STATEMENT OF RONALD T. EVANS BEFORE THE HOUSE SUBCOMMITTEE ON ENERGY AND MINERAL RESOURCES
JUNE 12, 2008

Denbury Resources, Inc., ("Denbury") appreciates this opportunity to share with Members of the House Subcommittee on Energy and Mineral Resources its experience with enhanced oil recovery using carbon dioxide or "CO_2 EOR." CO_2 EOR presents significant opportunities to reduce the nation's dependence on foreign energy sources while simultaneously helping to reduce industrial emissions. With the right policies in place, many billions of barrels of oil are accessible on the Gulf Coast and around the United States and millions of tons of CO_2 can be sequestered through CO_2 EOR. However, some impediments exists – primarily tax and economic – to capturing and transporting CO_2 on a broader scale in order to inject it and produce these significant volumes of domestic oil.

As Senior Vice President, Reservoir Engineering, for Denbury, I oversee all reservoir engineering, land functions and acquisition activities; am responsible for securing and contracting sources of anthropogenic CO_2; and coordinate our government relations. Denbury is currently the largest oil producer in the State of Mississippi and one of the largest injectors of carbon dioxide in terms of volume in the United States. Denbury's primary business focus is enhanced oil recovery utilizing CO_2. At the present time we operate ten (10) active CO_2 enhanced oil projects, nine in the State of Mississippi and one in the State of Louisiana.

Denbury also owns the largest natural deposit of CO_2 east of the Mississippi River, called Jackson Dome in central Mississippi, which we extract and transport through approximately 350 miles of dedicated CO_2 pipelines for use in EOR. Denbury is currently in the process of designing or constructing an additional 375 miles of CO_2 pipelines in order to expand our operations into additional fields throughout the Gulf Coast of the United States. The Subcommittee may also be interested to know that Denbury is working with the federal Department of Energy and various research universities on several Phase II and Phase III demonstration projects in the Regional Carbon Sequestration Partnership Program. Finally, while our business model focuses primarily on the transportation and sequestration aspects of carbon capture and sequestration ("CCS"), we are also very familiar with the capture component both in terms of (1) the compression demands of transportation and sequestration and (2) our enhanced oil operations, which capture and recycle large volumes of CO_2 in order to recover additional volumes of oil. Given this background, Denbury is pleased to share with you its expertise in CO_2 EOR and its views on policy implications for the nation's energy security and efforts to reduce industrial emissions.

A thorough understanding of both (1) the physical processes by which CO_2 is obtained, transported and injected for purposes of EOR, and (2) the economics that underlie existing and future EOR-related use of CO_2 is essential to any consideration of potential policy issues. The costs associated with capturing and transporting CO_2, whether in the context of EOR or otherwise, are significant and varying and – perhaps the single largest obstacle to developing carbon capture and transportation infrastructure beyond the limited, discrete projects currently in operation. From Denbury's perspective, it is critical that any contemplated state or federal legislation or regulation not increase these costs and impede private sector development of the infrastructure necessary to meet the demands of our energy hungry and potentially carbon-constrained world.

I. Capture / Compression

The starting point for any CO_2 EOR project is to produce or capture the CO_2. Denbury currently obtains all of its CO_2 from its natural deposit at Jackson Dome. Certain existing and some evolving technologies allow CO_2 emitted from various manufacturing processes to be captured. The combustion or gasification of hydrocarbon-based fuels such as coal, petcoke or other hydrocarbons produces particularly large volumes of CO_2 at varying levels of quality and purity. As new capture-inclusive projects are constructed, Denbury plans to acquire thousands of metric tons of CO_2 each day for use in EOR.

