MEETING RECAP

GEOENGINEERING

Contemplating the Issues and the Need for Research

Government-University-Industry Research Roundtable
October 12-13, 2010 * Washington, D.C.

This meeting recap was prepared by National Academies staff as an informal record of issues discussed during public sessions of the October 12-13, 2010 meeting of the Government-University-Industry Research Roundtable (GUIRR). The document is for information purposes only and supplements the meeting agenda available online at www.nas.edu/guirr. It has not been reviewed and should not be cited or quoted, as the views expressed do not necessarily reflect the views of the National Academies or members of GUIRR.

Geoengineering may be defined as the deliberate large-scale modification of the earth's climate systems to counteract climate change, beyond traditional strategies to reduce emissions. It is a complex and controversial idea that is garnering increasing global attention and worry. Members of the Government-University-Industry Research Roundtable (GUIRR) were confronted with the risks, merits, and feasibility of various geoengineering schemes. The group discussed the need for R&D to better understand the options while also pondering some of the fundamental non-geophysical risks of method: namely governance, costs, stability, and evaluation measures. The conversation proved to be a means for government, university, and industry leaders to examine and better understand the issues, options, and ramifications of geoengineering before the nation is confronted with a true climate emergency.

The meeting opened with a working dinner held October 12, 2010. The invited keynote presenter, Honorable Bart Gordon, Member of the U.S. House of Representatives and Chairman of the House Committee on Science and Technology, was detained at the last minute by pressing business and thus asked the Staff Director for the committee's Energy and Environment Subcommittee, Christopher King, to deliver the keynote address in his stead.

Mr. King began by noting that Congressman Gordon prefers the term "climate engineering" to "geoengineering", as it more clearly describes the activity while also conveying the gravity of what is being talked about. He then expressed the Tennessee Congressman's views on the topic, which may be summarized with the following quote: "Climate engineering carries with it a tremendous range of uncertainties and possibilities, ethical and political concerns, and the potential for catastrophic environmental effects. Time is needed to research these technologies and to develop appropriate governance structures. We've started the conversation in Congress with the UK Parliament; I hope that appropriate research investments will follow. Healthy debate, clear action on emission reductions, and sound scientific research today will provide society with a solid foundation for the tough decision-making that climate change will demand in the future."

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The meeting continued the next day with an opening presentation by Ken Caldeira entitled: "What is Geoengineering? A Survey of the Proposed Options". Dr. Caldeira is an atmospheric scientist who works at the Carnegie Institution for Science's Department of Global Ecology. There is no commonly accepted definition for geoengineering, began Caldeira; rather, it is more of a "family of ideas" that typically include the following elements: intentional, large-scale, involves alteration of natural systems, novel or unfamiliar, and attempts to diminish climate change impacts. There are two distinct geoengineering approaches: *carbon dioxide removal* (CDR) and *solar radiation management* (SRM). CDR options address the root causes of the problem – excess CO_2 in the environment – and are less controversial in that the best options do not introduce new kinds of environmental risk or new governance issues. They are, however, slow and either expensive or not scalable.

SRM options, in contrast, act quickly and are inexpensive and scalable, but they don't address the root cause and they do introduce new kinds of risk and governance issues. Examples of both approaches were briefly described. Caldeira closed with comments about responsibility and the need for sound scientific research. Intervening in complex, large-scale systems, he noted, most assuredly results in unanticipated outcomes.

Next to present was Alan Robock, a professor in the School of Environmental and Biological Sciences at Rutgers University, who spoke about "Assessing the Implications of Large-Scale Climate Intervention." Dr. Robock began by mentioning two distinguished scientists (one a Nobel laureate in chemistry) who, despairing of prompt political response to global warming, suggested in 2006 that temporary geoengineering be tried as an emergency response. An uptick in public discussion about various earth-cooling schemes, particularly SRM, has followed – the positive possibilities as well as foreboding consequences. In 2008 Dr. Robock put forth a list of "20 reasons why geoengineering may be a bad idea." The list is composed of three categories: climate system response; unknowns; and political, ethical and moral issues. In the intervening years, he has carefully considered, researched, and revised his list and concludes today that 16 of his initial concerns remain valid, three are negligible, and one (effects on cirrus clouds as aerosols fall into the troposphere) is a question mark. However, he has identified four more concerns, suggesting that there are still at least 20 reasons why geoengineering is a bad idea. Robock closed by highlighting the United Nations Framework Convention on Climate Change of 1992, stating: "We now must include geoengineering in our pledge to 'prevent dangerous anthropogenic interference with the climate system.'"

Jamais Cascio, a Research Fellow with the Institute for the Future, followed with a presentation entitled "Hacking the Earth without Voiding the Warranty: The Dilemma of Geoengineering." He opened with a question: "What happens when big systems intersect?", then underscored the importance of thinking through the unexpected outcomes. He also posed a rule and its corollary:

Rule #1: Desperate people do desperate things.
Rule #1a: Definitions of "desperate" vary considerably.

