



BUILDING PUBLIC ACCEPTABILITY FOR CARBON CAPTURE AND SEQUESTRATION

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CARBON CAPTURE AND SEQUESTRATION CAN HELP ADDRESS THE CLIMATE CHALLENGE

Global warming is the most important and challenging environmental issue we have ever faced. Scientists agree that acting quickly to reduce carbon dioxide (CO₂) emissions is necessary to minimize potentially catastrophic climate change. Fossil fuel-fired power plants are the single largest source of CO₂ emissions in the United States, contributing 40 percent of the total. Coal's abundance makes it the low-cost option for electricity generation and plans to expand capacity will significantly increase emissions absent carbon constraints. While developing renewable energy and promoting energy efficiency must be central in any future energy portfolio, we must also reduce carbon emissions from coal-fired power plants significantly to avoid the most damaging impacts of global climate change.

Carbon dioxide capture and sequestration (CCS) can help reduce CO₂ emissions from coal until other options are more mature. CCS involves capturing CO₂ emissions at large stationary sources and injecting the CO₂ deep underground where it will remain trapped, much the way that oil and gas resources have for millions of years.

The Intergovernmental Panel on Climate Change (IPCC), a global network of scientific experts, believes that CCS could meet between 15 and 55 percent of global carbon mitigation needs over the next century. Several large scale CCS projects are under way around the globe. While they have demonstrated that underground formations can hold injected CO₂, further study is needed to answer key questions about permanence, safety, and operational management in a variety of settings.



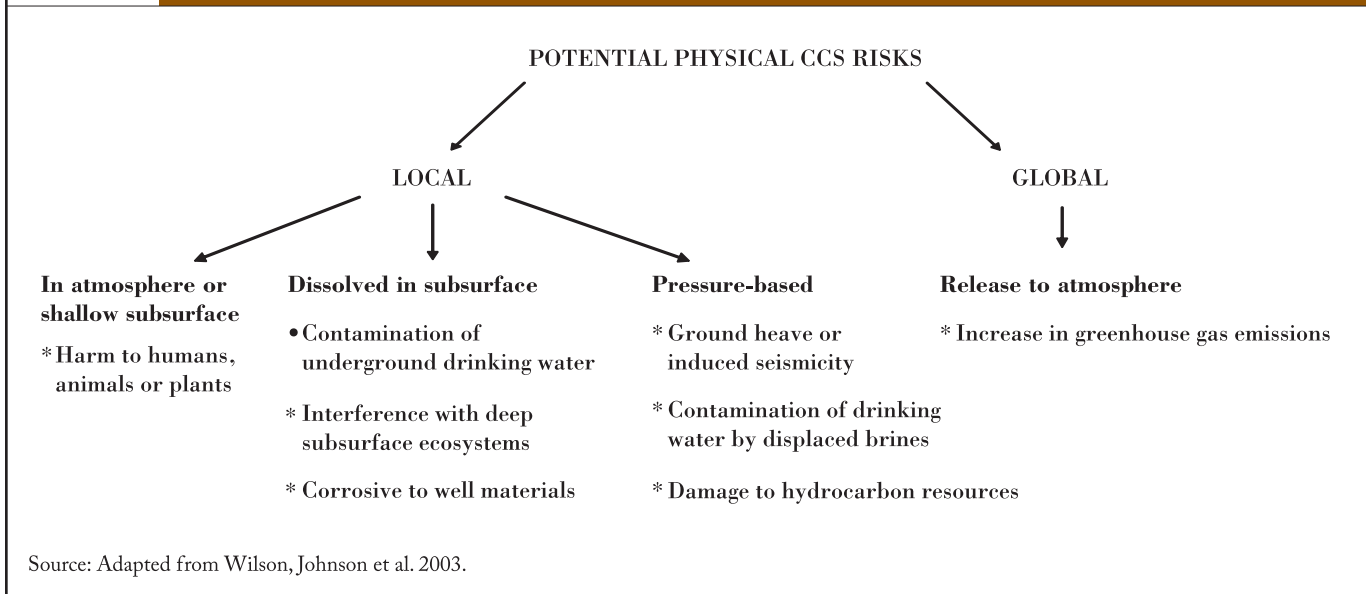
SUMMARY

Carbon dioxide capture and sequestration (CCS) could prove an essential component of the effort to address the climate change challenge. While demonstration projects across the globe can show that CCS risks are low, public perception of such risks will be critical in influencing how policy and regulatory frameworks develop around the technology. This brief outlines the risks associated with CCS, describes how the public views the technology, and explains what can be done to develop long-term public support. We conclude that the best way to build public acceptance for CCS is by developing large, well-managed demonstration projects; promoting robust regulations and industry standards; and creating more interactive public outreach and education programs.

