COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

"Geoengineering III: Domestic and International Research Governance"

Thursday, March 18, 2010
12:00 pm
2318 Rayburn House Office Building

Purpose

On Thursday, March 18, 2010, the House Committee on Science and Technology will hold a hearing entitled "*Geoengineering III: Domestic and International Research Governance*." The purpose of this hearing is to explore the governance needs, both domestic and international, to initiate geoengineering research programs. Specifically, discussion will focus on governance to guide potential geoengineering research projects and which U.S. agencies and institutions have the capacity or authorities to conduct such research.

Witnesses

Panel I

- **The Honorable Phil Willis, MP** is the Chair of the Science and Technology Committee in the United Kingdom House of Commons.[1]

Panel II

- **Dr. Frank Rusco** is the Director of Natural Resources and Environment at the Government Accountability Office (GAO).
- **Dr. Scott Barrett** is the Lenfest Professor of Natural Resource Economics at the School of International and Public Affairs and the Earth Institute at Columbia University.
- **Dr. Jane Long** is the Deputy Principal Associate Director at Large and a Fellow for the Center for Global Strategic Research at Lawrence Livermore National Lab.
- **Dr. Granger Morgan** is the Department Head of Engineering and Public Policy and Lord Chair Professor in Engineering at Carnegie Mellon University.

Background

Geoengineering can be described as the deliberate large-scale modification of the earth's climate systems for the purposes of counteracting climate change. Geoengineering has recently gained

[1] *Chairman Willis will testify via satellite.*

recognition as a potential tool in our response to climate change. However, the science is new and largely untested and the international implications of research and demonstration are complex and often novel in nature. For these reasons, a pressing need for governance of geoengineering research has emerged. Geoengineering can be controversial because of the potential for environmental harm and adverse socio-political impacts, uncertainty regarding the effectiveness and cost of the technologies, the scale that may be needed to demonstrate the technology, and concern that the prospect of geoengineering may weaken current climate change mitigation efforts.[2] These issues highlight the potential barriers to research as well as the need for governance of these emerging technologies. Experts are calling for a governance model or set of models that will allow the field to develop in an adaptive manner that facilitates development and exploration of effective technologies that are environmentally and socially acceptable while being relevant for both domestic and international policy solutions.

There is broad consensus among geoengineering experts that expansive reductions in greenhouse gas emissions must be made to limit the effects of climate change. However, political inertia and trends in greenhouse gas emissions indicate that traditional mitigation efforts may not provide an adequate response to mitigate the effects of climate change.[3] Tools other than emissions reductions may be therefore needed. Proponents claim that geoengineering technologies, compared to traditional mitigation techniques, offer faster-acting, politically palatable, and cost-effective solutions. Only through research and testing can these assertions be validated or refuted. That said, greenhouse gas mitigation strategies alone may ultimately prove insufficient and the lead times that will be needed for sufficient geoengineering research, should it become necessary for deployment, may be years long.

Today's hearing is the third in a series of hearings that is intended to provide a forum for an open discussion of the merits and disadvantages of geoengineering research. These hearings are not intended to be an endorsement of geoengineering deployment.

<u>Collaboration with the U.K. Science and Technology Committee</u>

The U.S. and the U.K. Science and Technology committees have successfully built upon each other's efforts to advance the international and domestic dialogues on the need for international collaboration on regulation, oversight, environmental monitoring, and funding of geoengineering research. In April of 2009, Chairman Gordon met with the Science and Technology Committee[4] of the U.K. House of Commons, chaired by the Honorable Phil Willis, MP. The chairmen agreed that their committees should identify a subject for collaboration. The U.K. Committee had recently published a report, *Engineering, Turning Ideas into Reality*, recommending that the government develop a publicly-funded program of geoengineering research. Given the international implications of geoengineering research and the authorities and interests of each committee, geoengineering emerged as an appropriate subject for collaboration by the chairmen.

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[2] The Royal Society (2009). Geoengineering the Climate: Science, Governance and Uncertainty. Edited by J. Sheperd et al., New York.

