ENHANCED OIL RECOVERY

Enhanced oil recovery (EOR) involves carbon dioxide (CO_2) injection into depleted oil fields to increase reservoir pressure and oil fluidity, enabling oil to escape from rock pores and flow more easily toward production wells to increase oil field production. Any CO_2 that comes to the surface with the recovered oil is captured and recycled and at the end of the enhanced oil recovery period, all injected and recycled CO_2 is stored permanently underground *(IEA 2010)*.

Approximately 80% of the world's CO_2 injection occurs in the Permian Basin of Texas and New Mexico, making the region the largest commercial market for CO_2. In the Texas Gulf Coast alone, the Texas Bureau of Economic Geology has estimated that an additional 3.8 billion barrels of oil recovery could be achieved through CO_2-EOR which is almost twice the entire annual domestic oil production of the United States at this time *(Duncan 2009)*.

Separating and selling pipeline CO_2 for use in Enhanced Oil Recovery (EOR) has been a commercial reality in the United States for over three decades. CO_2-EOR technologies have been demonstrated at a commercial scale for over 30 years in the Permian Basin in Texas and New Mexico. So while this is not a new technique, its application for sequestering man-made CO_2 in conjunction with extending the economic life of suitable oil fields is (ARI 2010). Until recently most of the CO_2 used for EOR has come from naturally-occurring underground reservoirs, however as global climate concerns become more pronounced new technologies are being developed to utilise industrial CO_2 which would otherwise be released into the atmosphere *(DOE 2008)*.

Currently in North Dakota a conventional surface coal gasification facility supplies industrial CO_2 into a 320km pipeline for an EOR operation in Canada which is also the world's largest carbon capture and storage project. Carbon Energy's technology is more economically favourable than mining followed by surface gasification and also has a smaller environmental footprint than traditional mines and surface gasification.

EOR is a complementary technology that when combined with underground coal gasification will deliver the production of clean energy from coal with a low environmental footprint and commercially-attractive carbon capture and storage.

In the short-term, CO_2-EOR can make a significant contribution to mitigating increases in CO_2 emissions into the atmosphere by putting substantial quantities of man-made CO_2 into permanent storage in depleted oil reservoirs *(Duncan 2009)*.

In one year alone the over US$800 million has been devoted to projects involving Enhanced Oil Recovery in the United States as part of the U.S. Department of Energy's Clean Coal Power Initiative *(DOE 2009)*.

In the past, the factors limiting the use of carbon dioxide enhanced oil recovery (CO_2-EOR) techniques have been the lack of nearby CO_2 sources and oil price volatility. Nowadays with high oil prices, CO_2-EOR provides an economical means by which large amounts of captured CO_2 can be sequestered *(EORI 2010)*.

CO_2-EOR holds great promise for oil producers and CO_2 suppliers alike as successful application of this technology can result in approximately 15% incremental oil production in Wyoming *(EORI 2010)*.

Carbon Energy's Wyoming Project includes an Off-Take Agreement for carbon dioxide (CO_2). Carbon dioxide

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ENHANCED OIL RECOVERY

produced by industry in Wyoming is often sold as an additional revenue stream and injected into depleted oil fields to increase the productive life of mature oil reservoirs. Due to the supply shortfall of pipeline CO_2 for EOR in Wyoming, the current market outlook for separating CO_2 from Carbon Energy's syngas and selling to nearby EOR operators presents a lucrative additional revenue stream that also doubles as a commercially-attractive means of Carbon Capture and Storage (CCS). The latter is an important consideration in the context of Wyoming being an energy-rich state taking steps to reduce its carbon pollution.

The world's largest carbon capture and storage project which uses EOR techniques.
International Energy Agency GHG Weyburn-Midale CO_2 Monitoring & Storage Project

Source: International Energy Agency Greenhouse Gas Programme 2010
Location: Saskatchewan, Canada

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