PS Carbon Storage Options for the Power Industry in the Texas Gulf Coast Area*

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Abstract

The Texas Tertiary lignite belt currently provides a significant share of the state energy needs and will continue to do so for the foreseeable future. Possible implementation of carbon policy may entail injection of the CO_2 into the subsurface. The carbon storage capacity in the Gulf Coast area is large but favorable storage sites are not necessarily located underneath the power plants (for example, offshore). The same areas (onshore) also contain valuable groundwater resources that require protection. Risks to groundwater drive the regulatory framework of carbon storage. Risks are multiple resulting from leakage of the buoyant CO_2 but also from brine invasion following pressurization of the system along weakness conduits such as wellbores with defects and/or vertically transmissive faults. Brine production and reinjection can be engineered to reduce the excess pressure, but at an added cost. It follows that permanence of the storage needs to be ensured by a judicious choice of the injection sites. We present guidelines and suggestions for effective storage of CO_2 in the Gulf Coast area.

Carbon storage options for the power industry in the Texas Gulf Coast area

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1- Abstract

The Texas Tertiary lignite belt currently provides a significant share of the state energy needs and will continue to do so for the foreseeable future. Possible implementation of carbon policy may entail injection of the CO_2 into the subsurface. The carbon storage capacity in the Gulf Coast area is large but favorable storage sites are not necessarily located underneath the power plants (for example, offshore). The same areas (onshore) also contain valuable groundwater resources that require protection. Risks to groundwater drive the regulatory framework of carbon storage. Risks are multiple resulting from leakage of the buoyant CO_2 but also from brine invasion following pressurization of the system along weakness conduits such as wellbores with defects and/or vertically transmissive faults. Brine production and reinjection can be engineered to reduce the excess pressure, but at an added cost. It follows that permanence of the storage needs to be ensured by a judicious choice of the injection sites.

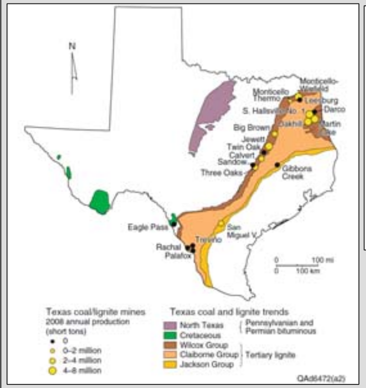

Figure 1. Texas lignite and bituminous coal deposits, coal mines in 2008 (from Ambrose et al., 2010)

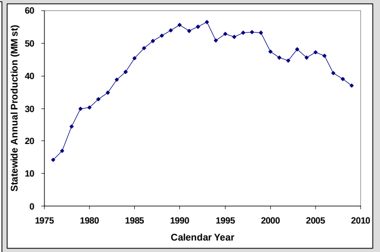

Figure 2. 1975–2009 statewide coal/lignite annual production (from Nicot et al., 2011)

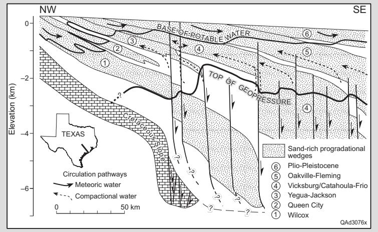

Figure 3. Typical cross-section of the Gulf Coast showing base of the fresh water and top of the geopressured zone (from Galloway, 1982 and Galloway et al., 1982). Sediment thickness increases towards the Gulf of Mexico

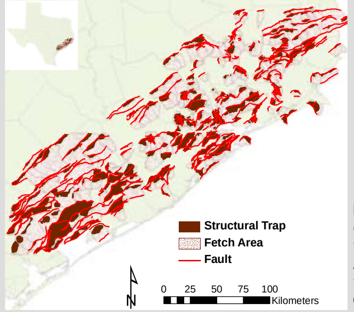

Figure 4. Closed structural traps abutting growth faults and corresponding fetch area – top of Frio (from Nicot and Hovorka, 2009). Areas left in background color eventually lead to a salt diapir and are not primary targets for CO_2 injection

2- How Much

Approximately ~10 coal-fired power plants (**Figure 1**) consumes around (**Figure 2**) 45 millions short tons of coal every year that roughly translates into 150 million metric tons of CO_2 representing ~20% of the state CO_2 emissions. Assuming that the need for capturing and sequestering CO_2 will last 50 years, storage capacity has to be >7.5 billion metric tons, that translates, assuming a density of supercritical CO_2 of 0.7, into a volume of ~50 billion barrels.

On the capacity side, the Gulf Coast Basin contains a thick sedimentary pile (**Figure 3**) with many structural traps (**Figure 4**).

3- Where?

In the Gulf Coast Basin, there are essentially 4 options to dispose of CO_2 emissions underground, arguably in order of increasing capacity

(1) Depleted fields
(2) CO_2 EOR and stacked storage (>10 Bbbl to recover)
(3) Onshore storage in saline aquifers
(4) Offshore storage in saline aquifers

Depleted Fields

The 3 RRC districts along the Gulf Coast (2, 3, and 4) have produced in the past 20 years a volume >35 Bbbl of mostly gas (>40 TCF of gas, assuming a reservoir gas density of 0.14) and oil. Going back to the beginning of the industry in the area would yield a volume larger than that of future emissions from coal-fired power plants, and this, not accounting for the much larger volumes of produced water discharged at ground surface in the first half of the 20th century.

CO_2 EOR and Stacked Storage

The Gulf Coast contains >6 Bbbl of oil technically recoverable though CO_2 EOR (**Figure 5**), increasing capacity of depleted field and generating a profit to establish the infrastructure needed to store CO_2 in underlying saline formations ("stacked storage").