Aside from the threshold questions of how to properly classify CO_2 and whether and to what extent to restrict emissions, from Denbury's perspective, the capture of CO_2 presents no significant policy issues. Rather, the capture component presents a significant economic issue: First, existing capture technology is expensive. The byproduct of hydrocarbon combustion or gasification is a stream of gases and other impurities that contains various quantities of CO_2. In order for CO_2 to be usable in EOR it must be injected in a relatively pure form. Similarly, CO_2 injected into deep saline reservoirs must be in a relatively pure form to maximize the storage space available to be filled with CO_2. Thus, a significant component of the capture cost is the cost to separate and purify the CO_2 to be injected. The lower the percentage of CO_2 in the stream of gases, and the greater the amount of impurities in the stream, the greater the cost of capture. Second, most technologies capture the CO_2 at a lower pressure than is required to either enter a typical CO_2 pipeline or to inject into a deep saline reservoir or EOR project. The costs of the compressors and the power necessary to drive them are significant -- approximately $7.50/ton of the estimated $20/ton total cost[1] for CO_2 that is transported moderate distances. Therefore, the compression costs associated with CO_2 capture are slightly more than one-third (33%) of the total CCS cost for the least expensive sources of anthropogenic (man-made) CO_2. Additional compression costs are incurred to maintain pressure in pipelines and again when CO_2 is pressured up to a sufficient level for EOR reservoir injection. In summary, without some means of reducing the cost of captured anthropogenic CO_2 significantly, infrastructure development will likely remain stagnant.

To address this issue, last year the Finance Committee approved a tax credit for the capture and sequestration of CO_2 of $10.00/ton in connection with EOR and $20/ton for non-EOR projects for up to 75,000,000 tons sequestered. From Denbury's perspective, this would be sufficient to incentivize construction of additional pipelines from emission sites to geologic sequestration sites in connection with EOR activities. Unfortunately, this provision was not included in the energy legislation ultimately signed into law in December. We hope that Congress will address the issue of CCS costs in 2008, especially those associated with capture and compression, and note that proposed projects from gasification through to sequestration have the potential to create hundreds and perhaps thousands of jobs across the country.

---

[1] Total costs of CCS varies substantially by source of CO_2 - to upwards of $70/ton - and even across proposed gasification projects because of variances in each process. This figure represents an estimate of the lowest-cost industrial-sourced CO_2.

II. Transportation

The most economical way to transport CO_2 is through pipelines at pressures in excess of 1100 psi so that the CO_2 is transported as a supercritical fluid (dense phase). At pressures in excess of 1100 psi and temperatures common for CO_2 pipelines, CO_2 is a supercritical fluid which means that the CO_2 has properties of both a liquid and a gas. Larger volumes of CO_2 can be transported through CO_2 pipelines in this dense phase than can be transported as a gas. Given the pressure requirements to maintain CO_2 in the dense phase, CO_2 pipelines are generally operated at pressures greater than 2,000 psi. This pressure is well in excess of the average operating pressure of a natural gas pipeline, though the material used to manufacture both types is the same.

At the present time there exist over 3,500 miles of dedicated CO_2 pipelines, most of which have been transporting CO_2 for over 20 years -- and some for over 30 years. (see Attachment No. 1) However, this is just a fraction of the pipeline network that exists for oil and natural gas and covers very limited geographic areas. The vast majority of CO_2 pipelines transport natural CO_2 from natural underground CO_2 production sources that are owned and operated by the CO_2 pipeline owner -- generally for use in enhanced recovery projects also owned and operated by the CO_2 pipeline owner. In cases where the owner of the CO_2 pipeline has CO_2 production volumes in excess of its own EOR requirements, the excess CO_2 volumes are sold to EOR operators in other projects or to industrial gas suppliers. This limited number of regional CO_2 shippers and consumers stands in marked contrast to the numerous and geographically widespread producers and consumers of oil and natural gas products. As with the development of the extensive network of natural gas, oil and hydrocarbon products pipelines, CO_2 pipelines should also be given room to grow by state and federal regulatory authorities

