Gulf Coast CCUS

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Gulf of Mexico annual oil production

Kaiser and Narra, 2018,

Deep water (>400ft)

Shallow water (<400ft)
Exploration
Too Much of a Good Thing?

Another Oil Major Sees Peak Oil Demand On The Horizon

By Julianne Geiger  -  Sep 29, 2020, 5:00 PM CDT

French energy giant Total SE (formerly Total S.A.) spread more doom and gloom into the oil markets today, foretelling of the oil industry’s ultimate horror—peak oil demand.

What’s next?
A New Frontier: CCS

Projected growth of storage, based on historical growth of hydrocarbons

Ringrose and Meckel, 2019
Outline

• 2 questions
  • What is the opportunity?
  • How does it work?
• CO2-EOR
• Storage in depleted fields
• Saline storage
  • Play elements
  • Plays
  • Running room in the GoM
• Conclusion
Source: CO₂ Emissions

Heat map showing total volume of local yearly CO₂ emissions

Key
- Point source of CO2 emissions (size proportional to yearly emissions volume)
- High
- Low

Data: NatCarb, 2019
CO$_2$-EOR

• Long experience
• Familiar geology
• Well developed regulation
• Dual revenue stream
Gulf Coast CO$_2$-EOR Candidates

- $>$ Min miscibility pressure (or $>$6000' depth)
- $>$1mmbbl produced
- Waterflooded or good water drive

Núñez-López et al, 2007
CO₂-EOR Opportunity

Fig. 6 Bar graph of miscible CO₂ EOR resource potential in the Gulf Coast

Fig. 7 CO₂ sequestration capacity in miscible oil reservoirs along the Gulf Coast

Núñez-López et al, 2007

4.7Bbbl recoverable oil
2.6Gt CO₂ storage
Depleted Field Storage

• Familiar geology
• Proven reservoirs, seals and traps
• Chance to extend field life, delay decommissioning
• Possibly re-use infrastructure
• Potential surprises with increasing subsurface pressure
• Immature regulation
GoM Depleted Fields Studied

Agartan et al, 2018
Storage Capacity of Studied Fields

Agartan et al, 2018
Extrapolated Storage Capacity

675 fields
3514 individual reservoirs
4.74Gt total capacity

Agartan et al, 2018
Saline Storage

• Greenfield development
• Familiar geology, but....where would you go to optimize storage?
• Not bound by current or historic hydrocarbon production
  • New locations are possible
  • New plays are possible
• Immature regulation
• The new frontier
CO₂ Density

IEA, 2008

Critical depth (~1 km in GoM)

Ground surface
Depth to Top of Overpressure

Burke et al, 2012
Gulf of Mexico Storage Window

Gulf Coast Cross-section, Dallas to Deepwater

Window for CO$_2$ storage defined by minimum pressure for supercritical CO$_2$ (~1km) and top of overpressure
Trapping

Buoyant trapping: Works for both hydrocarbons and CO₂

But we don’t want the CO₂ back—migration losses are viable storage

Bourg et al, 2015
Modelled CO$_2$ Injection into Brine

CO$_2$ concentration

0% 100%

Chris MacMinn, Oxford University
Reservoir

Familiar tanks of sand—fantastic for hydrocarbons

Meckel et al, 2019

Yperen et al, 2020
Reservoir: For CO$_2$ Heterogeneity is useful

Meckel et al, 2019
Classic marine shale seals but also baffled “confining systems” (Olaru, 2020)
A sufficiently baffled, tortuous flow path may be enough to permanently retain CO₂
Southwest Hub

Triassic fluvial systems with discontinuous paleosols and overbank muds

Project to store Perth industrial emissions

Very limited onshore storage options, no regional seals

Sharma et al, 2017
Seal: Southwest Hub Plume Model

- Injection at ~3200m depth
- 800kt/yr for 30 yrs, followed by 1000 yrs shut-in
- Plume is completely contained below 2400m
- For finite injection volumes, baffles can be enough

Sharma et al, 2017
Turtle Play: Great for Petroleum

Best reservoir at crest of structure—thickest sands, highest perms, little crestal compartmentalization, low stratigraphic complexity

