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The Environmental Injustice of "Clean Coal": Expanding the National Conversation on Carbon Capture and Storage Technology to Include an Analysis of Potential Environmental Justice Impacts

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ABSTRACT

Over the past decade, the coal industry has created a multi-million dollar public relations campaign to insulate coal from the green energy revolution and the anticipated public backlash against dirty and unsustainable fuels. This campaign, promoting "clean coal," has effectively shifted the national conversation on energy and climate change to situate coal as a viable clean energy source and the best option available to mitigate climate change. As the U.S. gets closer to passing national climate legislation and the deadline for achieving significant global reductions in carbon emissions draws near, opposition to the coal industry and its Clean Coal Campaign is organizing on a number of fronts. The environmental justice movement, through its leadership on climate justice, can serve as a centralizing force for these disparate advocacy efforts, bringing together students, scientists, policy advocates, community residents, and others engaged to fight clean coal and advance real green energy solutions. This article will look at the history of the Clean Coal Campaign and weigh the arguments for and against clean coal, focusing particularly on carbon capture and sequestration. It will then overview the advocacy efforts occurring across the U.S. to oppose coal and expose the fallacy of clean coal. Finally, it will defend the centralization of these efforts in an environmental justice-based climate justice movement that utilizes the varied resources, expertise and energy of the current advocacy efforts to stop coal and achieve a clean, green renewable energy economy.

INTRODUCTION

As the scientific understanding of climate change has improved, and U.S. policymakers have become more aware of the looming impacts of the global fossil fuel lifestyle, the national debate on sustainable energy options has captured the attention of the public. Much of this debate has been on what alternatives exist to shift America away from its fossil fuel dependence and the feasibility of these alternatives being implemented to scale in time to combat global climate change. While some sectors are attempting to shift the national energy options in new directions, much of the debate has been captured by the traditional fossil fuel industry, particularly the coal industry, which has a vested interest in maintaining its dominance over America's energy choices. The coal industry has jumped on the green bandwagon by promoting the concept of "clean coal," a theoretical model of coal production that would burn coal in a carbon-neutral way.

While the public relations and media campaigns promoting "clean coal" have pumped millions into the idea that "clean coal" is the only feasible alternative to our current coal use, the industry has failed to create a working model of the idea that can be implemented to scale in the timeline needed to address climate change. In fact, the industry has failed to put sufficient resources into the research and development necessary to establish "clean coal" as a viable energy alternative. In addition, even if "clean coal" was feasible and successful, it would not address the myriad cradle-to-grave public health, economic, and environmental impacts that coal has on communities throughout the world. Calling coal clean merely because its carbon emissions are captured ignores the extensive dirty impacts of coal use.

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Moving into the energy future, it is essential that a substantive dialogue on the reality of "clean coal" and the totality of coal's impacts be undertaken to counterbalance the millions being spent to promote this potential future technology. In addition, it is important to establish a clear public understanding of what "clean coal" means so that the nation can decide whether "clean coal" is worth investing our national resources in and gambling our global future on. This article attempts to assist that conversation by providing a broad overview of what "clean coal" means and what "clean coal" technology would entail. Finally, this article lays out the environmental justice critiques of "clean coal." It is imperative that any future energy resource be used in a way that reduces and mitigates its impacts on the most burdened and vulnerable communities. While this article does not purport to answer these concerns for the "clean coal" industry, it advances the conversation around clean coal by ensuring that those potential impacts are included in the national energy dialogue.

OVERVIEW OF "CLEAN COAL"

Defining "clean coal"

The term "clean coal" is used to refer to burning coal in a way that reduces emissions or otherwise lessens coal's environmental impact. "Clean coal" technology includes "washing" coal of minerals and other polluting components, gasification, and the treating of flue gases to lessen sulfur dioxide (SO_2), nitrogen oxide (NO_x), and mercury emissions. In the context of climate change, the term "clean coal" is used most frequently as shorthand for technology that burns coal more efficiently and/or decreases its CO_2 emissions.

Carbon capture and storage: background and methods

Carbon capture and storage (CCS) is a potential technology that would enable coal to be burned without emitting CO_2, eliminating the public health and environmental impacts created by CO_2 emissions. CCS has three parts: capture, transport, and storage of CO_2.