Even if science demonstrates that the risks of CCS are low, lack of public support could halt wide-scale deployment. This brief outlines the risks associated with CCS, describes how the public views the technology, and explains what can be done to prevent a NUMBY (not *under* my backyard) syndrome from emerging.

TYPES OF CCS RISK

Because CO₂ is less dense than water, underground CO₂ can migrate toward the surface unless contained by suitable cap rocks, or trapped by other chemical and physical mechanisms. Carbon capture and sequestration risks fall into two general categories—risks that are local in scope and those that are global (see Figure 1). The physical risks described here can

FIGURE 1 Types of Physical Risk Related to CCS

lead to other economic and financial risks (such as a decline in property values adjacent to sequestration sites), but they are not the direct subject of this paper. According to the IPCC, well-chosen and operated sites have low risk, with less than 1 percent of the injected CO₂ likely to escape from storage reservoirs over a thousand-year period.

Local risks might threaten human and ecosystem health, underground resources such as drinking water, and the structural integrity of overlying surfaces. While CO₂ is non-toxic, at high concentrations it can asphyxiate humans and animals. High CO₂ concentrations in the soil can also kill plants by preventing oxygen uptake by the roots. The dissolution of CO₂ in the subsurface could contaminate drinking water either directly or through the mobilization of metals or organic pollutants, which may also interfere with subsurface ecosystems. Finally, when CO₂ interacts with water it becomes corrosive, making damage to wells a concern, especially since corroded wells could allow CO₂ to leak to the atmosphere.

Another set of local risks relates to the quantity of CO₂ injected and resulting pressure. When CO₂ is injected into the subsurface it raises reservoir pressure and could lead to induced seismicity, fracturing, subsidence, or ground heave if pressures become too high. Carbon dioxide may displace saline waters from underground pore space into sources of drinking water, causing them to become contaminated. Migration could also damage oil and gas resources.

The global risk is of CO₂ leakage to the atmosphere, raising greenhouse gas concentrations that contribute to global warming. Although there is a 15-40 percent energy penalty associated with capturing and compressing carbon dioxide at a power plant, leakage is very unlikely to contribute to greater climate change in a well-designed system. The loss of carbon credits alone will pressure project developers to ensure that carbon dioxide stays in planned underground reservoirs.

Improved scientific understanding of these risks and the practical experience from large demonstration projects will inform development of best practices, safety standards, and regulation that can reduce the likelihood of such risks and create public confidence in the technology. How such risks are perceived by the public and the resulting impact on CCS technology is discussed below.

PUBLIC PERCEPTION OF CCS

Studies from across the globe find that the vast majority of the public is not aware of carbon capture and sequestration, and even fewer understand the technology and its risks. There is good reason to be concerned over public perception of CCS; lack of information will prevent a balanced evaluation of its costs and benefits. It may also create exaggerated perceptions of risk which can delay or stop implementation of this new technology.

Research demonstrates that people are most concerned with unfamiliar technologies and those risks perceived to be out

of their control; capable of directly impacting their lives; or capable of catastrophic, uncertain, and irreversible damage. Risks associated with CCS contain many of these characteristics. Government regulation, education and outreach programs, and mitigation plans are some of the elements necessary to address these concerns in order to gain the public support necessary for full-scale deployment of CCS technologies.

