Carbon Capture and Sequestration

The Sum of Its Parts

By David Jacoby

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Carbon capture and sequestration (CCS) drastically reduces carbon dioxide emissions from power plants and industrial factories. The US government is subsidizing research into CCS as part of the American Recovery and Reinvestment Act of 2009, and President Obama set a goal of a cost-effective CCS deployment plan within 10 years. The Department of Energy has allocated $1.4 billion toward 12 shared public-private research projects that study or use CO_2 from industrial sources for storage or productive use. *(See http://fossil.energy.gov/recovery/projects/industrial_ccs.html for complete listing.)* So far, $22 million has been disbursed and such projects are a boost to gas suppliers.

Currently, there is strong investor interest in carbon capture, and this is a good thing for industrial gas suppliers. Once captured, CO_2 can be pumped into oil wells in a process known as enhanced oil recovery (EOR). This process can improve oil yield by up to 20 percent and is an important method of increasing yield from older oil wells. *(For more on EOR see "The Excitement in Oil and Gas: Two On-going Revolutions," on p. 22.)* Praxair estimates the CCS market at $300 billion and has seen its stock gain on prospects for its proprietary technologies that service the CCS markets. As the climate heats up, there is increased interest in connecting the "bad" sources of CO_2 (pollution streams from processing and manufacturing operations) to oil and gas fields through carbon capture and sequestration projects. This article examines that supply chain.

The Economics of CCS

The economics of CCS are far from proven. The total supply chain cost depends on factors such as the relative cost of different EOR techniques, which can be thermal processes like steam injection or flooding with surfactants, polymers, or other chemicals. Geological formation characteristics determine the type of EOR used. Gas injection opportunities are limited by geology since there must be a known, deep vault for CO_2 injection. Water is another critical factor. If it is plentiful and cheap, steam injection is more economical; where water is expensive compared to the value of the gas, CO_2 injection is favored.

The raw gas cost is dependent on the economics of the source. Sources like cement and chemical plants, refineries, or paper mills may receive subsidies at different rates for avoiding CO_2 emissions. These plants also produce CO_2 at different purity levels and with different treatment requirements that affect the cost of CO_2. Other gases being used for injection, such as nitrogen, hydrocarbons, solvents, or some combination of these, also vary in price.

The cost of the EOR equipment, such as compressors, pumps, wellheads, vessels, instrumentation, and meters, and the cost of transportation, storage, and power also play into the economics of CCS. Supply chain costs vary depending on whether a company is just storing CO_2 underground or supplying it to an EOR operation. If the CO_2 is used productively, obviously CCS costs are lower.

Active Projects

ADCO (Abu Dhabi Company for Onshore Oil Operations) and ADMA (Abu Dhabi Marine Operating Company), both under the ADNOC (Abu Dhabi National Oil Company) umbrella, are piloting a CO_2 injection project in Abu Dhabi in the United Arab Emirates with Praxair. Praxair is supplying 60 tons per day of CO_2 to ADCO, and ADCO is pumping that into its offshore Umm Shaif and Lower Zakum oilfields. ADNOC is also studying the potential to capture carbon from industrial plants for the same purpose, although capturing the gas costs about 20 percent more than just sending it skywards.

In Spain, Leni Gas & Oil PLC (LGO) partnered with Praxair to use nitrogen injection to stimulate production as nitrogen in well stimulation is effective and has relatively small environmental impacts. Nitrogen, which is inert and does not corrode, can be used in conjunction with water or polymer flooding and can boost production by about a third. *(See related topic, "Nitrogen Fracs Can Decrease Water Use in Amenable Geologies," p. 34.)*

Praxair has previous nitrogen injection experience with Pemex in southern Mexico. ExxonMobil partnered with Praxair to build, own, and operate an air separation unit (ASU) for nitrogen injection at ExxonMobil's Hawkins, TX, gas processing plant. The ASU will supply 85 million cubic feet per day of nitrogen.

The Technology Race

Suppliers and investors in CCS that demonstrate sustained technological leadership at low cost will be the winners in the highly competitive race to make this practice economically attractive. Praxair has a number of patents, including a vacuum pressure swing adsorption processes and apparatus technology that recycles purified CO_2 to increase CO_2 recovery, thereby increasing EOR yield. BASF has developed a similar system that it is piloting with Linde and RWE (Essen, Germany), with the help of the German federal ministry of economics and technology. BASF also invented new solvents that reduce the energy required for the carbon capture system. New EOR technologies under development that use microbes, enzymes, and other feeds like algae, may offer a price point of one-third to one-sixth that of CO_2.

To make the economics of CCS successful, supply chain links to EOR are required. This will require new technologies and methods of CO_2 capture, purification, recycling, and reuse, including EOR, and will inevitably involve strategic alliances or acquisitions. Have you figured out who your dance partner is yet? ■

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