The construction and installation of CO_2 pipelines is a capital intensive effort, the costs of which have increased in recent years for a variety of reasons, including rising steel prices, construction costs and energy prices. By way of example, Denbury's 93 mile, 20 inch Freestate pipeline (see Attachment No. 2) completed in 2006 cost approximately $30,000 per inch-mile, resulting in an effective transportation rate of approximately $3.50/ton at full capacity. The initial 37 mile segment of Denbury's 24 inch Delta pipeline was completed in 2007 at a cost of approximately $55,000 per inch-mile. We estimate that our planned 314 mile, 24 inch Green Pipeline that will run from Donaldsonville, Louisiana to Hastings field in southeast Texas will cost approximately, $100,000 per inch-mile resulting in an effective transportation rate of approximately $7/ton at full capacity. While the length (pumping stations to maintain adequate pressure add an additional $1 to $2 per ton to transportation costs), route obstacles and type of terrain all added to the estimated cost of the Green pipeline, the fact remains that such endeavors, even under the best of circumstances are extremely costly and take years of careful planning.

III. Taxation

Today, a substantial portion of all CO_2, natural gas, oil and products pipelines in the U.S. are owned and operated by companies that are organized as Publicly Traded Partnerships commonly referred to as Master Limited Partnerships ("MLPs"), which through their lower cost of capital have been an important financing source for building these assets. Section 7704 of the tax code permits MLPs to be taxed so that income and tax liabilities are passed through to the partners, even though the MLPs are large public entities, provided 90 percent or more of the MLP's gross income is derived from certain qualifying activities. These activities include exploration, development, processing and transportation of natural resources, including pipelines transporting gas, oil, or products thereof (see Sec. 7704(d)(1)(E)). While this provision covers the processing and pipelining of "natural" CO_2, it is unclear whether it covers anthropogenic CO_2. Because of this uncertainty, much of the existing CO_2 pipeline capacity (that owned by MLPs) cannot currently be used to transport anthropogenic CO_2 from emissions sites -- at least not without significantly higher tax costs than other pipeline assets in the industry.

Last year, as part of its energy tax package, the Senate Finance Committee adopted a modification to include industrial source CO_2 in the definition of qualifying income (see Sec. 817 of the Energy Enhancement and Investment Act of 2007, June 19, 2007). However, Congress ultimately failed to include that package of provisions in the Energy Independence and Security Act of 2007 (P.L. 110-140). Without this modification of the tax code, a substantial portion of the pipeline industry will most likely not contribute capital to the construction of the CO_2 pipeline infrastructure necessary to facilitate CCS through transportation of anthropogenic CO_2. We strongly urge Members of the Energy and Mineral Resources Subcommittee to work with their colleagues on the Ways and Means Committee and their counterparts in the Senate to accomplish this important clarification.

IV. CO_2 EOR - Injection / Sequestration

Approximately half of the oil that has ever been discovered will remain in the reservoir following primary and secondary production operations. In the proper environment, enhanced oil recovery utilizing CO_2 has the ability to recover up to an additional 25% of the original oil in place or half of the remaining oil in place following primary and secondary operations. Enhanced oil recovery utilizing CO_2 requires multiple injection wells throughout a unitized field or reservoir. CO_2 injection wells are permitted and approved by each State's division or department of Underground Injection Control utilizing the standards and policies issued by the EPA. CO_2 injection wells utilized in tertiary oil recovery (a.k.a. EOR) are permitted and approved as Class II Injection wells. Such wells have been in existence for over 30 years. We believe existing laws and regulations provide sufficient protection of the fresh water and ground water reservoirs from the injection of CO_2 in EOR operations or, for that matter, in deep saline reservoirs.

At the present time, CO_2 injections for the purposes of CO_2 EOR total approximately 2 billion cubic feet per day (Bcf/d) in three regions of the country, West Texas, Mississippi and Wyoming. Several other oil producing regions of the country could and would benefit from CO_2 EOR. Unfortunately, these other areas do not have naturally occurring CO_2 supplies. We estimate that if naturally occurring CO_2 were available in all oil producing regions in the country, CO_2 EOR could inject upwards of five or six times the current amount of CO_2 being injected. To put this in perspective, this additional CO_2 volume is equivalent to approximately 40 typical gasification projects (200 MMcf/d per project).

