Testimony of William Roby
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Chairman Costa, members of the Energy and Mineral Resources Subcommittee and other guests, my name is William Roby. I am Vice President of Worldwide Engineering and Technical Services of Occidental Oil and Gas Corporation. I greatly appreciate the opportunity to speak today regarding both Occidental's use of carbon dioxide to enhance the recovery of oil and associated gas in the United States and some of the emerging policy issues related to enhanced oil recovery. These issues are of great importance to the Nation, particularly as demand grows and we seek ways to increase domestic production of oil and natural gas in this country while reducing the concentration of carbon dioxide in the atmosphere.

By way of background, Occidental Oil and Gas Corporation is a Los Angeles-based oil and gas exploration and production company with operations in the United States, the Middle East, North Africa and Latin America. Sixty-three percent of Occidental's 2007 production occurred in the United States, primarily in the states of California, Texas, New Mexico, and Kansas. Seventy-five percent of our proven reserves are located in the United States.

Before I discuss Occidental's experience with enhanced oil recovery using carbon dioxide or CO2, I want to briefly explain what I mean when I use the term "enhanced oil recovery." Enhanced oil recovery, or EOR, is a generic term for techniques that increase the amount of oil extracted from a reservoir beyond primary and secondary recovery methods. Primary recovery refers to production where the hydrocarbons in the reservoir flow into the well due to the natural pressure in the reservoir. Secondary recovery refers to production where the hydrocarbons flow into the well because pressure in the reservoir is increased by injecting fluids, such as water or hydrocarbon gas, typically already found in the reservoir. Lastly, enhanced oil recovery refers to production from injecting

materials not normally found in the reservoir such as steam, CO2 in large quantities, or other chemicals. These techniques are designed to increase reservoir pressure, reduce the oil's viscosity or alter oil's properties that cause it to be trapped in small pore spaces in the rock, thus improving oil's ability to flow through the reservoir and improve extraction.

Enhanced oil recovery techniques have substantial economic and environmental benefits. They can increase production from an oil reservoir by an additional 10% to 50% of the oil originally contained in the reservoir. As a result, oil that traditionally would have been left in place contributes directly to our domestic supply. Recovering more oil from existing fields with EOR uses far fewer resources than simply abandoning older fields and installing new infrastructure, such as roads, pipelines and equipment, for primary production in new locations. In addition to these benefits from all EOR techniques, EOR using carbon dioxide flooding is a commercially viable method for reducing greenhouse gas emissions by reusing and storing CO2 underground that would otherwise be emitted from industrial or power generation facilities to the atmosphere.

Carbon dioxide has been used for over thirty years in the Permian Basin in West Texas and New Mexico to enhance oil recovery. Since that time, Occidental has become the largest user of CO2 injection for EOR in the world, and CO2 flooding is our most commonly used EOR technique in the Permian Basin. By using this technique, along with other new technologies, we have been able to substantially increase the productivity and lengthen the life of existing oil fields. Through the use of CO2 flooding and other EOR techniques, the fields that Occidental operates in the Permian Basin will produce over one billion barrels of oil more than would have been produced without this technology. Our experience has been that CO2 flooding has increased the ultimate oil recovery from the fields where we employ it by an average of nearly 25 percent. We now operate approximately 8,700 wells in 28 EOR projects in Texas and New Mexico utilizing CO2 to increase oil production. We have nearly 3,700 CO2 injection wells that

support 5,000 production wells, and we inject approximately 1.4 billion cubic feet of CO2 each day or 500 billion cubic feet per year in the Permian Basin alone.

Using CO2 to enhance the recovery of oil is technically challenging and costly. Some oil formations are not amenable to carbon dioxide injection, depending on the geologic structure, permeability and homogeneity of the formation. For those fields where CO2 injection is feasible, such as in the Permian Basin, we incur costs both to purchase or produce CO2 and to acquire, operate and maintain the necessary above-ground processing equipment. Projects are capital intensive because they require extensive infrastructure to transport, compress, capture and recycle CO2; operating costs, such as for additional electricity needs, are also high; and oil production response sometimes takes many months to occur. These costs add significantly to our total cost to produce a barrel of oil. We estimate that using CO2 enhanced recovery at our Permian Basin operations increases the cost of recovering a barrel of oil by more than 50% over typical primary and secondary recovery operations.

Notwithstanding the cost, based on our experience in the Permian Basin, we believe the use of carbon dioxide to increase oil recovery is an extremely important technology for meeting our national energy needs, and Occidental encourages Congress to develop policies and incentives for increasing the use of this technology. Enhanced oil recovery using CO2 has helped increase supplies from some of the Nation's most prolific fields. National policies and incentives to promote the use of carbon dioxide injection could significantly increase proven reserves of oil and gas in the United States. Increasing domestic reserves has many additional benefits, including extending the life and recoverable reserves of aging reservoirs, increasing tax and royalty revenues for the public, increasing employment opportunities to operate the fields, and providing greater domestic supplies of energy, all of which could, perhaps, reduce or forestall speculative exploration in undeveloped areas.

