, which might not be familiar to everyone, is designed to decrease the carbon intensity of California's transportation fuels and provide an increasing range of low-carbon and renewable fuels. The LCFS incentivizes production and use of low-carbon fuels by awarding valuable emission credits to producers of low-carbon-intensity fuels, which may include biofuels and/or biofuels with carbon capture and storage (BECCS), CO<sub>2</sub>-enhanced oil recovery projects with verifiable CO<sub>2</sub> trapping, and other low-carbon-intensity fuels such as natural gas, hydrogen, and electricity. California emissions credits can be awarded to producers in any state selling low-carbon fuels to the California market, provided the Air Resource Board can certify the emission reductions. With California's population now at nearly 40 million people, and with the sixth largest economy in the world (larger now than the economies of France or Brazil), California has a large transportation fuel market that is very attractive to fuel producers. Therefore, the development of specific regulations that will provide the ground rules for potential GCS providers could be very significant because it will facilitate application of GCS for reducing CO<sub>2</sub> emissions for these two potentially very large California programs, the LCFS and cap and trade. It is also noteworthy that the value of a credit in the LCFS market has been running as much as ten times that in the general cap-and-trade market, and it seems that the LCFS credit price has at times been high enough to make carbon capture and storage (CCS) economic if those prices could be sustained. It is important to note that California is committed to achieving its GHG reduction goals and enforcing its laws, independent of changes in U.S. Presidential administration or in Congress.

Certification that GHG emissions reductions from a GCS project are real, permanent, quantifiable, and verifiable is a significant challenge. First, regarding the question of whether emissions reductions by GCS are real, this pertains to broad life-cycle elements that are largely outside of the scope of the subsurface storage part (GCS) of CCS, so I will omit discussion of this aspect for brevity here. Permanency brings up the question of how long CO<sub>2</sub> needs to stay underground. Of course early research into GCS was carried out on this question and it was a pleasure to search the peer-reviewed literature to make use of these studies. From the prior work,

it was evident that a range of time scales for sequestration could be considered to define effective permanence in order to achieve the objectives of GCS, i.e., to define a rational sequestration time scale.

Combining the sequestration time scale with quantification and verifiability over that time is more of a challenge. Quantifying emissions reductions in the context of GCS involves quantifying surface leakage and comparing the amount of CO<sub>2</sub> injected against how much CO<sub>2</sub> leaks back to the atmosphere. There is an excellent published body of work on trapping of CO<sub>2</sub> and on monitoring for leakage of CO<sub>2</sub>. Again, it was very satisfying to access and review this literature to conclude that practical aspects of monitoring (what technologies to deploy, density of measurement, frequency of measurement, overall approach in terms of modeling and analysis, etc.) mean that zero surface leakage over the sequestration time scale can never be proven, but that the risk of surface leakage (product of likelihood and magnitude of surface leakage) can be made very small. And it is well understood that the reduction of surface leakage risk is made easier by good site selection. While the U.S. Class VI injection permit protocols protect underground sources of drinking water (USDW), Class VI rules do not address explicitly surface leakage which can occur in some scenarios without impacting USDW (e.g., where USDW is absent, or when leakage occurs up a well that bypasses USDW).

With the above understanding, it becomes apparent that the regulating agency and the GCS operator need to work closely together to select excellent GCS sites that minimize surface leakage risk, and to develop monitoring plans that optimally reduce surface leakage detection limits. Monitoring plans should include monitoring approaches that can detect and quantify leakage if it occurs at some level above a detection threshold. A very significant role for scientists and engineers, who have extensively studied GCS and developed or analyzed related monitoring strategies, is to translate the large body of risk-based site-selection and monitoring knowledge into recommendations that agency staff can use in formulating the QM and related protocols for their jurisdictions.

From my personal perspective and recent experience, it is very satisfying and rewarding to draw on, and help to expand, the large body of literature and knowledge available in order to synthesize and extract essential elements needed for agencies to include in their GCS regulations and protocols. From a broader perspective of addressing the energy-climate crisis, it is essential that scientists and engineers aim generally to facilitate bringing their research findings to practical applications to regulatory bodies wherever they are, i.e., at regional, state, or national levels, as these bodies develop programs that will actually lower GHG emissions in a timely manner. I believe most researchers will find great satisfaction in pursuing this goal.