While there are three possible ways to capture carbon, none are economically and technologically viable. Precombustion capture, in which coal is converted into a gas before it is burned and the resulting CO_2 is removed, is efficient in terms of capture but costly to build, and is therefore not widely used.[1] Post-combustion capture, in which CO_2 is removed from plant emissions, is technologically possible but inefficient in terms of capture.[2] Finally, oxyfuel capture, in which coal is burned in pure oxygen, allows for efficient CO_2 removal but has yet to be operationalized at scale.[3]

Despite the multiple potential[4] forms of carbon capture, the necessary technology is not ready for wide scale adoption. Even the U.S. Department of Energy (DOE), a CCS proponent, admits that the technology is not yet cost effective.[5]

If CO_2 could be captured, it would then have to be transported, primarily via pipelines, to storage sites. While some pipelines are already in use in the United States,[6] many more would have to be constructed to transport CO_2 at the necessary scale—requiring a huge upfront investment.[7]

Finally, after transport, the captured CO_2 would have to be stored deep underground. Carbon storage is theoretically possible in depleted oil and gas reserves, unmineable coal seams, deep saline aquifers, oil reserves,[8]

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[1]Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage, Summary For Policymakers*, at 5 (2005), *available at* <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf> (pre-combustion technology is currently utilized in fertilizer manufacturing and hydrogen production).

[2]The Intergovernmental Panel on Climate Change (IPCC) report on CCS states that post-combustion capture is "economically feasible under specific conditions," meaning that the technology has been operationalized and is understood, and could be cost effective in the correct regulatory setting. However, it seems doubtful that such a regulatory regime will be adopted in enough time to effectively mitigate climate change. Post-combustion CO_2 capture is used in the natural gas processing industry. Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage, Summary For Policymakers*, at 5 (2005), <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf>.

[3]Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage, Summary For Policymakers*, at 5 (2005), *available at* <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf>.

[4]Working Group III of the Intergovernmental Panel on Climate Change, *Ibid*.

[5]U.S. Dep't of Energy, Carbon Capture Research (2007), <http://www.fossil.energy.gov/programs/sequestration/capture/index.html> (the DOE states that "existing capture technologies … are not cost-effective when considered in the context of sequestering CO2 from power plants").

[6]2,500 km of CO_2 pipelines currently exist in the United States, transporting 40MtCO_2/year. Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage, Summary For Policymakers*, at 5 (2005), *available at* <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf>.

[7]Emily Rochon et al., Greenpeace International, False Hope: Why Carbon Capture and Storage Won't Save the Climate 12 (2008), *available at* <http://www.greenpeace.org/usa/press-center/reports4/false-hope-why-carbon-capture> (citing P. Ragden et al., Federal Environmental Agency, Technologies for CO2 Capture and Storage, Summary, F.R.G. 18 (2006)).

[8]Storing CO_2 in oil reserves is called Enhanced Oil Recovery (EOR) because it supports oil flow by maintaining pressure. EOR thereby partially offsets the cost of CCS. U.S. Dep't of Energy, Carbon Capture Research (2007), <http://www.fossil.energy.gov/programs/sequestration/capture/index.html>. However, EOR's financial impact is questionable, because potential EOR projects are too limited in size and number to make a significant dent in CCS' substantial cost. Emily Rochon et al., Greenpeace International, False Hope: Why Carbon Capture and Storage Won't Save the Climate 14 (2008), *available at* <http://www.greenpeace.org/usa/press-center/reports4/false-hope-why-carbon-capture> (citing *Carbon Sequestration Technologies: Hearing Before the S. Subcomm. on Science, Technology, and Innovation, S. Comm. on Commerce, Science, and Transportatio*n, 110th Cong. (2007) (statement of Dr. Bryan Hannegan, Vice President, Environment Electric Power Research Institute)).

deep saline reservoirs, and ocean waters or seabeds.[9] Practically, however, many technological and economic barriers remain, limiting its utility as part of the necessary short-term carbon mitigation strategy. Again, the technology has yet to be demonstrated at scale.[10]