The amount of CO_2 injected in CO_2 EOR projects varies by oil producing area and project design. Although each project is different, the range of CO_2 injected to produce a barrel of oil is four to twelve thousand cubic feet (Mcf). In order to produce oil through CO_2 EOR, the injected CO_2 must physically contact the oil remaining in the reservoir. Oil remaining in the reservoir after secondary recovery operations cannot be recovered or produced unless the oil is physically altered. CO_2 dissolves into the oil causing the oil to swell, the viscosity to reduce and the surface tension (force holding the oil to the rock) to reduce, allowing the oil to become mobile. Due to reservoir heterogeneities and existing well spacing some oil is not contacted and thus these characteristics of each CO_2 EOR project are the limiting factor to recovering a greater percentage of the remaining oil. Further, CO_2 EOR, while applicable to a fairly wide range of reservoirs and oil gravities, is not applicable to all. Generally, in order to keep the CO_2 in the dense phase, a reservoir pressure in excess of 1,100 psi must be achieved, thus CO_2 EOR is generally conducted in reservoirs below 3,000 feet. In our opinion, CO_2 EOR is the most efficient tertiary recovery technology available today for reservoirs in which CO_2 EOR is applicable.

At the present time Denbury is injecting approximately 550 million cubic feet per day (MMcf/d) of CO_2 into its current CO_2 EOR projects and is planning on initiating injections into three additional CO_2 EOR projects in the near future which will increase our total injections to approximately 800 MMcf/d. Denbury has allocated essentially 100% of its proven CO_2 reserves to current and future projects that we own or have the option to purchase. Therefore we have been negotiating and contracting for anthropogenic volumes of CO_2 from proposed gasification projects and other existing anthropogenic CO_2 sources. We have signed three CO_2 purchase contracts to date totaling almost 800 MMcf/d of anthropogenic CO_2. These contracted volumes of anthropogenic $CO_{2,}$ and others in negotiation, are necessary for Denbury to expand its CO_2 EOR operations to additional fields. These contracts also contain CO_2 pricing provisions that are tied to the price of oil, so as oil prices increase, the price paid for the anthropogenic CO_2 increases. These contracted CO_2 prices may or may not be sufficient to cover the CO_2 capture and compression costs depending on several variables including (existing and future) capture and compression costs, the price of oil, the CO_2 source, and the distance from the source to the CO_2 EOR project.

V. Conclusion

The U.S. economy will continue to require massive amounts of energy well into the future. We believe the country needs to use all of its resources to meet this demand. Given current environmental conditions, there is also a desire to sequester significant volumes of CO_2 from industrial sources. CO_2 EOR's ability to address both of these realities make it uniquely well-suited to play an important role in America's energy and environmental future. For this to happen, the federal government should help address the significant costs of capturing and transporting CO_2 as discussed above. The most important step Congress can take at present is to amend Section 7704(d)(1)(E) of the tax code to make clear that transportation of anthropogenic CO_2 is included. This will allow a significant number of industry participants to lead the way in developing the infrastructure necessary for a carbon constrained, energy dependent world. By providing necessary mechanisms to foster CO_2 EOR (whether on federal or privately owned land), and allowing states to continue to oversee its development, the U.S. can realize significant increases in domestic oil production and benefit from reduced industrial emissions.

Just as we believe the country needs to draw upon all of its vast resources to meet our energy requirements, we recognize that many different avenues must be explored and researched to exponentially reduce emissions. The EOR industry's experience with using CO_2 and its knowledge of oil reservoir geology should greatly facilitate the commencement of significant CO_2 sequestration today versus some distant time in the future. The substantial body of knowledge and expertise with CO_2 EOR that exists is why we believe it will be the primary method of sequestering CO_2 in the near term, while research is completed on additional technologies and geological formations. CO_2 EOR is not the sole answer to America's energy or environmental challenges. However, it can be a key part of solving this complex puzzle.

Attachment No. 1

U.S. CO_2 Pipeline Map

Attachment No. 2

Denbury's CO_2 Pipelines