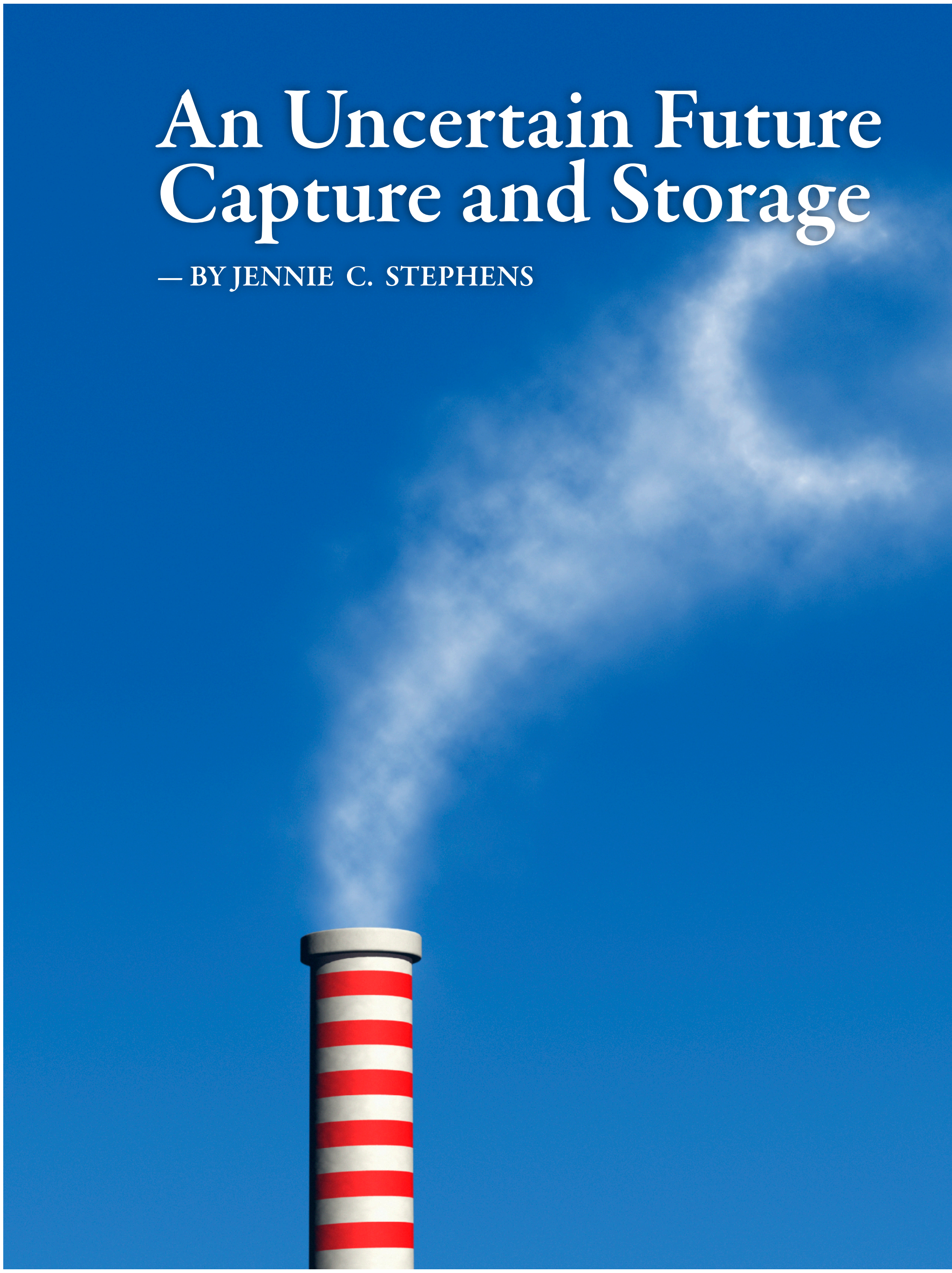
An Uncertain Future Capture and Storage

— BY JENNIE C. STEPHENS



INTRODUCTION

As the coal-reliant countries of the world have been increasingly forced to consider reducing carbon dioxide (CO_2) emissions to mitigate climate change, carbon capture and storage (CCS) has emerged as a technology with critically important political influence. Visions of "clean" coal-fired power plants that will not emit CO_2 into the atmosphere have provided powerful motivation for large public and private investments in CCS technology [1]. And the scale of CO_2 emission reductions deemed necessary for climate stabilization is so large that some consider CCS a necessary future technology without which society will be unable to mitigate climate change. Despite growing interest and investment in CCS, the technology's future remains uncertain and the pace of technological development has been slower than many had envisioned five or ten years ago. [2]