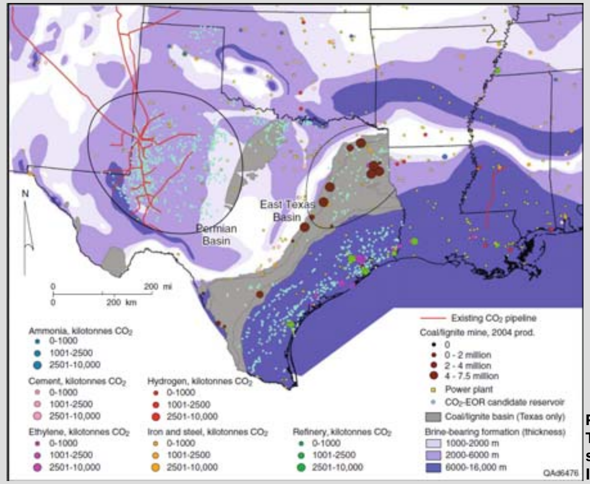

Figure 5. Map of potential CO_2-miscible floods for the Gulf Coast region (green dots) vs. CO_2 sources (red dots)

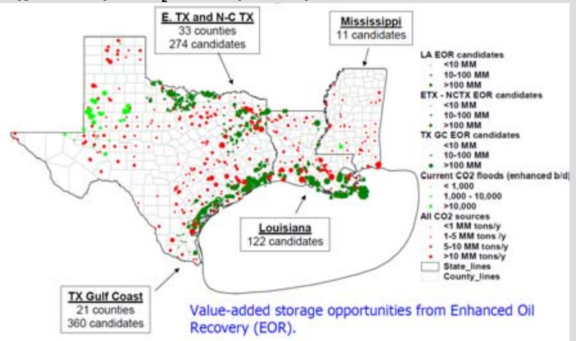

Figure 6. Map showing thickness of sediments of sedimentary basins in Texas and nearby states and CO_2 sources (Ambrose et al., 2010). It suggests that the Gulf Coast Basin represents a major opportunity to store large amounts of CO_2.

Onshore and Offshore Storage in Saline aquifers

The recent NETL atlas (version 3) suggests that capacity of Texas Gulf Coast formations, both offshore and onshore, is at least a volume of 4,000 Bbbl and probably much larger. Offshore storage, despite technological complications, represents a significant fraction of that storage. It limits likelihood of encountering older wells, generally the most worrying in terms of proper abandonment and ability to withstand an increase in pressure. Additional potential benefits of utilizing State offshore lands include single land and mineral owner, revenues generated go to Permanent Education Fund, and reduced risks to drinking water.

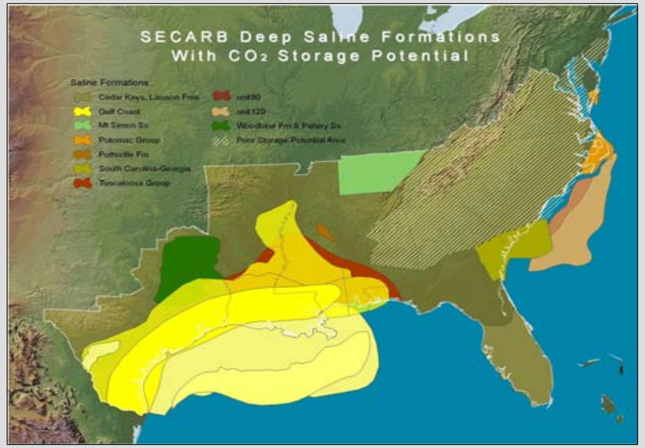

Figure 7. Regional capacity assessment units for the southeastern United States. Initial simplified capacity calculations suggest ample storage potential

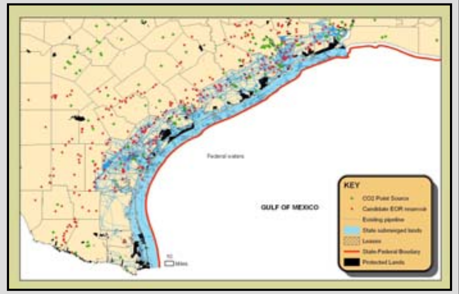

Figure 8. Map indicating CO2 point sources, prospective EOR reservoirs, existing pipeline network, and State-owned offshore lands (blue).

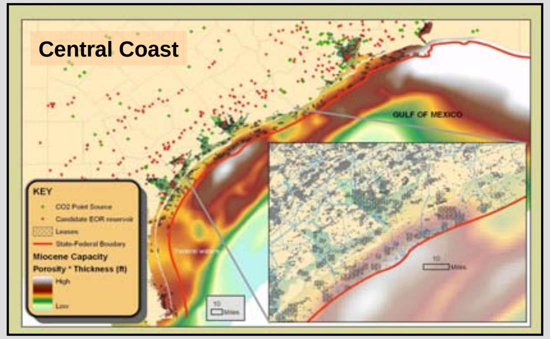

Figure 9. Map of relative capacity reflecting net-sand interval in the Miocene section. Detailed inset is for central Texas coast.

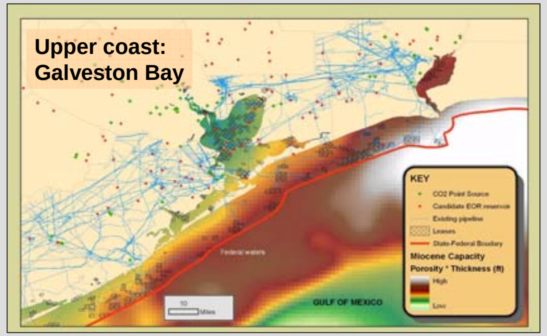

Figure 10. Detailed map of upper Texas coast (Galveston Bay area) indicating relative capacity reflecting net-sand interval in the Miocene section.

Acknowledgments

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