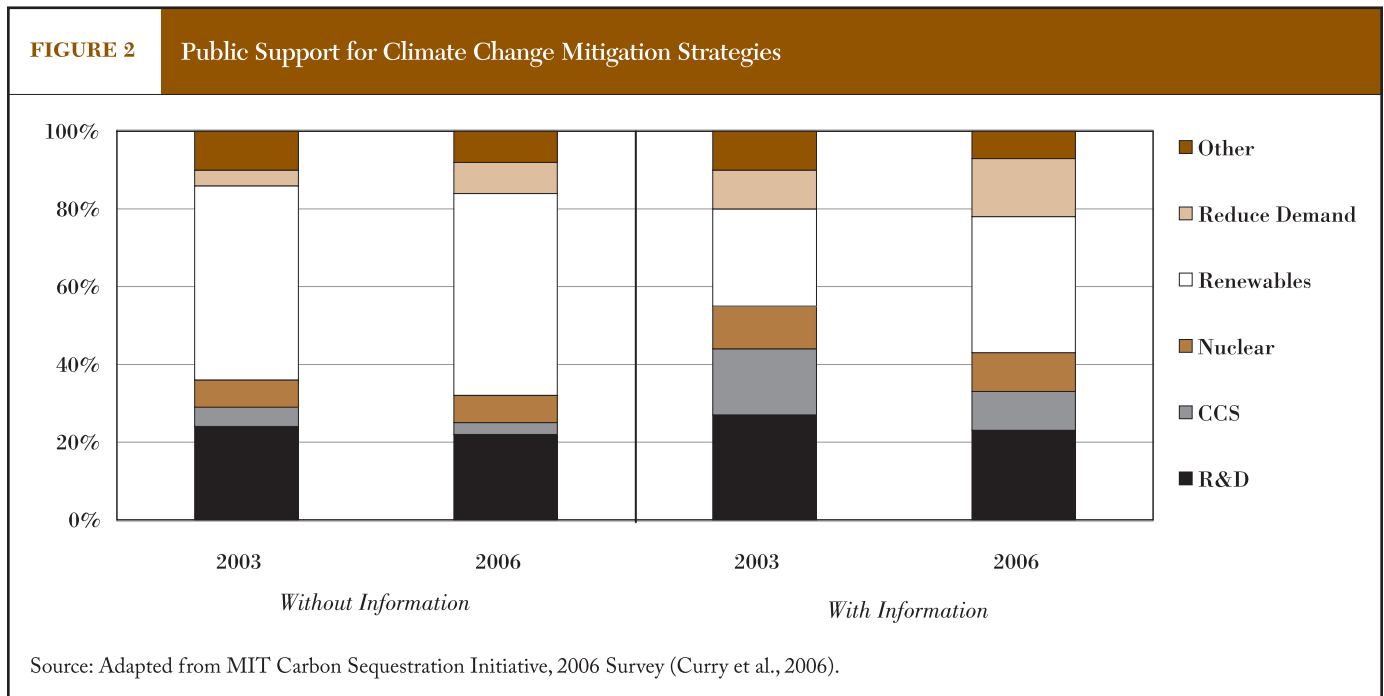
At least one recent study implies that public acceptability of CCS increases as a greater understanding is developed. A 2006 update of a survey done by the Massachusetts Institute of Technology indicates that public support for CCS as a tool to address the climate challenge is currently similar in scale to that for nuclear power (see Figure 2). Importantly, the survey also found that support for CCS compared to other options grew significantly after more detailed information was provided (Reiner, 2006).

Support for CCS is also linked to public attitudes about fossil fuel alternatives such as renewable energy, demand reduction, and efficiency measures. According to the MIT survey, support for these alternatives grew from 2003 to 2006, reducing the share of support for CCS over that time period mostly due to concerns that CCS will perpetuate fossil fuel use. Attitudes about fossil fuel use have shifted as awareness of the impacts on the local environment, climate, and national security has grown. Public support for CCS will depend on its relative role in a portfolio of greenhouse gas mitigation options. Importantly,

the public's concern that any support for CCS will result in a corresponding loss of support for renewable and efficiency measures—a zero-sum game—must be addressed.

Because public knowledge of CCS is limited, media portrayal of the technology will be important to the initial formation of public opinion. How the media compares different greenhouse gas mitigation options certainly influences how the public defines its own preferences. And how the media uses language, chooses to stress one set of concerns over another, and chooses sources of information characterizing CCS are important in shaping public attitudes. There has been a recent flurry of media interest as a result of the change in political climate and introduction of a number of global climate change bills that include CCS. A recent survey of newspaper articles related to CCS in the U.S. indicates that the media has remained neutral in its coverage so far (Mander, 2006). Media portrayal will play a key role in developing public opinion and ultimately in the success of CCS as a carbon mitigation option.

Non-governmental organization (NGO) perceptions of CCS are also important. NGOs are active communicators of environmental risk and strategies to mitigate those risks. The public often looks to them, rather than to industry or government, as a credible source for information about the environment. NGO opinions on CCS are varied. A number of groups have recently refined their position – several have moved toward qualified support of CCS, especially if it is part of a suite of



mitigation options including renewable energy development and energy efficiency measures. Others are waiting for more evidence that CCS is safe and that promoting these practices will not slow or block the emergence of more sustainable energy options.