STATUS OF CCS TECHNOLOGY

CCS incorporates various technologies associated with capturing and transporting CO_2 and storing the compressed gas somewhere other than the atmosphere. Most current conceptualizations of a complete CCS system focus on the potential of storing the CO_2 in underground geologic reservoirs, although ocean storage and terrestrial storage have also been considered. The different components of a fully integrated CCS system are at various levels of technical readiness, but most parts of a full CCS system have been used and applied, often at a smaller scale, in other industrial applications. Despite growing interest and investment, a fully integrated coal-fired power plant with CCS has not yet been demonstrated. [3] There are, however, numerous small scale projects that focus on demonstrating a limited part of a full CCS system. [4] A public database maintained by the U.S. Department of Energy's National Energy Technology Laboratory currently documents a total of 254 CCS projects, including proposed, active and cancelled projects.[5] These projects are geographically distributed in 27 countries including 65 projects focused on capture, 61 projects focused on storage, and 128 that involve both capture and storage. Of these projects, most are in the planning phase and only 20 are actually currently capturing and/or injecting CO_2. Among the current priorities for advancing CCS are enhancing the capture process to reduce the energy intensity and cost of capture, demonstrating underground CO_2 capture in a diverse set of geologic formations, and demonstrating and deploying integrated and scaled-up CCS power-plant systems that allow for "learning-by-doing."

A CHANGE IN COAL POLITICS IN THE UNITED STATES

The potential of CCS technology has changed the politics of coal in many places, but its influence in the United States is particularly pronounced. The United States has so far focused its national response to climate change on technology rather than policy and is

among the countries in the world that has invested most heavily in CCS. [6]

The scope and scale of U.S. interest in CCS is critical, because due to its size, status, and disproportionate contribution to accumulated CO_2 emissions, the United States has unique potential for political and technological influence over energy technology development and the trajectory of global atmospheric CO_2 concentrations.

The magnitude of the U.S. reliance on coal (about 45 percent of the nation's electricity comes from coal) has been a dominant factor influencing both national energy policy and the lack of national climate policy. Politicians from regions of the country where the coal industry is most influential have been among the most powerful opponents of national climate change legislation. For coal states and politicians representing those states, however, CCS has provided a potential vision of a carbon constrained future in which the coal industry could still thrive. From a political perspective, therefore, the potential of CCS technology has been valuable in contributing to the engagement of critical actors in national climate policy discussions; CCS has enabled some constituents who had been previously reluctant to even acknowledge the challenges of climate change to engage in the climate-energy political discourse.

Despite the powerful political influence of coal, public opposition to building new coal-fired power plants has grown rapidly in the past few years. In 2005, over 100 new coal-fired power plants in the United States were in various stages of planning, but cancellations have been frequent and since then only a handful of new plants have actually been built. While economic factors and rising capital costs clearly contributed to these proposed plant cancellations, some plants have been cancelled in direct response to concerns about CO_2 emissions and the economic and environmental liability of locking-in to a high carbon emitting power plant.

In this context CCS can be viewed as playing a new moderating role in opposition to coal. A few years ago anti-coal advocates who called for a moratorium on coal-fired power plants may have been considered radical and impractical. Now some of the same advocates can use CCS as a qualifier to their calls for a moratorium on coal fired power plants. That is, a position that says "no new coal plants unless they have CCS" represents a more practical stance. This anti-coal position seems more reasonable. Given the long anticipated time horizon before CCS may be implemented (due to the need still to demonstrate the technology at scale and also the complicated changes to the regulatory and economic system that would be necessary to create incentives for actual CCS implementation), a call for no new coal plants without CCS is, in the short-term, equivalent to a call for no new coal plants.

CHANGING INVESTMENT LANDSCAPE

Given the large-scale infrastructure investments required to develop CCS and the minimal regulatory requirements to incentivize its advancement, both public and private investment has been and will continue to be critical to the technology's advancement.


Artist rendering of carbon capture and storage facility.

Since 2005, US$25 billion in direct government funding for CCS has been announced worldwide, with 80 percent of these announcements focused on support for large-scale CCS demonstration projects.[6] While not all of these announcements have resulted in distribution of public funds, the magnitude of government investment has been large, with the United States, Canada, Australia, and Norway among those with the largest public commitments to CCS. Although the global financial crisis has contributed to the cancellation or delay of several projects,[7] it also resulted in some increases of funding in the United States because the 2009 American Recovery and Reinvestment Act committed more than US$3.1 billion to CCS.

