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Before the
Senate Committee on Energy and Natural Resources

April 20, 2010

Chairman Bingaman, Ranking Member Murkowski, and Members of the Committee, thank you for the opportunity to appear before you today to discuss the science, the economics, and the industrial development of carbon dioxide (CO_2) capture and storage, (commonly abbreviated to CCS). I consider it a great honor to be able to provide this committee with my perspective as a scientist and as an entrepreneur working in this field.

For context, I will provide you with a brief description of my activities related to this area. In 2008, I received my Ph.D. in Geoscience from Harvard University, where my doctoral research focused on the physics and chemistry of CO_2 in the subsurface as well as on a variety of chemical processes designed to convert CO_2 into stable carbonate minerals. Since then, I have been a research fellow at MIT, where I have continued to study the behavior of CO_2 that has been injected into the subsurface, and I have started a venture capital backed company that is working on several early stage CCS projects.

In my testimony, I will make five points regarding CCS. These five points support the central conclusion that without CCS, it will be extremely difficult make significant and affordable cuts in greenhouse gas emissions, while maintaining a secure and reliable supply of energy for the nation.

The first and most important point that I wish to make is that CCS is essential for addressing greenhouse gas emissions, while simultaneously maintaining a robust and affordable energy supply. America's coal and natural gas reserves contain nearly 4 times the energy content of Saudi Arabian oil; but, without the large-scale deployment of CCS, it is arithmetically ***impossible*** for us to use those reserves—neither the coal nor the natural gas, and certainly not both—for productive purposes, while simultaneously making significant cuts in our greenhouse gas emissions. Furthermore, the existing industrial infrastructure of CO_2 emitting facilities (e.g., power stations, refiners, chemical plants, etc.) represents well over $1Trillion of invested capital; but again, it is arithmetically ***impossible*** to make stated cuts in our CO_2 emissions without either dismantling the majority of that installed capital or by doing CCS.

Let me give an example to illustrate. The wind industry—which is doubtless a success story in the energy sector over the past decade—currently displaces approximately 50MT of CO_2 per year.[i] Retrofitting just six large coal power stations to capture 90% of their CO_2 would have the same impact. In short, CCS can enable both the productive use of America's prodigious energy reserves and the continued use of its CO_2 emitting infrastructure, while simultaneously decreasing our greenhouse gas emissions.

The second point is that the technology to do CCS is here ***today***. There is a persistent notion that the technology for doing CCS is still years away. That notion is false. Thanks to the portability of the technology from the multi-trillion dollar oil, gas, and chemical industries, we know how to separate CO_2 from mixed gas streams; we know how to move CO_2 in pipelines; and we know how to inject and store CO_2 safely in the proper geologic structures. Indeed, essentially every aspect of the CCS process is currently being performed at scale in some industrial process.

That is not to say that CCS will be easy; but it is to say that the project risks are not fundamentally technological. Rather, the primary project risks involve getting complicated systems integration correct and importantly, being able to secure finance for large scale CCS investments in an uncertain regulatory environment. Systems integration and complex engineering are great strengths of American industry; while coping with uncertain regulations can be done—but only at unnecessarily increased expense.

My third point is that *geology matters*. The importance of getting the geology right is an issue that I believe has not received proper attention to date. The geologic and geophysical communities—including oil & gas operators—have developed tremendous expertise in understanding the behavior of buoyant fluids in the sub-surface. From this expertise, we can make rigorous assessments of the sequestration capability of specific geologic formations. The sequestration capability of a given geologic formation depends on (1) the rate at which CO_2 can be safely injected into the formation and (2) the ability of the formation to safely confine the injected CO_2 to a well defined zone.

Safety remains a major concern of the American public with respect to CCS, and there are many places in which trying to store CO_2 would be a very bad idea; but there are also many locations where CO_2 can be safely and permanently stored. It is important for the viability of the industry that regulatory agencies establish processes to certify specific formations as sequestration fields. The Montana State legislature has done this very well by developing a unitization process by which the state's Board of Oil & Gas Conservation will certify candidate sequestration sites. In my opinion, state agencies such as that are well-equipped to handle this process and should be encouraged to do so.

My fourth point is that the CCS industry will only advance if all the relevant stakeholders are appropriately included in each project. Strong stakeholder opposition can and will kill any energy project. As such, it is crucial that existing owners of mineral rights as well as land owners be appropriately communicated with and compensated at an early development stage of any CO_2 storage project. I have significant experience working with such stakeholders on early stage CCS projects in several different communities. Through this experience, I have found that face-to-face discussion and honest negotiation have been very effective in getting the relevant stakeholders onboard. Indeed, with the appropriate groundwork, CCS has been broadly welcomed in these communities as an industry similar to oil & gas production or natural gas storage that is both safe as well as compatible with multiple land uses such as ranching, farming, and recreation. Furthermore, the geologic structures being targeted for CO_2 sequestration are often in the vicinity of existing oil & gas activities, but if managed properly, the CCS project can occur symbiotically with these activities.

My final point is that the major hurdle for moving CCS projects forward is the difficulty associated with financing large industrial projects in an uncertain regulatory environment. This committee can significantly accelerate the CCS industry by addressing CCS-specific legal items to minimize unnecessary risk, and—more importantly—by providing a set of financial incentives for early stage CCS projects. Senator Barrasso's bill reduces one item of risk by explicitly reinforcing, on public lands, the common-law precedent that storage space belongs to surface owners; and Senator Rockefeller's bill provides valuable startup funds for RD&D.

The key to jump starting the CCS industry, however, is the passage of a set of financial incentives for first mover projects. The US wind industry, for example, installed 1 MW in 1996 and over 10,000MW last year, and that growth has been driven almost entirely by a combination of state-level renewable portfolio standards and federal-level production tax credits. A similar set of incentives, such as the CO_2 storage tax credit proposed by Senator Rockefeller and others, would dramatically accelerate the rate of CCS adoption in the United States.

In conclusion, I would like to reiterate that given the appropriate geology, we have the technology as well as the industrial know how to do CCS today at power-plant scale. If, however, we fail to either provide the appropriate financial incentives for doing CCS, or if we fail to bring stakeholders on board with each CCS project, then the industry will not grow in the US. And, if the US CCS industry does not grow rapidly, then we will either be unable to make meaningful cuts in our CO_2 emissions, or we will be forced to dismantle our country's significant installed base of CO_2 emitting industrial facilities. Furthermore, we will be constrained from responsibly harnessing America's prodigious fossil fuel reserves.

Thank you, and I look forward to your questions.

[i] American Wind Energy Association, 2010.