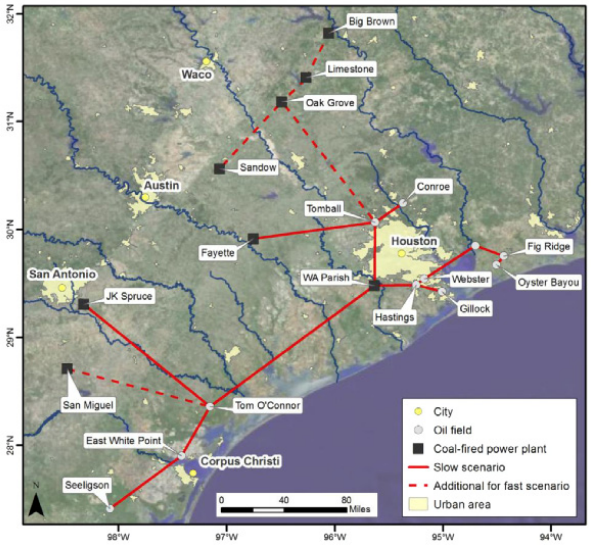
Unconventional EOR: CCUS Network Value in the Gulf Coast

Project Description

A cash flow analysis of the carbon capture and storage (CCS) network in the Gulf Coast was performed to determine the value of CCS industry. Possible contract structures between power/industrial capture facilities and enhanced oil recovery (EOR)/sequestration operators were also explored. The study compared several bounding cases for understanding the economic viability of capturing large quantities of anthropogenic CO_2 from coal-fired power generators within the Electric Reliability Council of Texas (ERCOT) electric grid and using it for pure CO_2 EOR in the onshore coastal region of Texas along the Gulf of Mexico.



Pipelines used in the analysis of the Gulf Coast CCUS Network

Methods

We developed a model in which all captured CO_2 in excess of that needed for EOR is sequestered in saline formations at the same geographic locations as the oil reservoirs but at a different depth. We analyzed the extraction of oil from the same set of 10 reservoirs within 20- and 5-year timeframes to describe how the scale of the carbon capture, use and storage (CCUS) network changes to meet the rate of CO_2 demand for oil recovery. A cash-flow analysis was run in the four scenarios, which provide the bounding cases for the cash flow of a CCUS system in the Texas Gulf Coast and ERCOT grid.

		Economic scenarios	
		CO_2 *sales price*, EOR entities purchase CO_2 from coal-fired power plants with CO_2 capture	CO_2 *emissions penalty* on total emissions from (1) electricity from coal, natural gas (NG), and oil; (2) combustion of oil from EOR
Operational scenarios	*'Slow' EOR production*, three coal EGUs have CO_2 capture; oil is produced at a nearly constant rate over 20 years	Scenario 1	Scenario 2
	'Fast' EOR production, 21 coal EGUs have CO_2 capture; the majority of oil produced in <10 years	Scenario 3	Scenario 4

Description of four scenarios run to bound the cash-flow analysis for the modeled system producing oil from 10 EOR reservoirs from a given number of electric generating units (EGUs).

The scenario results were not necessarily meant to present one scenario as more probable than or preferable to another, yet most realistic scenarios for development of a CCUS network should fall within the boundaries of the four scenarios. Our system-wide perspective is meant to demonstrate the economics as viewed from outside the system rather than inside the system. In this way, any business and government players that could be part of a similar CCUS network in Texas can use this study as a basis for understanding realistic possibilities for cooperation (e.g., sharing of costs and revenues under uncertain future conditions).

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Key Findings

- Cash flow scenarios show a system-wide net present value (NPV) range from -$23 billion (scenario 4: fast EOR development with CO_2 emissions penalty) to -$1.0 billion (scenario 1, slow EOR development with CO_2 sales price). These two scenarios sequester large quantities of CO_2 of 1,450 Mt CO_2 and 240 Mt CO_2, respectively, over 20 years.
- Because system-wide NPVs are all negative, the results can be broadly interpreted as the additional costs of sequestering large quantities of CO_2 while using oil revenues to pay for a large portion of the costs. These additional NPV costs range from $5 to $25/t CO_2.
- The more CO_2 captured, the lower the NPV of the system. This result stems from our assumption that a similar amount of EOR oil is produced no matter how much CO_2 is available. It is feasible that more CO_2-EOR oil would be produced with more available CO_2.
- The CO_2-emissions-penalty scenarios generate less NPV than the CO_2-sales-price cases, especially in the fast development scenarios.
- If the cost of purchasing, recycling, and reinjecting CO_2 is low enough, it is feasible for pure CO_2-EOR operations to have a positive NPV in the present economic environment with no CO_2 emissions penalty.

	EOR only no CO_2 emissions penalty on oil		EOR only with CO_2 emissions penalty on oil		EOR + saline storage no CO_2 emissions penalty on oil		EOR + saline storage with CO_2 emissions penalty on oil	
Scenario name	NPV	IRR (%)	NPV	IRR	NPV	IRR	NPV	IRR
1: slow EOR, CO_2 sales price	0	10	0	10	−200	9	−200	9
	−700	3	−700	3	−800	2	−800	2
	−1900	—	−1900	—	−2000	—	−2000	—
2: slow EOR, CO_2 emission penalty	1600	22	−1400	—	1400	20	−1600	—
	−100	9	−3100	—	−200	8	−3200	—
	−1300	—	−4300	—	−1400	—	−4400	—
3: fast EOR, CO_2 sales price	1000	20	1000	20	−2600	—	−2600	—
	−200	—	−200	—	−4700	—	−4700	—
	−3000	—	−3000	—	−8800	—	−8800	—
4: fast EOR, CO_2 emissions penalty	3900	47	−2000	—	400	22	−5500	—
	2700	42	−3200	—	−1700	—	−7600	—
	0	10	−5900	—	−6000	—	−11 900	—

Net Present Value (NPV) and Internal Rate of Return (IRR) for the EOR and saline sequestration components of the CCUS network. Values are in millions of dollars in 2009. If three values are present for each scenario, they represent results assuming the three electricity prices ($0.05 kW/h, industrial, and residential).

Citation

King, C. W., Gülen, Gürcan, Cohen, S. M., and Nuñez-Lopez, Vanessa, 2013, The system-wide economics of a carbon dioxide capture, utilization, and storage network: Texas Gulf Coast w/ pure CO_2–EOR flood: Environmental Research Letters, 8, 034030.

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