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Hearing on Prospects for Advanced Coal Technologies: Efficient Energy Production, Carbon Capture and Sequestration
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Chairman Lampson, Ranking Member Inglis, thank you for inviting me to testify here today on carbon capture and sequestration. I am Gardiner Hill, Director of CCS Technology at BP, and a petroleum and civil engineer by training.

For those of you who don't know, BP has made a commitment to investing $8 billion over the next 10 years in alternative energy—including wind, solar, and fossil-fuel powered power plants with carbon capture and sequestration (CCS). We have announced 2 projects using CCS—one in Scotland, the other at our Carson refinery in California.

BP, and the oil and gas industry generally, has more than thirty years of experience injecting carbon dioxide in oil and gas reservoirs. We do so every day for enhanced oil recovery—injecting CO_2 into depleted oil reservoirs, recovering the remaining oil, and inevitably leaving CO_2 behind. In other words, CO_2 storage is a technology that is available today and we know that it has the potential to play a significant role in helping to reduce CO_2 emissions into the atmosphere, helping to combat climate change.

My role today is to explain how CO_2 stays underground. It is important to understand that many natural geological stores of CO_2 have been discovered underground—often by people looking for oil and gas. In many cases, the CO_2 has been trapped underground for millions of years in geological traps, plus CO_2 is also found indigenous in many oil and gas fields, where is has been stored underground naturally for millions of years. It is true that under certain circumstances, CO_2 does leak naturally from underground. Indeed the world's natural carbonated mineral waters, long prized and bottled for drinking, come from natural CO_2 sources. The reasons why some rock formations trap the CO_2 permanently and some do not are well understood and this understanding will be used to select and manage storage sites to minimize the change of leakage.

The best rocks for CO_2 storage are depleted oil and gas fields and deep saline formations. These are layers of porous rock, such as sandstone, more than half a mile underground, located underneath a layer of impermeable rock, or cap-rock, which acts as a seal. In the case of oil and gas fields, it was this cap-rock that trapped the oil and gas underground for millions of years.

Depleted oil and gas fields are the best places to start storing CO_2 because their geology is well known, and they are proven traps.

Deep saline formations are rocks with pore spaces that are filled with very salty water—much saltier than seawater. They exist in most regions of the world and appear to have a very large capacity for CO_2 storage. However, the geology of saline formations is currently less well understood than that of oil and gas fields and so more work needs to be done to understand which formations will be best suited to CO_2 storage, but the potential appears to be huge!

So why does CO_2 stay underground? As CO_2 is pumped deep underground it is compressed by the higher pressures and becomes essentially a liquid, which then becomes trapped in the pore spaces between the grains of rock. The longer the CO_2 remains underground, the more securely it is stored. There are four different ways that CO_2 gets trapped underground.

The first mechanism is called structural storage. This can be best demonstrated by BP's joint venture with Sonatrach called In Salah, which is a natural gas development in Central Algeria. At In Salah, the natural gas produced from the deep rock formations is a mixture of methane (CH4) and CO_2. Once it reaches the surface, the natural gas is separated into methane and CO_2. The Methane gas is pumped North to Europe, while the CO_2 is pumped deep underground—back into the rock formations from which the natural gas was originally extracted. 1 million tons per year of captured CO_2 is injected and stored in this way. When it is pumped deep underground, it is initially more buoyant than water and will rise up through the porous rocks until it reaches the top of the formation where it is trapped by an impermeable layer of cap-rock, such as shale at the In Salah field. The cap-rock that kept the natural gas in the rock formation for millions of years keeps the liquid CO_2 stored in the underground reservoir. The wells that were drilled to place the CO_2 in storage can be sealed with plugs made of steel and cement.

The second mechanism is where CO_2 gets trapped in the rock pore space through what is known as residual trapping. In this instance, the reservoir rock acts like a tight, rigid sponge. When liquid CO_2 is pumped into a rock formation, much of it becomes stuck within the pore spaces of the rock and does not move.

The third mechanism is called dissolution storage. In this instance, CO_2 dissolves in salty water, just like sugar dissolves in tea. The water with CO_2 dissolved in it is then heavier than the water around it and so it sinks to the bottom of the rock, trapping the CO_2 indefinitely.

And finally, the fourth mechanism is when CO_2 dissolves in salt water, becoming weakly acidic and reacting with the minerals in the surrounding rocks, forming new minerals as a coating on the rock—much like shellfish use calcium and carbon from seawater to form their shells. This process effectively binds the CO_2 to the rocks, trapping it there.

We have the technology and the knowledge to get started on storing carbon underground. BP, in partnership with Edison Mission, has announced a CCS project at our Carson refinery in Southern California. We will be taking petcoke, a refinery byproduct, and gasifying it. The resulting hydrogen will be used to power a 500 megawatt power plant, and the CO_2 will be stored underground, probably via an Enhanced Oil Recovery process (EOR), which is the mechanism I outlined at the start of the testimony in which industry has over 30 years experience.. We know that CCS is part of the solution to the climate change problem, i.e. ref IPCC special report and Princeton Wedges analysis, etc.—estimates are that CCS technology has the capability to contribute around a quarter of the emission reductions needed to get to environmental stabilization. We have the technological know-how to do this, we need the policy and regulatory framework to enable its deployment.

Thank you and I welcome any questions you may have.