EXAMPLES OF PUBLIC RESPONSE TO POTENTIAL CO₂ HAZARDS

Two specific examples offer insight into how the public might react to CCS: a natural CO₂ hazard and an experimental ocean sequestration project. The public's divergent reactions to these analogs illustrate both its capacity to coexist with CO₂ hazards as well as its ability to halt projects with which it is not comfortable.

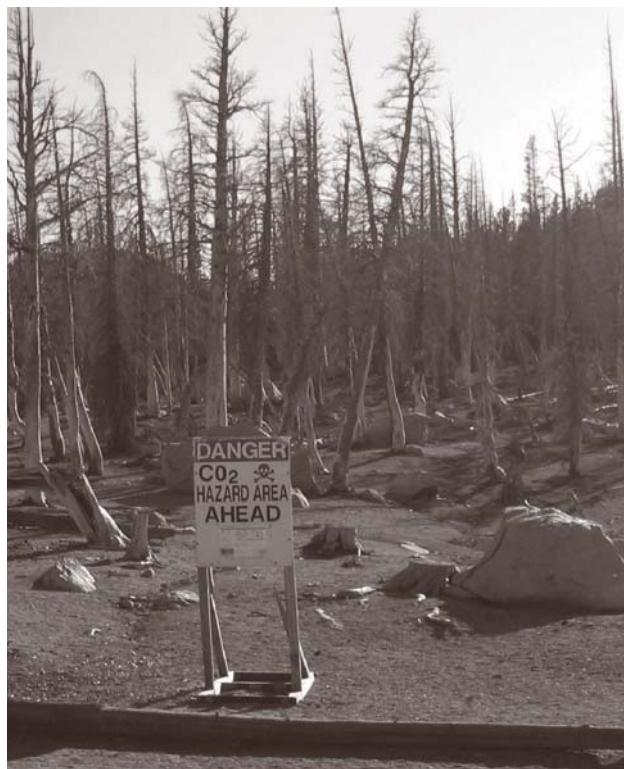
In Mammoth Lakes, California, a volcanic fissure has allowed CO₂ to slowly build up in the soil near the popular recreation site of Horseshoe Lake. About 150 acres of trees have died or suffered as a result. Warning signs are posted around key access points to the lake (see Figure 3), but the public takes the risks in stride and continues to use the area for hiking, fishing, boating, and picnicking. When risks are perceived to be small, natural, and manageable, the public seems to be more comfortable accepting them.

In contrast, the perceived magnitude and uncertainty of potential hazards from experimental ocean sequestration has created considerable public opposition to the technology. In 1998, the Natural Energy Laboratory of Hawaii Authority was to host an experiment to observe the behavior of CO₂ injected into the deep ocean off the coast of Kona. While scientific models offered predictions, scientists understood relatively little about environmental impacts of deep ocean injection.

Project developers decided to abandon the project due largely to strong public opposition. Without sufficient funding for an outreach effort, public opinion was informed primarily by environmental groups and media accounts that heightened concerns about impacts to the ocean ecology and fueled anti-fossil fuel and not-in-my-backyard sentiments. People felt excluded from the discussions and were not moved by public relations campaigns that aimed to convince, rather than consult. Failure to engage the public at the beginning contributed to distrust of the project and the larger process of injecting CO₂ into the deep ocean.

The proposed Kona injection demonstration illustrates why ocean sequestration has become a non-starter in the United States and elsewhere. In addition to significant scientific uncertainties about the technology, strong public opposition,

FIGURE 3 Effects of CO₂ Leakage from Natural Volcanic Activity in Mammoth Lakes, California



Horseshoe Lake. Photo Credit: Jeffrey Logan

driven by poor outreach efforts from the beginning, were responsible for halting the project. This case study shows that scientific uncertainty mixed with insufficient public outreach and participation can quickly fuel public opposition. (For a comprehensive discussion of the ocean sequestration issue in Hawaii, see de Figueiredo, 2003.)