Sands encased in shale—likely high pressure and therefore high productivity from a few wells

Simple trap, single point of failure—simple to appraise

Mature source rock

Short migration, minimal losses

Peel, 2020
Turtle Play: Not so good for CCS

Best reservoir at crest of structure—may be difficult to access pore space down-dip

Sands encased in shale—rapid pressure build-up likely to limit CO2 injection

Mature source rock

Short migration, high likelihood of hydrocarbons

Peel, 2020
Salt Roller: Better for CCS

Crestal region:
- poor reservoir, poor connectivity
- high compartmentalization
- high stratigraphic complexity

Lots of ways to contain migrating CO₂

Salt-floored basin, not connected to source:
Fewer wells, no competing uses

Best reservoir in synclines:
- high injectivity down-dip
- Good aquifer connection mitigates pressure buildup

Lots of running room for injected CO₂
Stratigraphic complexity spreads plume, improve storage efficiency

Peel, 2020
Gulf Coast CCS

- Proven reservoirs and seals but many wells
- New plays and new running room
Gulf Coast Saline Storage Capacity

125Gt in TX coastal Miocene section
30Gt in TX Miocene section in state waters

Treviño and Meckel, 2017
Gulf Coast CCS: Projects underway

Gulf Coast Sequestration (GCS) will build and operate the country’s premier geologic sequestration asset, partnering with industrial customers to capture CO₂ and safely contain it underground.

We are developing a regional sequestration "hub" capable of securely storing CO₂ volumes from multiple large industrial customers. We will assist our customers in achieving their goals of sustainability and environmental responsibility.

Hub 5: Gulf of Mexico, USA

Gulf of Mexico Hub has been split into two separate hub regions: Texas – working to find solutions to policy gaps that are currently potential barriers to project development, Louisiana – developing concepts for the hub, based on discussions with industrial emitters and other relevant stakeholders.

Potential emitters:
- Power plants
- Refineries
- Chemical plants
- Fertilizers
- Hydrogen

Status:
In identification phase

OGCI’s role:
- Convene and engage with industrial and governmental stakeholders
- Engage commercially normalized pathways and action plans
- Identify investment opportunities
- Work on policies and regulations
- Share knowledge with other hubs

Total CO₂ emissions:
Over 200 MntCO₂ per year across 2-3 defined hubs in Texas and Louisiana

OGCI member company participation
- ExxonMobil
- Shell
- Occidental
- Chevron
- BP
- Chevron

CCUS projects in the USA ➔
## Comparing Storage Schemes

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<th>Storage Scheme</th>
<th>Key Considerations</th>
<th>Gulf Coast Scale</th>
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<td>CO2-EOR</td>
<td>• Dual revenue stream, proven business model</td>
<td>~5Gt?</td>
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<tr>
<td></td>
<td>• Use existing facilities</td>
<td></td>
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<td></td>
<td>• Mature permitting/regulation</td>
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<tr>
<td></td>
<td>• Limited suitable locations</td>
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<tr>
<td>Storage in depleted fields</td>
<td>• Brownfield redevelopment–new revenue stream, delayed decommissioning</td>
<td>~10Gt?</td>
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<tr>
<td></td>
<td>• Proven seals and reservoirs</td>
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<td></td>
<td>• Compact footprint to monitor</td>
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<tr>
<td></td>
<td>• Immature permitting/regulation</td>
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<tr>
<td>Saline storage</td>
<td>• Giant capacity, large running room</td>
<td>100s of Gt</td>
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<td></td>
<td>• Widely available</td>
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<td>• Take advantage of new plays</td>
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<td>• Immature permitting/regulation</td>
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Conclusion

• CCS has huge growth potential
• The Gulf Coast is a natural place to do it
• CO2-EOR
• Storage in depleted fields
• Saline storage
  • Same principles as petroleum geology, but there are twists
    • Increasing pressure
    • Don’t want it back
    • Focus on seal
  • New plays and new drivers
• A new frontier!
Acknowledgments

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