[3] Lenton and Vaughan (2008). A review of climate geoengineering options. Tyndal Centre for Climate Change Research, UEA.

[4] *Formerly the U.K. Innovation, Universities, Science and Skills Committee.*

The chairmen coordinated the research and both committees have been in close communication throughout. The U.K. Committee established its terms of reference for its inquiry into the regulation of geoengineering, issued a call for evidence in November 2009, and is issuing a Committee report on the topic in March 2010. This report will be submitted as written testimony on behalf of Chairman Willis at today's hearing. The official agreement between the U.S. and U.K. committees, outlining the terms of work and collaborative agreement, will be included in the final hearing record.

In the first session of the 111th Congress the U.S. Science and Technology Committee began a formal inquiry into the potential for geoengineering to be a tool of last resort in a much broader program of climate change mitigation and adaptation strategies. To initiate this, Chairman Gordon requested information on geoengineering from the Government Accountability Office (GAO) on September 21, 2009. Dr. Frank Rusco, Director of Natural Resources and Environment at GAO will present the draft response to this request as his written testimony at today's hearing. The Committee formally introduced the topic of geoengineering research in Congress on November 5, 2009 with a Science and Technology Full Committee hearing, "*Geoengineering: Assessing the Implications of Large-Scale Climate Intervention.*" On February 4, 2010 the Energy and Environment Subcommittee held the second hearing in the series, "*Geoengineering II: The Scientific Basis and Engineering Challenges.*" Together with today's hearing, this series of hearings serves as the foundation for an inclusive and transparent dialogue on geoengineering at the Congressional level.

Definition of Geoengineering

Geoengineering technologies aim to intervene in the climate system through large-scale and deliberate modifications of the earth's energy balance in order to reduce temperatures and counteract the effects of climate change.[5] Most proposed geoengineering technologies fall into two categories: Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM).The objective of SRM methods is to reflect a portion of the sun's radiation back into space, thereby reducing the amount of solar radiation trapped in the earth's atmosphere and stabilizing its energy balance. CDR methods propose to reduce excess CO_2 concentrations by capturing, storing or consuming carbon directly from air, as compared to direct capture from power plant flue gas and storage as a gas. CDR proposals typically include such methods as carbon sequestration in biomass and soils, modified forestry management, ocean fertilization, modified ocean circulation, non-traditional carbon capture, sequestration, distribution of mined minerals over agricultural soils, among others.[6]

The above definition of geoengineering may need to be modified going forward to create a more productive discourse on our response to climate change. CDR technologies remove excess amounts of CO_2 from the air, thus presenting different hazards and risks than SRM technologies. In fact, many CDR technologies could be categorized with traditional carbon mitigation strategies, especially if they were undertaken at a small scale. For example, a mid-scale program for avoided reforestation does not carry the same risks as large-scale atmospheric sulfuric injections. In fact, such a program's risks and challenges may not be greatly divergent from some traditional carbon management proposals, such as carbon credits. CDR technologies may not

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[5] The Royal Society (2009).
[6] *See the draft CRS report (2010) that is attached to this charter for descriptions of CDR and SRM technologies.*

invoke the need for international governance instruments either. SRM approaches, on the other hand, call for the introduction of technologies into the environment; therefore, presenting novel challenges to governance and larger hurdles for basic research and risk assessment. Some experts suggest that the term "geoengineering" encompass fewer of the more benign technologies discussed above. Coming to a resolution on appropriate terminology for this field may be a key step to increasing public understanding of geoengineering and assist the field in moving forward.

Domestic Research

Although formal research in Federal agencies has been largely limited to a small number of National Science Foundation (NSF) grants to study closely-scoped issues related to geoengineering,[7] it is clear that a number of Federal agencies have jurisdiction over one or more areas imbedded in geoengineering research. It is as yet unclear how Federal geoengineering research programs could be organized or allocated among Federal research bodies, as well as how non-governmental research consortia might contribute. The location of existing expertise in pertinent scientific and engineering fields, and the ability to execute comprehensive plans for interdisciplinary, inter-agency coordination would be key considerations in structuring domestic research in this area. Furthermore, it should be recognized that many of the developments and research activities needed for a formal geoengineering research program are also desirable for non-geoengineering purposes, such as general climate science research.

