Finance

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The Future of Carbon Dioxide Injection EOR in the United States

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What is EOR and where is it used in the United States?

(This article is the first in a periodic series exploring legal issues relating to CO_2 enhanced oil recovery and serves as an introduction to the process. Our next article will focus on issues relating to the regulatory regime for CO_2 transportation.)

Background

In the primary phase of oil production, after a conventional oil well is first drilled, the natural pressure of the oil reservoir, sometimes assisted by pumping, lifts the oil to the surface.[1] When the reservoir's natural pressure subsides following a well's initial production, oil producers may extend the life of a well through secondary recovery processes, which usually involve injecting water or gas into the reservoir through a non-production well to increase pressure and direct underground oil to the production well.[2] These first two phases typically recover 30-40 percent of the original oil in a conventional oil field.[3] In the third and final phase, enhanced oil recovery (EOR) techniques can be used to further extend the useful life of a conventional oil well. This final phase can result in recovery of up to 5-15 percent of the oil otherwise trapped in a conventional oil field.[4]

EOR encompasses several tertiary recovery methods to extend the life of multiple wells in an oil reservoir. Generally, EOR methods aim both to increase reservoir pressure and change the properties of the oil, including by altering its density to improve recovery.[5] This article focuses on one EOR method, the use of carbon dioxide injection (CO_2EOR), one of the most common EOR methods in use by producers today.[6]

CO_2EOR usually requires the producer to inject intervals of compressed, supercritical CO_2 into an oil reservoir.[7] The CO_2 typically dissolves in the oil, reducing its viscosity or changing its density as it displaces

[1] Int'l Energy Agency, Storing CO_2 Through Enhanced Oil Recovery: Combining EOR With CO_2 Storage (EOR+) For Profit 9 (2015).

[2] *Id*.

[3] U.S. Dep't of Energy, Office of Fossil Energy, *Enhanced Oil Recovery*.

[4] Int'l Energy Agency, *supra* note 1.

[5] Int'l Energy Agency, *supra* note 1, at 10.

[6] Apec Energy Working Grp., Feasibility Of Accelerating The Deployment Of Carbon Capture, Utilization And Storage In Developing Apec Economies 1 (March 2014).

[7] Int'l Energy Agency, *supra* note 1, at 10-11.

the oil from the reservoir's porous rock.[8] Producers then alternate supercritical CO_2 injections with water injections to further direct and drive the oil-CO_2 solution toward the production well.[9] As above, CO_2EOR can result in a 5-15 percent increase in the production from a well[10] and can extend the productive life of an oil field, in some cases, for decades.[11]

In 1972, Chevron installed the first large-scale CO_2EOR project in the western Texas Permian Basin in the U.S.[12] By 2013, CO_2EOR contributed approximately 3.7 percent (about 280,000 barrels per day) to U.S. oil production.[13] Today, there are approximately 70 oil fields in eleven U.S. states located largely in the Gulf Coast, Mountain West and Great Plains, which have employed CO_2EOR technology as a means to enhance oil recovery.[14] The Permian Basin project remains the most productive CO_2EOR project in the U.S. in terms of daily oil production.[15] This use of CO_2EOR in Texas is set to continue. Globally, the U.S. has the highest number of active CO_2EOR projects and ranks first in terms of total oil production from CO_2EOR, accounting for approximately 80 percent of oil sourced globally from CO_2 injection.[16]

Other regions are investing in CO_2EOR technology for mature fields as well, although with a relatively small contribution to global production. There are some 140 CO_2EOR projects worldwide that contribute approximately 0.35 percent to global daily oil production, or about 300,000 barrels per day.[17] In 2014, the Asia Pacific Economic Cooperation (APEC) commissioned a review of eight member countries for CO_2EOR potential and estimated the process could incrementally increase recoverable oil resources by 18-78 billion barrels for the countries studied.[18] However, as the review noted, for these APEC countries to increase production from CO_2EOR injection, a steady source of low-cost CO_2, together with a means to transport the CO_2 to oil fields and greater legal certainty, are critical.[19] Additionally, APEC foreshadowed that it will be key for these countries to identify potential CO_2 sources in close proximity to suitable oil reservoirs, to create more responsive policy and legal frameworks, and to create methods to evaluate proposed CO_2EOR projects in order to plan, finance and implement successful proposals.[20]

What are the available sources of CO_2 for EOR in the United States?

In 2010, approximately 78 percent of CO_2 used in U.S. CO_2EOR operations came from geologic sources of naturally occurring CO_2.[21] Naturally occurring CO_2 sources in Colorado and New Mexico provide the bulk of CO_2 supply for the Permian Basin.[22] For other CO_2EOR projects in the U.S., CO_2 is obtained from both natural formations and anthropogenic sources, including CO_2 combustion sources (such as power plants)

[8] Sean McCoy, Int'l Energy Agency, *Potential for EOR to Kick-Start Early Projects CCS Projects*.