Given the high cost and large risks (both financial and environmental) associated with CCS investments, the vast majority of CCS projects around the world have relied on a combination of public and private funding. Quantifying levels of private investment is difficult, but it is clear that levels of private funding are related and to some extent connected to levels of public support. In addition, private sector investment in CCS has been influenced by firms' perceptions of an emerging CCS market which is influenced by perceptions of the emerging legal and regulatory framework for CCS. In the private sector, the oil and gas industry has dominated private CCS investment due in large part to the strategic opportunity associated with their technical capacity in sub-surface geological engineering.

AN INTERNATIONAL CCS COMMUNITY

As both public and private investment in CCS has grown, a diverse international network of professionals focused on the advancement of CCS technology has emerged. This international CCS community has been developing and expanding in multiple ways as the level of interest in CCS has been increasing. This community is dynamic and includes scientific and technical experts, as well as representatives from business, government, academia and non-governmental organizations. Within this international community, a shared perception of the value of advancing CCS technology is generally assumed.[8] The community seems to have a consistent and rather homogenous policy message related to the need for government support to advance the technology, and this message appears to have been influential in lobbying for increased support in many countries and at the international level. Like any community of professionals focused on the advancement of a specific technology, the growth of the CCS community has been, at least in part, self-perpetuating, i.e., the community has effectively advocated for increased investment in CCS technology, which has contributed to its expansion. While technological advocacy is a necessary part of the innovation process,[9, 10] some concern has been raised that the degree of advocacy among CCS experts could have a net negative impact on CCS advancement if public concerns about the technology are not understood or taken seriously by the community.[11]

PUBLIC CONTROVERSY

Although many who work within the CCS community accept the usefulness and necessity of CCS technology, public controversy has potential to thwart its advancement. Public concern and opposition to CCS can be divided into two categories related to different perceived risks at global and local levels:

(1) general opposition to the technology as an end-of-pipe, expensive climate mitigation option that is resource-intensive, promotes the use of fossil fuels, competes with renewable energy sources, and is technologically complex and environmentally risky and;
(2) project-specific opposition among communities that are confronted with planned projects and perceive local risks associated with those projects.[12, 13]

The environmental community has been divided in their level of support for this technology.[14] Skepticism about the technology's potential to facilitate a transition away from fossil fuels is strong,[15] but there are also environmental organizations that are highly supportive or accepting of CCS (e.g., the World Wildlife Fund, Bellona, and the Natural Resources Defense Council).

Project-specific opposition can be seen in various recent proposed CCS projects, such as Vattenfall's cancelled and postponed storage projects in Denmark and Germany[16] and the cancelled Barendrecht project in the Netherlands.[17, 18] The first public reporting of CO_2 leakage at a CCS storage project occurred in January 2011 in Saskatchewan Canada, where a farmer alleged that CO_2 from the Weyburn project was degrading his land and killing animals on his property.[19] While representatives of industry and the government moved quickly to reassure the public that the leaking CO_2 was likely from a natural source rather than from the CO_2 storage project, the controversy is not yet over as the community is waiting for an independent investigation that is currently underway. The impact of these public controversies on the future of CCS is not yet clear.

AN UNCERTAIN FUTURE

As a climate mitigation technology, CCS has a particularly interesting, unique attribute which is that it offers no co-benefits, i.e. quite literally the only reason to implement CCS is to reduce CO_2 emissions. While most climate mitigation strategies (including renewable energy, reduced resource consumption, changes in agricultural practices, promoting local food systems, etc), offer multiple benefits, CCS is an expensive, technologically complicated approach to CO_2 emission reductions that offers limited versatility and flexibility once infrastructural investments are made. Among other challenges facing CCS are: liability concerns (who will be ultimately responsible for ensuring the long-term underground storage of the CO_2),[20] monitoring and enforcement (how will stored CO_2 be accurately and confidently measured and documented),[21] and leakage risks (what are the potential environmental, health and safety risks of potential CO_2 leakage). With respect to the technology's potential to meaningfully contribute to stabilization of atmospheric CO_2 concentrations, another challenge facing CCS is the large-scale of deployment that would be required.

The only reason to implement CCS is to reduce CO_2 emissions.

A complicated uncertain future for CCS emerges when the strong levels of interest and investment that the technology has received to date are juxtaposed with its multiple challenges. From a technological perspective, it has been argued that the infrastructural requirements and inflexibility of CCS result in difficult "technological lock-in."[22] From a political perspective, it could also be argued that investment requirements and the sunk-costs associated with the amount of money already invested in CCS result in a difficult "political lock-in." For those governments and private companies that have already invested millions or billions of dollars to advance CCS, ending their support for this technology may be difficult even if perceptions of the relative challenges and potential of CCS continues to change over time. ■

Jennie C. Stephens is an Assistant Professor of the Environmental Science and Policy (ES&P) Program in the Department of International Development for Community and Environment at Clark University in Worcester, Massachusetts.

