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PLAINS CO_2 REDUCTION PARTNERSHIP

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Carbon Management and Global Warming

Carbon dioxide (CO_2) is a gas composed of one atom of carbon and two atoms of oxygen. CO_2 occurs naturally in the atmosphere, is essential to plant life and, as a greenhouse gas (GHG), helps create the greenhouse effect that keeps our planet livable. CO_2 is exhaled by humans and is used to put the bubbles in soft drinks, as a coolant (dry ice), and in fire extinguishers.

GHGs, including CO_2, trap a portion of the sun's energy in the Earth's atmosphere and make our planet warm enough to support life. Human (anthropogenic) activity, including the use of fossil fuel, generates a significant volume of GHGs like CO_2. There is concern that the anthropogenic GHG entering the atmosphere is causing increased warming and that this warming will affect climate on a global scale. CO_2 sequestration—the capture and long-term storage of CO_2—is one of several carbon management actions that helps to control anthropogenic CO_2 emissions to the atmosphere.

The PCOR Partnership

The PCOR Partnership, led by the University of North Dakota Energy & Environmental Research Center, is one of seven regional partnerships established by the U.S. Department of Energy National Energy Technology Laboratory to assess carbon sequestration opportunities that exist nationwide. The PCOR Partnership covers an area of over 1.4 million square miles in the central interior of North America and includes all or part of nine states and four Canadian provinces. The central interior of North America contains several seismically stable geologic basins that are ideal sinks for geologic CO_2 sequestration. These basins have been well characterized because of commercial oil and gas activities. The geologic characteristics of the oil and gas reservoirs offer significant opportunities for developing the expertise and infrastructure required to make geologic CO_2 sequestration a commercial reality while maintaining, and even enhancing, the regional economy.

The coal-fired electrical utilities in the region produce over 60% of the CO_2 emissions from stationary sources. With the distinct possibility of carbon management becoming more important in the future, industries that rely on fossil fuels are looking to CO_2 sequestration as a strategy for carbon management. Further, many of the region's oil fields could develop CO_2-based enhanced oil recovery (EOR) projects with the increased availability of CO_2. The PCOR Partnership has developed a regional vision for the widespread commercial development of CO_2 sequestration. The vision includes several key elements: 1) targeting tertiary EOR opportunities; 2) employing the existing oil and gas regulatory structure and agencies for oversight; 3) developing a protocol for the establishment of geologic sequestration units that is based on the standard oil field practice of unitization; 4) developing rigorous site selection criteria that will allow for the adoption of commercially viable measuring, monitoring, and verification (MMV) procedures; and 5) developing the information needed to monetize carbon credits to reduce the costs of industrial projects. The realization of this vision will result in the development of EOR-based opportunities, to be followed by non-resource-recovery-based sequestration when the EOR opportunities have been exhausted.

The PCOR Partnership Region

The variable nature of the sources and sinks reflects the geographic and socioeconomic diversity of the PCOR Partnership region. In the upper Mississippi River Valley and along the western shores of the Great Lakes, large coal-fired electrical generators power the manufacturing plants and breweries of St. Louis, Minneapolis–St. Paul, and Milwaukee. To the west, the prairies and badlands of the north-central U.S. and central Canada are home to coal-fired power plants, natural gas-processing plants, ethanol plants, and refineries that further fuel the industrial and domestic needs of cities throughout North America.

Geological formations deep beneath the surface of the region hold incredible potential to store CO_2. Oil fields already considered to be capable of sequestering CO_2 can be found in five states and all of the provinces of the region. Saline formations and coalfields exist in basins that, in some cases, extend unbroken over thousands of square miles. Many large sources in the region are proximally located to large-capacity sinks. In some cases, the infrastructure necessary for CO_2 sequestration is already largely in place. CO_2-based EOR and enhanced coalbed methane (ECBM) are value-added sequestration technologies that have the potential for future large-scale deployment in the region.

The economic viability of near-term sequestration will require a value-added component, and EOR and/or ECBM are likely to provide the needed impetus for large-scale injection of CO_2 into geologic formations. EOR and ECBM then become vehicles to help pay for the additional characterization and infrastructure required for future storage in nearby formations.

Bountiful oil fields in the PCOR Partnership region have a potential capacity to store over 10 billion tons of CO_2. The U.S. portion of the Williston Basin includes over 20 large oil fields that are suitable for large-scale CO_2-flood EOR operations. One of the PCOR Partnership's Phase III demonstration projects involves capturing CO_2 from a coal-fired power plant and transporting it via pipeline to an oil field in the U.S. portion of the Williston Basin, where it will be injected for simultaneous EOR and sequestration. It is anticipated that a minimum of 1 million tons of CO_2 will be injected annually through this effort.

CO_2 EOR and Sequestration – The Case for Policies That Facilitate Collaboration

Events currently unfolding at national and state levels have strong implications with regard to the pace of deployment of technologies and strategies to reduce CO_2 emissions. CO_2 sequestration policies are under rapid development. This factor, along with an urgency of implementing emission reductions because of heightened public awareness, shows we are at a critical policy juncture with respect to carbon management.

One serious concern has to do with any policy that might marginalize EOR as a sequestration tool. The emission reduction potential and sequestration associated with EOR is immense, and revenues from oil produced will offset the cost to the economy and will, ultimately, accelerate more widespread deployment. With the growing energy concerns in the United States, the contributions of CO_2 EOR in the advancement of carbon capture and sequestration need to be placed front-and-center in the policy debate.