[9] Nat'l Energy Tech. Lab., Carbon Dioxide Enhanced Oil Recovery: Untapped Domestic Energy Supply And Long Term Carbon Storage Solution 5 (March 2010).

[10] Int'l Energy Agency, *supra* note 1.

[11] U.S. Dep't. Of Energy, Office Of Fossil Energy, *supra* note 3.

[12] Nat'l Energy Tech. Lab., *supra* note 9, at 10.

[13] U.S. Energy Info. Admin., Annual Energy Outlook 2015, A-28 (April 2015).

[14] U.S. Dep't Of Energy, Office Of Fossil Energy, *supra* note 3. (See also Nat'l Enhanced Oil Recovery Initiative, 5 Things to Know about CO_2-EOR.)

[15] Michael L. Godec, CO_2-EOR to CCS: Prospects and Challenges of Combining CO_2-EOR with Storage, (February 2012).

[16] *Id*.

[17] Int'l Energy Agency, *supra* note 1, at 11.

[18] The countries studied include Brunei, People's Republic of China, Indonesia, Malaysia, Thailand, Mexico, Peru and Vietnam. Apec Energy Working Grp., *supra* note 6, at ii.

[19] Apec Energy Working Grp., *supra* note 6, at iv.

[20] *Id*. at 110.

[21] Godec, *supra* note 15.

[22] Nat'l Energy Tech. Lab., A Review Of The CO_2 Pipeline Infrastructure In The U.S. 4 (April 21, 2015).

and other industrial processes (such as natural gas processing facilities). In the U.S., there are seventeen primary sources of CO_2 capture for EOR, including power plants in Texas, Mississippi and North Dakota; natural gas processing facilities in Texas, Wyoming and Michigan; and industrial processing facilities in Kansas, Louisiana and Oklahoma.[23]

This CO_2 is transported within a 7,200-km network of pipelines operated by over a dozen companies.[24] Depending on both the jurisdiction (whether state or federal) and other factors, a jurisdiction may require a pipeline to be operated as a common carrier, which is generally required to serve all customers at reasonable rates.[25] Other pipelines may operate as a private carrier, not subject to common carrier rights and responsibilities.[26] The U.S. CO_2 supply and pipeline network has been developed by both oil producers for their own integrated CO_2EOR projects and by third parties that deliver CO_2 to oil producers.[27]

Large, naturally occurring reserves of CO_2 are generally not commonplace near oil fields, and locating a sufficient supply of CO_2 can be a challenge for producers.[28] Additional projects in North America will add to the CO_2 supply for EOR, such as the Petra Nova Project in Texas, scheduled to be operational later this year.[29]

A US$1 billion joint venture between NRG Energy and JX Nippon Oil & Gas Exploration Corporation, the Petra Nova Project is partially supported by funding made available by the U.S. Department of Energy for certain large-scale carbon capture and sequestration (CCS) projects. The Project is unique as it involves the use of CCS technology on an unprecedented scale and sources its CO_2 from the flue gas emissions of one of the coal-fired units located at the W.A. Parish Power Plant outside Houston. When completed later this year, it will deliver the refined CO_2 by pipeline 130km to the mature West Ranch Oil Field for enhanced oil recovery.[30] The Project serves a dual purpose of providing a reliable and cost-efficient supply of CO_2 for EOR and reducing greenhouse gas emissions from the W.A. Parish Power Plant into the atmosphere.[31]

What is the cost of CO_2EOR in the United States?

When evaluating the costs and viability of CO_2 injection as a means of extending the useful life of an oil reservoir, CO_2EOR project participants should weigh the direct costs associated with sourcing and maintaining a stable supply of CO_2, as well as those uncertain costs, such as the liabilities and risks associated with an industrial activity.

The direct costs of CO_2 supply typically include costs to collect, purify, transport and inject the CO_2 into the reservoir. For projects that purchase CO_2 from a third party, the CO_2 price will be determined by negotiation between private parties. It is typical for U.S. producers to enter into long-term supply contracts for CO_2 at a price that is linked to the price of oil, particularly where the underlying asset is being project-

[23] *Id*. at 3-4.

[24] *Id.* at 3.

[25] Philip M. Marston & Patricia A. Moore, From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage, 29 ENERGY L.J. 421, 456 (2008).

[26] *Id*.

[27] Kinder Morgan, *CO_2 Overview*.

[28] Nat'l Energy Tech. Lab., *supra* note 9, at 9.

[29] Int'l Energy Agency, *supra* note 1, at 14.