References

1. Meadowcroft, J. and O. Langhelle, eds. *Caching the Carbon: The Politics and Policy of Carbon Capture and Storage*. 2009, Edward Elgar: Cheltenham, UK.
2. Bäckstrand, K., J. Meadowcroft, and M. Oppenheimer, *The politics and policy of carbon capture and storage: Framing an emergent technology*. Global Environmental Change, 2011. **21**(2): p. 275-281.
3. Coninck, H.d., J.C. Stephens, and B. Metz, *Global learning on carbon capture and storage: A call for strong international cooperation on CCS demonstration*. Energy Policy, 2009. **37**(6): p. 2161-2165.
4. Global CCS Institute, *The Global Status of CCS 2010*. 2011.
5. NETL, *CCS Database*. *http://www.netl.doe.gov/technologies/carbon_seq/global/database/index.html*. 2011.
6. Tjernshaugen, A., *Political commitment to CO2 capture and storage: evidence from government RD&D budgets*. Mitigation, Adaptation, Strategy Global Change, 2008. **13**: p. 1-21.
7. Global CCS Institute, *Report 1: Status of Carbon Capture and Storage Project Globally*, in *Strategic Analysis of the Global Status of Carbon Capture and Storage*. 2009.
8. Stephens, J.C., et al., *Characterizing the International Carbon Capture and Storage Community*. Global Environmental Change, 2011. **21**: p. 379-390.
9. Global CCS Institute, *An Ideal Portfolio of CCS Projects and Rational for Supporting Projects*. 2009, LEK Consulting.
10. CSLF, *Carbon Sequestration Leadership Forum, Technology Roadmap, A Global Response to the Challenge of Climate Change*. http://www.cslforum.org/publications/documents/CSLF_Technology_Roadmap_2010.pdf, 2010.

References

11. Coninck, H.d., *Advocacy for carbon capture and storage could arouse distrust.* Nature, 2010. **463**(7279): p. 293-293.
12. Bielicki, J. and J.C. Stephens, *Public Perception of Carbon Capture and Storage Technology Workshop Report*, in *Energy Technology Innovation Policy Group Workshop Series.* 2008, Harvard Kennedy School: Cambridge MA.
13. Wilson, E.J., T.L. Johnson, and D.W. Keith, *Regulating the ultimate sink: Managing the risks of geologic CO_2 storage.* Environmental Science & Technology, 2003. **37**(16): p. 3476-3483.
14. Wong-Parodi, G., I. Ray, and A.E. Farrell, *Environmental non-government organizations' perceptions of geologic sequestration.* Environmental Research Letters, 2008. **3**(2).
15. Greenpeace International, *False Hope, Why Carbon Capture and Storage won't save the climate.* 2008: Amsterdam.
16. NyTeknik (2009) *Protester stoppar danskt CO2-lager (Protests stop Danish CO2 storage)* http://www.nyteknik.se/nyheter/energi_miljo/energi/article583207.ece.
17. Van Noorden, R., *Buried Trouble.* Nature, 2010. **463**: p. 871-873.
18. Feenstra, C.F.J., T. Mikunda, and S. Brunsting, *What happened in Barendrecht? Case study on the planned onshore carbon dioxide storage in Barendrecht, the Netherlands.* 2010, ECN and Global CCS Institute. http://admin.cottoncrc.org.au/files/files/pybx.pdf.
19. Weber, B. and J. Graham, *Land fizzing like soda pop: Farmer says CO2 injected underground is leaking*, in *The Canadian Free Press*. 2011: January 11, 2011.
20. Wilson, E.J., S.J. Friedmann, and M.F. Pollak, *Research for Deployment: Incorporating Risk, Regulation, and Liability for Carbon Capture and Sequestration.* Environmental Science & Technology, 2007. **41**(17): p. 5945-5952.
21. Pollak, M., S.J. Phillips, and S. Vajjhala, *Carbon capture and storage policy in the United States: A new coalition endeavors to change existing policy.* Global Environmental Change, 2011. **21**(2): p. 313-323.
22. Vergragt, P.J., N. Markusson, and H. Karlsson, *Carbon capture and storage, bio-energy with carbon capture and storage, and the escape from the fossil-fuel lock-in.* Global Environmental Change. **21**(2): p. 282-292.

Letters to the Editor

FAS wants to hear from you.

The PIR welcomes **Letters to the Editor**. Letters should not exceed 300 words and may be edited for length and clarity.

FAS Public Interest Report
1725 DeSales Street, NW
6th Floor
Washington, DC 20036
PHONE: (202) 546-3300
FAX: (202) 675-1010
EMAIL: pir@fas.org

Listen and Learn Podcasts

FAS records "Conversations with Experts" on a wide range of topics.

Download the interviews: www.FAS.org/podcasts/index.html