More importantly, the long-term nature of storage raises concerns about the feasibility of safe sequestration. Technology has yet to demonstrate that carbon could be safely stored for the centuries and millennia required. Even CCS proponents like the Intergovernmental Panel on Climate Change (IPCC) admit its limitations: the panel found that by 2050, only 30–60 percent of CO_2 emissions from electricity generation "*could* be technically suitable for capture."[11] This statistic is revealing: even in the IPCC's best case scenario, in which the plethora of remaining scientific questions are answered to the benefit of CCS development, only a mid-range of CO_2 emissions from the power sector will be eliminated. Putting all other concerns about coal and CCS aside, at best, the technology will be only one part of climate change mitigation. It is not a silver bullet.

THE DEFENSE OF "CLEAN COAL" AS A CLIMATE CHANGE MITIGATION STRATEGY

Despite the lack of science supporting industrial-scale CCS and its limited utility, the technology is still considered by many to be an important way of reducing CO_2 emissions. The primary reason for CCS' popularity—besides the strong push from coal lobbyists[12]—is coal's apparent low cost and its abundance.

Coal is has consistently been one of the cheapest energy sources available for the past two centuries. Coal is cheap because its price does not incorporate the totality of the resource's costs: from resource extraction, production and combustion. This artificially low price creates a competitive advantage over more expensive natural gas, oil, and renewable options, despite the many environmental and social costs of coal.

In addition to its low price, coal produces a large percentage of the world's power supply, and probably will continue to do so for the foreseeable future. Coal is particularly abundant in three key countries: the United States, China, and India.[13] The United States, for example, gets more than half its electricity from coal,[14] accounting for almost 40 percent of CO_2 emissions,[15] and a full 78 percent of China's electricity came from coal in 2006.[16] These national trends are reflected globally where coal use continues to expand exponentially each year. China alone builds the equivalent of two coal-fired plants every week, adding the electrical generation capacity of the U.K. each year.[17] These new coal-fired plants, accounting for the recent large increase in global CO_2 emissions,[18] increase the growing country's reliance on coal. India is projected to consume six percent more coal each year, meeting current U.S. usage rates by 2020.[19] The energy demand from modernizing countries like China and India is expected to continue growing unabated into the foreseeable future.

Proponents of "clean coal" argue that since coal is likely to remain a important source of electrical power for the foreseeable future and is also such a major contributor to climate change, investment in CCS research and development (R&D) is essential. They argue that even if the U.S. stops using coal, India and China will continue to use

[9]Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage, Summary For Policymakers*, at 3 (2005), *available at* <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf>.

[10]Matthew L. Wald, *The Energy Challenge: Mounting Costs Slow the Push for Clean Coal*, N.Y. Times, May 30, 2008, *available at* <http://www.nytimes.com/2008/05/30/business/30coal.html?scp=1&sq=22clean%20coal%22&st=cse>. The IPCC states that, under "specific conditions," storage in oil and gas fields and saline formations have been shown to be "economically feasible" by the oil and gas industry. Storage in coal beds has not been demonstrated. Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage, Summary For Policymakers*, at 6 (2005), *available at* <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf>.

[11]Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage, Summary For Policymakers*, at 9 (2005), *available at* <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf> (italics added).

[12]For example, in the first two quarters of 2008, the American Coalition for Clean Coal Electricity spent $4,650,759 on lobbying. Center for Responsive Politics, Alternate Energy Production & Services, <http://www.opensecrets.org/lobby/induscode.php?lname=E1500&year=2008>.

[13]The United States, China, Russia, and India have the largest proven coal reserves. British Petroleum, BP Statistical Review of World Energy, June 2008 32 (2008), *available at* <http://www.bp.com/sectiongenericarticle.do?categoryId=9023784&contentId=7044480>.

[14]U.S. Dep't of Energy, Coal (2007), <http://www.energy.gov/energysources/coal.htm>.

[15]Sierra Club, The Dirty Truth About Coal: Why Yesterday's Technology Should Not Be Part of Tomorrow's Energy Future 3 (2007), *available at* <http://www.sierraclub.org/coal/dirtytruth/report/> (citing U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2005* (2007)). The DOE states that 30 percent of carbon emissions come from power plants and other large point sources. U.S. Dep't of Energy (2007), Sequestration, <http://www.fossil.energy.gov/programs/sequestration/overview.html>.