The following are examples of how existing research capacities in Federal agencies could be engaged in geoengineering research from the basic science and engineering behind the technology, to quantifying its effectiveness, and to understanding the risk of such hazards as environmental impacts.

The National Science Foundation (NSF) supports basic foundational research that may assist in the identification of the most promising geoengineering technologies. The Biological and Environmental Research program (BER) at the Department of Energy's (DOE) Office of Science houses key expertise related to various elements of atmospheric and land-based geoengineering strategies. Satellite capabilities sited within the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) could help identify potential locations for land-based carbon management, inform atmospheric geoengineering approaches, and monitor large-scale land use changes. Climate modeling tools at NOAA, the Environmental Protection Agency (EPA) and DOE's Office of Science could potentially be used to monitor large-scale demonstration projects. Such resources could also be used in a basic research setting for reverse climate modeling activities to project the potential impacts of decreased solar radiation and atmospheric carbon levels. High-end computing capabilities within the Office of Science at DOE, e.g., facilities located at Oak Ridge National Lab, may be suited to provide such highly detailed climate projections.

For all CDR geoengineering strategies, a robust carbon accounting and verification program would be needed to ensure program effectiveness. Existing expertise in programs at EPA, the National Institute of Standards and Technology (NIST), and the Ameriflux and Atmospheric Radiation Measurement (ARM) programs within the BER program at DOE could contribute to

[7] For example, researchers at Rutgers University received a grant in 2008 to model stratospheric injections and sun shading.

such a program. In addition, monitoring and verification tools such as NOAA's Carbon Tracker and the Advanced Global Atmospheric Gases Experiment (AGAGE) at NASA could also be useful. More advanced and comprehensive tools may be needed, however.

More specifically, the Forest Service and National Resource Conservation Service at the Department of Agriculture (USDA), the United States Geological Survey (USGS) at the Department of Interior, and DOE's BER program could contribute expertise and management experience to land-based carbon reduction strategies such as afforestation, avoided deforestation, and biochar. NOAA's expertise in oceanography at offices such as the Geophysical Fluid Dynamics Laboratory (GFDL) could contribute to ocean fertilization research. DOE's Office of Fossil Energy (FE) and the National Energy Technology Laboratory (NETL) could leverage their capacity from such initiatives as FutureGen and the Clean Coal Power Initiative for air capture and non-traditional carbon sequestration research activities. And the Office of Basic Energy Sciences (BES) at DOE could inform the geological materials side of non-traditional carbon sequestration.

The U.S. State Department would coordinate activities and agreements with foreign ministries for some geoengineering technologies. State Department involvement would depend, as noted, upon which activities are determined to impede upon existing international agreements or be associated with trans-boundary impacts. In addition, the involvement of more cabinet-level departments and Federal agencies may be useful for effective development of geoengineering research given the potential for associated agricultural, economic, international security, and governance effects.

Criteria for Governance Development

Criteria to consider regarding the impacts of geoengineering technologies include: whether they are international or trans-boundary in scope; whether they dispense hazardous material into the environment or create hazardous conditions; and whether they directly intervene in the status of the ecosystem.

Governance needs for geoengineering research will likely differ based on the technology type, the stage of research, the target environment (e.g., the high seas, space, land, atmosphere), and where potential impacts may occur. As noted above, SRM and CDR technologies may have differing regulatory needs. CDR technologies that are similar in scope to most of those proposed today could be governed by existing U.S. laws and institutions. An exception to this would possibly be enhanced weathering in oceans and ocean fertilization techniques (both are CDR technologies), which may require international governance structures due to the potential for trans-boundary ecosystem impacts. SRM technologies, on the other hand, are more likely to require international governance for research. For example, two proposed SRM technologies, marine cloud whitening and atmospheric injections of sulfur particles would likely take place in an area governed by the international community, disperse trans-nationally, and have trans-national effects. Other SRM technologies such as land surface albedo modification may have lesser need for international governance.[8] Different governance needs will also become apparent as research develops from modeling, to assessments, and finally to field trials. Built-in flexibility

[8] *For example, the deployment of genetically engineered plants with increased albedo could invoke treaties such as the Convention on Biological Diversity of 1992.*

and feedback mechanisms throughout the research process will assist in the effective development and governance of these emerging technologies. Lastly, different environments for research and demonstration are likely to require different governance strategies. Activities that take place in or affect the high seas or space versus the lower atmosphere, terrestrial, and near-shore areas will fall under different jurisdictions with different legal authorities.