The Case for CO_2 EOR

EOR involves injecting substances into a reservoir through thermal, chemical, and gas-miscible processes. One example of a gas-miscible process is that of a CO_2 flood. CO_2 is injected into an oil reservoir via pipeline whereupon it expands and thereby pushes additional oil into production. EOR can recover an average of 35% of the remaining oil; some of the injected CO_2 returns with the recovered oil and can then be reinjected into the reservoir to minimize operating costs while maximizing economical and environmental benefits.

The era of CO_2 EOR effectively began with two large-scale floods in west Texas 35 years ago. The industry has grown since then to become a major factor in the industry in Texas, Wyoming, New Mexico, and Mississippi and produces over 90 million barrels of oil a year for the U.S. economy. The chief limiting factor of growth in other areas with oil properties has been a ready source of CO_2.

Industry estimates from the Permian Basin region of west Texas and New Mexico suggest 6 to 7 mcf of CO_2 is permanently stored per barrel of oil recovered. Since over a billion barrels have been recovered there, that represents 6 to 7 tcf (340–400 gigatons) of stored CO_2.

So what does all of this mean for CO_2 sequestration? First, an existing industry has evolved that possesses the operational practices to handle large volumes of CO_2 safely and effectively. The industry's best practices can be extended into the field of CO_2 sequestration with almost seamless ease. Surface CO_2 handling (including gas processing, compression, and transportation), well designs, injection practices, and surveillance of emplaced CO_2 are all directly applicable. Assurance of long-term storage is the key feature that needs to be demonstrated.

Second, the EOR industry is seriously constrained by availability of CO_2. With coal plants and other industrial facilities seeking to find a home for their CO_2, it becomes only a matter of economics, CO_2 capture technology improvements, and mutual trust to develop joint ventures between these two industries that are so critical to America's future.

Third, the domestically produced oil from EOR has been the sole revenue stream to fund EOR projects—from the source of CO_2, to the pipelines, to move it to the injection site, to produce the oil. Should EOR qualify as sequestration, the oil revenue will act as a critical resource to offset the huge infrastructure costs that, otherwise, will need to be funded by the public through higher energy costs. Storing the CO_2 and funding the infrastructure from the additional oil recovery would occur at the same time that important barrels of domestic oil contribute to U.S. energy security.

Fourth, CO_2-based EOR is important in that it extends the life of existing oil fields. Up to an additional 30 years of life can be gained by CO_2-based EOR. This reduces the need to develop new fields and greatly enhances our domestic oil supply, while sustaining vital revenue streams to state and local governments from the attendant tax collections.

Barriers

Just as in nature with deep-sourced, natural CO_2, there are low-risk sites that will permanently entrap CO_2, and there are places where it may migrate, perhaps even to the surface. CO_2 is a naturally occurring substance, and movement within the subsurface is very common. Rather than trying to fashion rules that protect against surface escape in all subsurface conditions, regulatory oversight needs to recognize the ubiquitous presence of the molecule while identifying low-risk sites for entrapment and provide flexibility in regulation to accommodate the attendant risk level.

The CO_2 EOR experience within the oil and gas industry can provide pathways to successful sequestration on a very large scale. The oil and gas industry can provide the tools of exploration, the science and experience to assess risks of site permanency and, most importantly, the tools and techniques to design and construct the wells for emplacement.

One of the largest potential barriers to deployment of sequestration projects would be the specification of overly complex well design and monitoring of sites. Experience shows that exotic well designs add little benefit, while, on the other hand, judicious site selection adds greatly to the security of emplacement. For example, subsurface sequestration formations overlain by bedded salts provide optimal conditions for long-term storage. The focus of regulation should be performance criteria, not design criteria.

The need for managing and mitigating any risks that may arise from the long-term custody of the emplaced CO_2 is also a critical item. The Interstate Oil and Gas Compact Commission has developed guidelines that are based on current practice for handling long-term liability in the oil and gas industry. The financial assurances provided therein seem to be the most viable solution to long-term custody issues and any potential liabilities that may arise.

EOR and Sequestration: Separate Paths?

Recent policy actions seem to be charting separate paths for CO_2 EOR and sequestration. For reasons stated earlier, recognizing EOR as a CO_2 storage event is critical. Advancements in using coal in such a way as to capture and sequester the by-product CO_2 are important steps for America's energy future. Disqualifying CO_2 stored during EOR as an offset to emissions will do nothing but delay the necessary commercial demonstrations of those technologies and further burden an already-stressed energy infrastructure. One example of an action working against this progress is setting up separate well design requirements for sequestration as compared to the proven designs currently used in CO_2 EOR.

Conclusions

Industry participation in the ongoing policy debates about CO_2 injection projects is critical. Special contributions are needed in categorizing appropriate sequestration sites, well design requirements, and CO_2 emplacement surveillance and monitoring. Regulations need to be developed in the context of a robust industrial knowledge base for carbon management issues. In most cases, existing oil and gas regulations can be applied with little or no modification to ensure that CO_2 sequestration is a safe and practical method for carbon management. The need for managing and mitigating any risks that may arise associated with the long-term custody of the emplaced CO_2 is also very important, and a Petroleum Insurance Fund-type approach may be an effective solution to any attendant issues related to excursions from the sequestration site. It is critical that EOR activities not be precluded or discounted as CO_2 sequestration opportunities.