[16]World Coal Institute, Coal Facts 2007, <http://www.worldcoal.org/pages/content/index.asp?PageID=188>.

[17]Massachusetts Institute of Technology, The Future of Coal: Options for a Carbon-Constrained World ix (2007), *available at* <http://web.mit.edu/coal/The_Future_of_Coal.pdf>.

[18]Massachusetts Institute of Technology, The Future of Coal: Options for a Carbon-Constrained World 63 (2007), *available at* <http://web.mit.edu/coal/The_Future_of_Coal.pdf>.

[19]Massachusetts Institute of Technology, The Future of Coal: Options for a Carbon-Constrained World 74 (2007), *available at* <http://web.mit.edu/coal/The_Future_of_Coal.pdf> (citing Planning Comm'n of Gov't of India, Draft Report of the Expert Committee On Integrated Energy Policy (2005), <http://planningcommission.nic.in/reports/genrep/intengpol.pdf>).

it to provide for their billions of citizens.[20] Ignoring the massive energy needs of China and India is unrealistic, CCS advocates maintain. It is more practical to help these countries use their coal as cleanly as possible instead of imposing unworkable requirements on them.

A sustainable energy future cannot ignore the need the developing world has for increased energy access. Yet, the energy dialogue cannot focus on these needs without also considering the public health, environmental, and economic impacts of our energy choices.

ENVIRONMENTAL JUSTICE CRITIQUES OF CCS

CCS perpetuates and could increase environmental injustices related to coal use

The term "clean coal" implies that we can keep consuming coal without suffering any detrimental consequences. The costs of the expected consequences of functional CCS belie this implication. There is no such thing as clean coal; burning coal always costs too much.

Advocates for CCS fail to acknowledge the social impact that coal has on communities located near its extraction, processing, and burning sites. These communities are still subject to the devastating impacts of coal, even when the carbon created by coal is captured and stored.

In fact, the total social and environmental impacts of coal use may *increase* with the use of CCS. Even if CCS eventually reduces carbon emissions from coal-burning plants, the long-term impacts of a shift to CCS technology could have unanticipated and far-reaching impacts on the environment that outweigh the benefits of short-term climate change mitigation. CCS technology is inherently more resource-intensive and expensive than conventional coal use. To work most efficiently, carbon capture needs to utilize pre-combustion technology because the CO_2 released from conventional coal-fired plants is very dilute. Pre-combustion gasification plants, however, consume 25 percent of the energy they produce, requiring that more coal be mined and burned to sell the same amount of energy.[21] Another 20 percent of the energy produced is typically consumed in compressing the CO_2 for storage.[22] CCS also uses 90 percent more fresh water than conventional coal-fired plants.[23] As a result of these inefficiencies, it has been estimated that the adoption of CCS as a primary component of climate change mitigation—as some argue it must be[24]—would require a 33 percent increase in resource consumption and would eliminate improvements in efficiency made in the last 50 years.[25]

Such an increase in coal consumption would negatively impact the communities and ecosystems where coal is mined. The environmental and human costs of coal mining and burning are numerous and well documented.[26] Briefly, they include the contamination of local air and water with pollutants (including mercury, NO_x, SO_2, and particulate matter), the violent destruction of areas containing coal through dynamiting, strip mining, and mountaintop removal, the health risks of black lung disease and mining itself,[27] and the release of methane, a greenhouse gas 20 times more powerful than CO_2. All these would increase with the adoption of CCS.

CCS storage creates unacceptable risks and potential new environmental injustices

CCS includes a multitude of unacceptable high risks beyond those typically associated with coal-fired power plants. These risks arise from the uncertainty and danger associated with long-term carbon storage and include the potential health impacts of abrupt CO_2 escape, contamination of water supplies, ecosystem destruction, and

[20]For example, the World Bank justified funding a huge conventional coal-fired plant in India because the country "faces power shortages that leave more than 400 million people without access to electricity, mainly in poor rural areas. The country needs to expand generation capacity by 160,000 megawatts over the next decade, and this new project helps address this gap." Quoted in Andrew C. Revkin, *Money for India's 'Ultra Mega' Coal Plants Approved*, N.Y. Times, Apr. 9, 2008, *available at* <http://dotearth.blogs.nytimes.com/2008/04/09/money-for-indias-ultra-mega-coal-plants-approved/>.