COMMUNICATION STRATEGIES AND PUBLIC INVOLVEMENT

Because the majority of the population knows little about CCS, providing clear, timely, and unbiased information is a crucial aspect of developing public acceptance. It is not just the message that is important, but the messenger and the form of communication as well. A one-way communication strategy, such as simply informing the public about CCS, will be insufficient. Instead, an open dialogue among stakeholders built through a transparent feedback process is needed to foster mutual trust. The International Association for Public Participation has developed a guide for an effective public process (see Table 1). Clearly, there are limitations in applying the full range of options to CCS projects, especially in the

TABLE 1 Public Participation Spectrum

<i>Increasing level of public impact</i>					
	Inform	Consult	Involve	Collaborate	Empower
Public Participation Goal:	To provide the public with balanced and objective information.	To obtain public feedback on analysis, alternatives, and/or decisions.	To work directly with the public to ensure that concerns are understood and considered.	To partner with the public in each aspect of the decision making process.	To place final decision making in the hands of the public.
Promise to the Public:	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns are reflected in the alternatives developed.	We will look to you for direct advice and information in formulating solutions to the maximum extent possible.	We will implement what you decide.
Example Tools:	<ul style="list-style-type: none"> • Fact sheets • Web sites • Open houses 	<ul style="list-style-type: none"> • Public comment • Focus groups • Surveys • Public meetings 	<ul style="list-style-type: none"> • Workshops • Deliberate polling 	<ul style="list-style-type: none"> • Citizen advisory committee • Consensus building • Participatory decision making 	<ul style="list-style-type: none"> • Citizen juries • Ballots • Delegated decisions
Source: Adapted from International Association for Public Participation, 2006. Copyright IAP2. All rights reserved.					

early days; but as experience with CCS evolves to include a wider range of projects and participants, the methodology can be adapted more fully.

Most CCS outreach to date falls under the least participatory level: inform. With little public awareness of CCS as a carbon mitigation technology, using tools such as web sites and fact sheets are important aspects of the communication plan. However, a strategy focused on informing and building public support without conducting an interactive dialogue runs the risk of alienating the public by not appearing transparent.

There is less progress in the more sophisticated levels of the spectrum: involve, collaborate, and empower. Employing these strategies can build confidence by giving the public a share of the ownership of the resulting policy by seeking and incorporating their feedback into public policy. Incorporating such sophisticated strategies for CCS will require a higher level of cooperation among the participating government agencies and additional experience with large-scale demonstration projects to provide the public with successful examples.

Public engagement measures may appear to be an over-investment in local communities who often may welcome the benefits of CCS projects. Policymakers and project developers must recognize that a larger national community will be observing

carefully, especially in the early days of CCS. These careful outreach investments may therefore pay dividends in unforeseen “prevented opposition.”

Greater public outreach and participatory dialogue on CCS projects will have important benefits. First, information gained through stakeholder dialogues can improve the siting and monitoring practices by allowing industry to modify them in response to stakeholder needs and concerns. Public participation can also speed deployment by informing developers of a project’s viability early on, and thus avoid wasting resources on ill-fated projects. Finally, moving along the public participation spectrum to an interactive dialogue on CCS helps ensure long-term, sustainable public support by engendering confidence in the process as well as the technology.

While important for the planning and development of individual projects, public outreach at this level may not be enough to go beyond the affected community and engage the public as a whole. This will require involvement of larger regional and national stakeholder groups, NGOs, and elected officials, among others. These groups will be active in any public debate over the costs and benefits of deploying CCS as a carbon mitigation technology and the policies necessary to ensure it is safe and effective. A larger public debate about a future national

greenhouse gas mitigation framework will also help shape attitudes about CCS. As described in the following section, most U.S. government efforts to date have focused solely on project-level outreach, not on the broader policy issues.

U.S. PUBLIC OUTREACH EFFORTS

The U.S. Department of Energy currently supports 25 pilot projects focusing on capture, transport, and/or injection of CO₂ in North America. The Regional Carbon Sequestration Partnership oversees these small-scale (roughly 3,000-10,000 tons) field injection tests (Phase II) and will soon begin work on seven larger (500,000-1 million tons) projects (Phase III). The primary objective of this effort is to build understanding of the physical, commercial, and social challenges that CCS may face.

The regional partnerships have begun the enormous task of engaging local, state, and federal regulators as well as the general public and the private sector. To date, none of these pilot projects have been opposed, largely due to outreach programs that seek to actively engage the community in the initial stages, with the goal of understanding their concerns and developing mutually acceptable means of addressing them (NETL, 2004).