The technical and scientific challenges are profound, he emphasized, but the ethical and political challenges are even greater. The challenges may be charted in a quadrant diagram, with climate impacts (rapid or slow) on one axis and geoengineering efforts (coordinated or independent) on the other, thus yielding four possible broad scenarios. Coordinated and slow ("orchestrated maneuvers", he called them) would be the most appealing scenario whereas rapid and independent ("mere anarchy") would be the most dangerous. Cascio concluded by proposing a checklist for climate engineering management that included a set of needs:

- Transparency
- International observation, management, control/ongoing advisory group
- Collaborative bottom-up group ("Eco-Scientists Without Borders")
- Clear mechanisms for resolving disputes (probably derived from Arms Control Treaties)
- Ban on non-state projects

Samuel Thernstrom took to the podium next, addressing "Geoengineering and Climate Policy: Risk, Knowledge, and Inertia." Mr. Thernstrom is Senior Policy Advisor for the Bipartisan Policy Center and Senior Climate Policy Advisor to the Clean Air Task Force. Thernstrom restated the issue: "Geoengineering is a radical concept supported by promising but limited analysis and evidence; a concept with profound implications, countless complexities, and enormous uncertainties." The various technologies and techniques, he noted, differ widely in terms of effectiveness, affordability, reliability, and risks, and our knowledge of even the most studied geoengineering techniques is very limited. He then posed the immediate policy question:
"Should the federal government embark upon a systematic, strategic effort to research these ideas and, if they seem sufficiently promising, develop the technologies themselves and, critically, the unique scientific, social, legal and political institutions that would be needed to deploy them?" Thernstrom's answer: Yes. He argued that climate policy needs to include a strategic program to research the full dimensions of geoengineering as an insurance policy to protect the world's population from the worst effects of global warming. Only research – compelled by what he called the "twin threats" (runaway global warming and the hazards of hasty geoengineering) – can reduce the risks and improve our understanding of geoengineering's potential capabilities. Throughout, Thernstrom emphasized that geoengineering is not an alternative to climate mitigation strategies.

Jane Long, Associate Director at Large for Lawrence Livermore National Laboratory, spoke also of the tension between urgency and caution in her presentation entitled "Coupling Research to Climate Strategy." Dr. Long focused attention on the social and governance implications of geoengineering and, more specifically, on the meaning of *intentionality*. Geoengineering is the intentional management of the globe, she stated, and if we're going to be intentional, we need to be strategic, choose carefully what to research, have meaningful rather than symbolic goals, align oversight with public values, and insist on transparency. Doing nothing, she noted, is also intentional. Society will want to take special measures to govern geoengineering research. "Both the Royal Society in the UK and the National Commission on Energy Policy in the U.S. have ongoing studies of geoengineering and both have recognized that the way we govern the research is just as important as what we govern." She concluded: "Although the governance requirements mean that getting started with geoengineering research will be very cumbersome, carefully governed research presents a very special opportunity to become more effective at managing our climate."

The Director of Natural Resources and Environment at the U.S. Government Accountability Office (GAO), Frank Rusco, followed with a presentation on "Governance and Multi-Agency Science Issues." In December 2009, Dr. Rusco and his team began work on a study for the Chairman of the U.S. House Science and Technology Committee to assess (1) the state of the science regarding geoengineering approaches and their effects, (2) federal involvement in geoengineering activities, and (3) the view of experts and federal officials about the extent to which federal laws and international agreements apply to geoengineering. In March 2010 Rusco testified before the congressional committee, acknowledging that:

- Substantial uncertainties remain regarding geoengineering approaches and their potential effects;
- Federal agencies have sponsored some research activities, but these activities are not part of a coordinated geoengineering research strategy; and
- Existing federal laws and international agreements could apply to certain geoengineering activities, but regulatory gaps remain.

[GAO-10-546T Climate Change; "Preliminary Observations on Geoengineering Science, Federal Efforts, and Governance Issues"].

Rusco informed GUIRR members that a follow-up report to Congress would be issued shortly and assert that federal agency research is not sufficiently coordinated or prioritized, but should be. He further noted that, in managing risk, we cannot be U.S.-centric. [See GAO-10-903, "A Coordinated Strategy Could Focus Federal Geoengineering Research and Inform Governance Efforts"].

Capping the discussion was a presentation by Denise Caruso, senior research scholar in the Department of Engineering and Public Policy at Carnegie Mellon University, on "Progress Under Uncertainty: How Collaboration Improves Risk Assessment for Complex Scientific Problems". She began by citing three categories of risk: that which is *perceived directly* (e.g., biking, driving, and texting while crossing a street), risk *perceived through science* (known but indirectly perceived; e.g., infectious disease, toxins), and *virtual risk* (unprecedented events, technological innovations). Geoengineering falls in the 'virtual risk' mix, along with genetic engineering, synthetic biology, and nanotechnology. All are interdisciplinary in nature, the data on interventions are ambiguous, systems are too complex to model effects of interventions, and there is great uncertainty. Progress under uncertainty, posited Caruso, "requires methods as interdisciplinary and challenging to the status quo as innovations they assess." The analytic-deliberative process can be deployed in cases of virtual risk, so it becomes more a matter of how and where to begin. Caruso provided suggestions. She closed with an observation: "Discomfort yields change. Ambiguity is unavoidable. Tolerance is key."

ABOUT GUIRR

MISSION

GUIRR's formal mission, revised in 1995, is "to convene senior-most representatives from government, universities, and industry to define and explore critical issues related to the national and global science and technology agenda that are of shared interest; to frame the next critical question stemming from current debate and analysis; and to incubate activities of on-going value to the stakeholders. This forum will be designed to facilitate candid dialogue among participants, to foster self-implementing activities, and, where appropriate, to carry awareness of consequences to the wider public."

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