[21]Tim Flannery, The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth 252 (Atlantic Monthly Press 2005).

[22]Tim Flannery, The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth 253 (Atlantic Monthly Press 2005).

[23]Emily Rochon et al., Greenpeace International, False Hope: Why Carbon Capture and Storage Won't Save the Climate 6 (2008), *available at* <http://www.greenpeace.org/usa/press-center/reports4/false-hope-why-carbon-capture> (citing Erik Shuster et al., National Energy Technology Laboratories Estimating Freshwater Needs to Meet Future Thermoelectric Generation Requirements, DOE/NETL-400/2007/1304, at 60 (2007), *available at* <http://www.netl.doe.gov/.../coalpower/ewr/pubs/2007%20Water%20Needs%20Analysis%20-%20Final%20REVISED%205-8-08.pdf>.

[24]*See* National Resources Defense Fund, Climate Facts: Return Carbon to the Ground 2, *available at* <http://www.nrdc.org/globalwarming/coal/return.pdf> ("Long-term geological disposal of CO2 (for thousands of years) is viable now and must be implemented quickly if we are to meet the challenge of sharply reducing global emissions this century"); Massachusetts Institute of Technology, The Future of Coal: Options for a Carbon-Constrained World x (2007), *available at* <http://web.mit.edu/coal/The_Future_of_Coal.pdf> ("We conclude that CO2 capture and sequestration (CCS) is the critical enabling technology that would reduce CO2 emission significantly while also allowing coal to meet the world's pressing energy needs"). The National Resources Defense Fund received $437,500 from the Joyce Foundation to "promote alternative plants using coal gasification with carbon sequestration." The Joyce Foundation, <http://www.joycefdn.org/Programs/Environment/GrantDetails.aspx?grantId = 29414>.

[25]Emily Rochon et al., Greenpeace International, False Hope: Why Carbon Capture and Storage Won't Save the Climate 5 (2008), *available at* <http://www.greenpeace.org/usa/press-center/reports4/false-hope-why-carbon-capture> (citing P. Ragden et al., Federal Environmental Agency, Technologies for CO2 Capture and Storage, Summary, F.R.G. 24 (2006)).

[26]*See* Sierra Club, The Dirty Truth About Coal: Why Yesterday's Technology Should Not Be Part of Tomorrow's Energy Future 5–15 (2007), *available at* <http://www.sierraclub.org/coal/dirtytruth/report/>.

[27]Jeff Biggers, *'Clean' Coal? Don't Try to Shovel That*, Washington Post, Mar. 2, 2008, at B02, *available at* <http://www.washingtonpost.com/wp-dyn/content/article/2008/02/29/AR2008022903390.html>.

increased CO_2 emissions from leakage.[28] The environmental burden and potential public health calamity caused by carbon storage particularly concern environmental justice communities.

These are the communities that have historically borne the burden of housing energy facilities, waste sites, and other undesirable land uses and are likely to bear the burdens and risks of CO_2 storage if CCS is implemented. While geological constraints would play a part in determining storage sites, history indicates that waste disposal facilities are almost always located in or near communities of color and low-income communities. There is no reason to think that CCS facilities will be any different, as wealthier and more powerful communities are likely to organize to ensure CO_2 storage facilities are not located in their neighborhoods.

The risks associated with CO_2 storage are real: should CO_2 quickly leak from a storage site, it could asphyxiate residents located nearby. Instances of this event have occurred naturally, such as the 1986 disaster at Lake Nyos in Cameroon.[29] Additional public health impacts from CO_2 storage could also occur on a less dramatic scale. For example, surrounding communities would suffer if CO_2 contaminated local drinking water or storage required the destruction of the surrounding environment.