FutureGen is a separate \$1 billion dollar government/industry initiative to build the world's first hydrogen electricity plant with CCS. Construction of the 275 megawatt plant is to begin in 2009 and is expected to be operational by 2012. DOE conducted public scoping meetings at each of the four potential FutureGen project sites in 2006. These meetings afforded stakeholders an opportunity to express concerns.

Compared to the regional partnerships, however, FutureGen has been able to focus less on engaging and educating the general public about the risks of CCS due in part to a predominant focus on the significant financial benefits the project will bring to both the host community and state. While economics will be an important consideration in the CCS debate, it will not be enough to neutralize the wider public concern over physical and environmental risks that remain unaddressed.

Experience from the DOE pilot projects will inform development of CCS regulation and future outreach efforts, but the impact on the larger policy debate is likely to be minimal. The high profile of FutureGen, or any single project, has not translated into a deeper understanding of CCS in the affected communities nor among the general public. Success at the project-level must be incorporated into a larger regulatory

effort to manage the risks of CCS based on input from public participation. Familiarity with CCS technologies, vital to creating wider public acceptance, can only be established through development of more large-scale demonstration projects.

CAN REGULATION REDUCE UNCERTAINTY AND BUILD ACCEPTANCE?

Studies on public acceptability of CCS show that concerns derive primarily from uncertainty about the potential risks and the lack of a system to manage those risks. This is exacerbated by a lack of awareness and understanding of the technology, as well as insufficient engagement with the public on the development of a regulatory structure for CCS. One important way to address these issues is to develop a comprehensive regulatory structure to manage the risks of CCS and establish channels for the public to participate and develop confidence in the technology.

There is currently no comprehensive statutory framework for siting, monitoring, and long-term care of CCS projects. Pilot projects are being regulated by EPA on a case-by-case basis through the Underground Injection Control program, as well as through existing federal and state statutes and precedents for similar industrial operations. While the existing demonstration and commercial-scale CCS projects have operated successfully so far, these sites have been carefully characterized and project developers have chosen to implement best management practices. As demonstration projects increase in scale and eventually become commercial, so may the potential hazards.

Lessons learned through the demonstration projects should be incorporated into a more permanent and binding regulatory framework that will ensure future commercial projects are operated safely. Any regulatory framework must be flexible enough to allow changes based on information gathered from field experiments, especially the larger ones that will test underground formations under more realistic conditions. This must also include requirements for public outreach, both to the local community, and through engagement of the wider public, including larger stakeholder groups, environmental groups, elected officials, and the media, all of whom drive the larger policy debate about the use of CCS as a greenhouse gas mitigation option. Reform of existing outreach requirements in the National Environmental Policy Act (NEPA) is one potential step to ensure that federal demonstration projects incorporate more sophisticated levels of public participation.

SUMMARY

The enormity of the threat posed by climate change requires global, cooperative, and decisive action to mitigate greenhouse gas emissions. Carbon capture and sequestration could help us address the significant challenge of reducing emissions from coal-fired power plants. Much work remains to ensure that CCS is safe, economical, and has public support. A series of large-scale demonstration projects that test not only the physical integrity of CCS, but also inform the regulatory framework governing these practices, will help gain public confidence in the technology.

A safe, transparent, and robust regulatory framework is a necessary component of ensuring public acceptance of CCS, but it alone is not sufficient. How initial CCS efforts are communicated to the public and other stakeholders will greatly influence the acceptability and viability of CCS as a carbon mitigation strategy. Government, industry, researchers, and non-governmental organizations should cooperate to educate, involve, and collaborate with the public to determine if and how CCS can be utilized in a safe and responsible manner.

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ACKNOWLEDGMENTS

The authors are grateful to Mark de Figueiredo and Jennie Stephens for reviewing earlier drafts of this publication. We would also like to thank Jonathan Pershing, Rob Bradley, John Larsen, and Liz Marshall of WRI for their feedback.

The Climate and Energy Program at WRI gratefully acknowledges the Pew Charitable Trust, BP, and the Robertson Foundation for supporting this, and other climate-related work.

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This is the second in a series of WRI policy briefs on CO₂ capture and sequestration. These briefs are part of a larger project WRI is leading with diverse stakeholders to develop and build consensus on guidelines for CCS deployment. More information on this project is available at <http://carboncapture.wri.org>.

ISBN 978-1-56973-667-8