The Committee has specifically asked for suggestions on how to foster further use of carbon dioxide enhanced oil recovery technology and to strengthen our domestic oil supply by removing impediments to the expansion of this technology. Since CO2 EOR is a costly business proposition, these projects require robust long-term economics to incentivize the producers to undertake the risk. We have the following suggestions on ways to foster further use of this technology:

1. Investment incentives: - we suggest you consider providing incentives such as investment credits, and accelerated depreciation of the project's capital cost, including infrastructure required to transport and inject carbon dioxide.

2. Royalty rates – we suggest that the government consider providing declining royalty rates on federal leases where CO2 EOR is used.

3. Legal issues – legal areas that warrant clarification include: 1) confirming subsurface pore-space as part of the mineral estate, 2) predictable and defined rights and obligations relating to subsurface pore-space ownership, 3) the ability to easily modify historic field unit agreements to accommodate EOR operations, including potential unitization issues raised by the sequestration of CO2, and 4) clear expectations regarding the disposition and abandonment of EOR wells and fields, including oilfield carbon dioxide sequestration sites. However, we believe the current regulatory provisions and permitting regimes for conventional CO2 EOR operations work very well and provide thorough oversight by the regulators and opportunity for public input.

In addition to these recommendations, I now want to discuss the role that CO2 EOR technology can play in controlling greenhouse gas emissions. In particular, one of the benefits of injecting carbon dioxide for enhanced oil recovery is the ability to store significant volumes of carbon dioxide in the reservoir both during and after oil and gas production. In typical EOR operations, approximately one third to one-half of the carbon dioxide initially injected becomes trapped in the reservoir. The rest is recycled from oil producing wells as a valuable commodity and reinjected. CO2 is not vented to the atmosphere. Additional trapping of carbon dioxide occurs with each subsequent injection

cycle so that, eventually, nearly all of the initial CO2 volume becomes stored in the formation and more CO2 must be procured to maintain oil production rates. As I mentioned earlier, Occidental currently injects approximately 500 billion cubic feet of CO2 per year. Of this 300 billion cubic feet is recycled CO2 from producing wells, and the other 200 billion cubic feet -- approximately 40% of the injected CO2 -- is newly supplied to the floods to make-up for the quantity stored through the CO2 flooding process. To put this in context, each year the amount of CO2 that Occidental injects is equivalent to the emissions from ten 150-megawatt coal-fired power plants.

Occidental has 30 plus years of history using naturally occurring carbon dioxide, which we produce from underground reservoirs or buy from other producers as a commodity. However, we could just as easily use carbon dioxide captured from emissions of electric utilities, refineries and other large sources - if it were available at competitive prices in the Permian Basin or at other fields suitable for CO2 flooding. We believe the key challenges to using man-made carbon dioxide in EOR operations are the cost of the technology to capture carbon dioxide from industrial and power generation sources and the cost of building the infrastructure to transport the carbon dioxide to an injection site and compress it to a higher pressure that allows it to be injected into an oil reservoir for enhanced recovery.

Additional incentives and policies would be useful to expedite building carbon dioxide pipelines and to offset the cost of adding equipment to capture and compress emissions containing carbon dioxide. Also, since natural CO2 supplies are not available near most oil fields that are amenable to CO2 flooding, consideration should be given to developing policies and incentives that encourage locating new industrial operations and power generation with large carbon dioxide emissions near such oil and gas reservoirs. The utilization of these man-made CO2 sources would enable more widespread application of CO2 EOR to increase domestic oil supplies.

Many organizations are now looking at the underground storage of carbon dioxide, which is also known as geological storage or sequestration, as an approach to controlling greenhouse gas emissions. Occidental sees mutual benefit from the use of carbon dioxide for enhanced oil recovery and the storage of carbon dioxide as a way to control greenhouse gas emissions. The 2005 special report sponsored by the Intergovernmental Panel on Climate Change on carbon dioxide capture and storage strongly endorsed the idea and said that EOR technology can provide a substantial technical head start on proving the concept of geologic storage of carbon dioxide at commercial scale. Occidental concurs.

Occidental also believes that industry experience using CO2 for enhanced oil recovery provides technical information and demonstrated results for long-term CO2 sequestration. In fact, this technology we are using is the gateway to future large scale carbon sequestration operations. The industry's 30-year history of using CO2 for EOR provides evidence that CO2 can be managed safely and should allay concerns about long-term storage of CO2 in oil and gas reservoirs as well as other geologic formations.

Occidental believes that, while storing man-made carbon dioxide in oil and gas reservoirs and other underground formations is not the only option for reducing greenhouse gas emissions, it is an important, commercially viable option that can be rapidly implemented to accomplish this objective, particularly because it carries with it the substantial additional benefit of increasing domestic oil and gas production.

Thank you for the opportunity to speak today and share Occidental's experience using carbon dioxide to enhance and increase oil and gas production in the United States, as well as our ideas for creating policies and incentives to increase its use and expedite development of a national infrastructure to capture, transport, inject, recycle and store underground carbon dioxide that has traditionally been emitted to the atmosphere.