Beyond these real public health risks, potential CO_2 leakage would undermine the entire purpose of CCS plants. The leakage of CO_2 would contribute directly to the climate change CCS is supposed to protect against. Even such a small-scale escape of stored CO_2 might eliminate the gains in CO_2 emissions reductions from CCS.[30] Though the likelihood of such an escape is apparently small, [31] the lack of advanced technology on the subject (as discussed below) leaves this an open question.

CCS will require long-term storage monitoring and upkeep. This requirement both increases the cost of the technology and creates a potential environmental justice problem, as communities surrounding the sites located farthest from those who hold power may not have the power or knowledge to ensure proper monitoring and upkeep.

We simply do not—and cannot—understand the long-term consequences of CCS well enough to ensure that disastrous leakage does not occur.[32] These are unacceptable risks to impose on the communities that will inevitably be tapped to house CO_2 storage facilities, and unacceptable long-term risks to require future generations to inherit.

CONCLUSION

The American public seems eager to transition to a new, clean, renewable energy economy. This economy could mean more jobs, safer workplaces, cleaner environments, improved national public health, and even locally-distributed energy sources. It could, in short, be a transformation of our country and a renewed understanding of how energy use impacts and affects public health, the environment, and the economy. Most importantly, there is the opportunity to lift up those communities that have been the most traditionally burdened and underserved by our fossil fuel economy.

CCS fails to take advantage of any of these opportunities, hides business-as-usual behind the rhetoric of change and new technology, and locks us into a continued fossil fuel economy for the foreseeable future. For the communities located near the coal mines, beside the processing plants, and on the other side of the fence from coal-burning power plants, continued reliance on coal does not create an alternative energy future. Moreover, the promotion of "clean coal" as a sustainable energy option without consideration of the potential impacts of this technology on communities of color and low-income communities continues the practice of externalizing impacts of our energy use on the most vulnerable communities across the country.

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[28] Emily Rochon et al., Greenpeace International, False Hope: Why Carbon Capture and Storage Won't Save the Climate 7 (2008), *available at* <http://www.greenpeace.org/usa/press-center/reports4/false-hope-why-carbon-capture>.

[29] Over a few short hours one night, CO_2 bubbled up from the volcanic-crater lake, killing 1,700 people and thousands of animals in the town bordering the lake. Peter J. Baxter, M. Kapila, and D. Mfonfu, *Lake Nyos Disaster, Cameroon, 1986: the Medical Effects of Large Scale Emission of Carbon Dioxide?*, 298 Brit. Med. J. 1437 (1989), available at <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid = 1836556>. While there is this historical example, an MIT study states that the likelihood of a leak on the scale of the Lake Nyos disaster is "exceedingly small." Massachusetts Institute of Technology, The Future of Coal: Options for a Carbon-Constrained World 67 (2007), *available at* <http://web.mit.edu/coal/The_Future_of_Coal.pdf>.

[30] Emily Rochon et al., Greenpeace International, False Hope: Why Carbon Capture and Storage Won't Save the Climate 7 (2008), *available at* <http://www.greenpeace.org/usa/press-center/reports4/false-hope-why-carbon-capture> (citing Christian Azar, *Carbon Capture and Storage from Fossil Fuels and Biomass—Costs and Potential Role in Stabilizing the Atmosphere*, 74 Climactic Change 47–79 (2006)).

[31] The MIT study found that it is "very likely" that over 99 percent of stored CO_2 will remain below ground over 100 years, and "likely" that the same percentage will remain for 1,000 years. Massachusetts Institute of Technology, The Future of Coal: Options for a Carbon-Constrained World 44 (2007), *available at* <http://web.mit.edu/coal/The_Future_of_Coal.pdf> (Working Group III of the Intergovernmental Panel on Climate Change, *IPCC Special Report: Carbon Dioxide Capture and Storage* (2005), *available at* <http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf>).

[32] The MIT study indicates the limitations of current scientific knowledge: "[T]he state of science today cannot provide quantitative estimates of their likelihood," though the experience we do have indicates the risks are small. Massachusetts Institute of Technology, The Future of Coal: Options for a Carbon-Constrained World 50 (2007), *available at* <http://web.mit.edu/coal/The_Future_of_Coal.pdf>.