Governance Options

Possible options for governance are outlined below. Please refer to the attached draft Congressional Research Service (CRS) report[9] and The Royal Society's study[10] for further information.

No Regulation

Governments could fully refrain from all governance of geoengineering, allowing the field to develop at will under existing frameworks. Advocates of this approach see private efforts as the best avenue to pursue research and development. Advocates of the "no regulation" approach may see government involvement as a stamp of approval for potentially unfavorable technologies. It is important to note that this approach essentially results in an unregulated research environment for largely new and unproven technologies, whose impacts are uncertain and may be unevenly distributed, even from small demonstration projects.

International Treaties and Agreements

At this time, no international treaties or institutions exist with sufficient mandate to regulate the full suite of current geoengineering technologies.[11] Although no existing international agreements or treaties govern geoengineering research by name, existing institutions could theoretically be modified to incorporate this field. For example, the U.N. Framework Convention on Climate Change (UNFCCC) may serve as a potential governing body for geoengineering. Another suggestion is that the Intergovernmental Panel on Climate Change (IPCC) could establish a technical framework to determine where the research should be focused and what technologies are scientifically justified.

Treaties for geoengineering research governance may be inappropriate at this time as the field encompasses many emerging technologies. In such a situation, treaty discussions could lead to a moratorium on research because nations often negotiate based on what their capacity for research, development, deployment and assessment is today, which in most cases is limited. Proponents of a moratorium argue that the potential risks of these technologies are just too great. Alternatively, some suggest that a research moratorium would be ill-advised because it would prematurely inhibit the generation of scientific knowledge and fail to discourage potentially dangerous experimentation by less responsible parties. It could limit society's ability to gather the information necessary to make informed judgments about the feasibility or acceptability of the proposed technologies. A moratorium could also deter responsible parties while failing to dissuade potentially dangerous experimentation by less responsible parties.

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[9] CRS (2010).
[10] The Royal Society (2009).
[11] *See the draft CRS report (2010) that is attached to this charter for descriptions of CDR and SRM technologies.*

International Research Consortia

Given how little is understood about the scientific, technical, and social components of proposed geoengineering technologies, crafting appropriate governance through new or existing treaties may be difficult. International research consortia such as the World Climate Research Program (WCRP) could be used effectively to safely advance the science while building a community of responsible researchers. This would essentially provide a middle ground between the *no regulation* and *international treaty* options. Past experiences show that international research consortia (e.g., the Human Genome Project and the European Organization for Nuclear Research) can succeed at prioritizing research for emerging technologies, developing effective and objective assessment frameworks, providing independent oversight of evolving governance needs, and developing voluntary codes of practice to govern emerging technologies.

Conclusions

Some geoengineering technologies appear to be technically feasible; however, there is high uncertainty regarding their effectiveness, costs, environmental effects, and socio-political impacts. Appropriate governance structures that allow for an iterative exchange between continued public dialogue and further research are needed to determine if such technologies are both capable of producing desired results and socially acceptable. Climate change is a global problem that impacts people and ecosystems at the local scale. If traditional mitigation efforts are not effective on their own,[12] we will need alternatives at the ready. In the next decade the debate over geoengineering will intensify. Research will lead to increasingly plausible and economically feasible ways to alter with the environment. At the same time, political and social pressure will grow – both to put plans into action (whether multi- or unilaterally), and to limit the development of geoengineering research. These issues led the U.K. and U.S. Science and Technology committees to jointly consider the role for potential governance structures to guide research in the near term and to oversee potential demonstration projects in the long term.

[12] Lenton and Vaughan. (2008).