[30] U.S. Dep't of Energy, Office of Fossil Energy, *Petra Nova – W.A. Parish Project*. (See also U.S. Dep't of Energy, Office of Fossil Energy, Petra Nova Project Breaks Ground on World's Largest Post-Combustion Carbon Capture Project (Sept. 5, 2014).)

[31] *Id*.

financed by international banks.[32] Purification, processing and transportation costs vary and can drive up the price of CO_2 supply depending on the quality of the CO_2 and the distance between the CO_2 supply source and the CO_2EOR project.[33]

In addition to direct foreseeable operational costs, project participants should be prepared for uncertain costs or liabilities that may stem from environmental and safety-related concerns. For example, the Safe Drinking Water Act and the Clean Water Act impose significant liability for a project's failure to properly handle the inputs used for CO_2 processing before injection and the water generated from CO_2 injection.[34] Regulatory compliance costs can also quickly escalate the cost of CO_2 supply, particularly with respect to transportation routes (pipeline, railroad or truck), which can bring federal, state and local regulations into play.

The ultimate cost of CO_2 supply will therefore vary for any oil producer employing CO_2EOR technology. In a survey of producers conducted in 2014, the U.S. Energy Information Agency estimated that the added costs of CO_2 supply can be between $20 and $30 per barrel, which can make a CO_2EOR project less attractive during an oil price slump.[35] The additional costs are particularly important to bear in mind given the current malaise in which oil prices have halved since 2014 and temporarily hit a 13-year low in January 2016.[36]

The ultimate cost of CO_2 production may fluctuate relative to price, and it is possible that a supplier may sell CO_2 below cost. A CO_2 supplier should also consider U.S. antitrust and deceptive pricing statutes, so that its actions in the event of pricing below cost do not constitute an illegal attempt by a supplier to either monopolize a market or deceive its customers. While we are not aware of any case involving a CO_2 supplier in antitrust or deceptive pricing, each supplier should be attuned to and undertake precautionary due diligence of the applicability of U.S. antitrust and deceptive trade practice laws and should familiarize itself with the laws of the jurisdiction(s) in which it operates.

Texas serves as a valuable example, as the Texas Free Enterprise and Antitrust Act of 1983[37] ("Texas Antitrust Act") was modeled after federal antitrust statutes.[38] Below-cost pricing is not per se unlawful under Texas law, provided that a supplier's pricing is not misleading or deceptive.[39] However, below-cost pricing could potentially violate the Texas Antitrust Act if a CO_2 supplier is found to have a monopoly over the CO_2 market and reasonably expects to recoup its losses later **and** either of the following two conditions is met:

(a) the price is below the average variable cost of CO_2; **or**

(b) there are substantial barriers to CO_2 market entry, **and** the supplier's price is below both the short-run profit-maximizing price and average total cost, **and** the benefit of the supplier's price depends on its tendency to affect competition and increase the eventual likelihood of a monopolized market.[40]

[32] *Id*.
[33] Int'l Energy Agency, *supra* note 1, at 19-20.
[34] 33 U.S.C. §1251(a) and 42 U.S.C. § 300h(b).
[35] U.S. Energy Info. Admin., *Today in Energy* (July 30, 2014).
[36] David Sheppard & Mamta Badkar, "Oil prices slide after weekly US stockpile data disappoint," Financial Times (July 7, 2016).
[37] Tex. Bus. & Com. Code Ann.§§ 15.01-15.52.
[38] Times Publ'g Co., Inc. v. Triad Commc'n, Inc., 826 S.W.2d 576, 580 (Tex. 1992).
[39] Tex. Bus. & Com. Code Ann. § 17.46.
[40] *Id*. at 588.

Conclusion

CO_2EOR technology can be an effective means to increase or maintain the productivity of an oil reservoir. Since the 1970s, CO_2EOR technology has generally been used most when oil prices were high; however, with oil prices relatively low and the increasing number of maturing oil fields around the world, CO_2EOR technology could play an important role in extending the productive life of reservoirs.

Additionally, the market for CO_2EOR projects may shift as jurisdictions further legislate against, or provide additional incentives for the sequestration of, greenhouse gases. Depending on the attributes of the particular oil reservoir, CO_2EOR projects can serve the dual function of boosting oil production while capturing CO_2 underground.

While a significant portion of the world's current CO_2 supply for EOR projects is produced from naturally occurring sources, continued increases in greenhouse gas emissions may expand the supply of CO_2 from anthropogenic sources. A company seeking to participate in a CO_2EOR project should undertake careful due diligence of the CO_2 supply and work with outside counsel to get comfortable with the proposed sourcing, pricing and compliance with local and federal antitrust regulations, as well as any emissions incentives that may be available to the proposed CO_2EOR project.

If you have any questions about the content of this Advisory, please contact the Pillsbury attorney with whom you regularly work, or the authors below.

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