Information Session: Industrial Carbon Management and 45Q Tax Credits

Dr. Tip Meckel
The University of Texas at Austin
Bureau of Economic Geology -Gulf Coast Carbon Center
June 11, 2019 – Port Arthur Chamber of Commerce
Outline

• Examples of existing and new projects
• 45Q Tax Credits: What, when, how, where?
• Subsurface aspects: Storage and Enhanced oil recovery (EOR) CCS & CCUS
• Accounting and Tax Credits
• CO$_2$ in Energy Systems
• Questions & Discussion
Recent comments about CO$_2$ emissions...

- Texas Senator Cornyn: "There is a growing consensus the **days of ignoring this issue are over**“.  
  - Cornyn introduced his own legislation, which he described as "an **innovation agenda**" to expand federal funding for research into **carbon capture technology from gas-generated power**.

---

**116TH CONGRESS 1ST SESSION**  
S. 1685

To require the Secretary of Energy to establish a program for the research, development, and demonstration of commercially viable technologies for the capture of carbon dioxide produced during the generation of natural gas-generated power.

---

**2020-2025: $50M/yr**  
Cooperative agreements with eligible entities for demonstration or pilot projects to license, permit, construct, and operate, by **not later than September 30, 2025**, three or more facilities to **capture carbon dioxide from qualifying electric generation facilities**.
17 Operating

- Power generation
  - Boundary Dam
  - Petra Nova
- Coal-to-liquids
  - Chemical production
- Iron and steel production
  - Synthetic natural gas
- Fertiliser production
  - Coffeyville
- Oil refining
  - Enid Fertilizer
- Natural gas processing
  - Shute Creek
- Hydrogen production
  - Century Plant
  - Lost Cabin
  - Uthmaniyah
  - Terrell (formerly Val Verde)
- Air Products
  - Sleipner
  - Krylov
  - Iowa
  - Quest

5 in construction

- Illinois Industrial
- Sinopec Oil
- Yanchang
- Lake Charles
- TCEP

Source: GCCSI

= 1Mtpa of CO₂ (area of circles proportional to capacity)
Existing TX Example: Petra Nova (NRG + West Ranch) Houston

• Post-combustion capture from coal-fired electric utility.

• Utilized significant DOE funding.

• Delivered on time and within budget.

• Captures 90 percent of CO₂ at 99 percent purity at an approximate generation scale of 240 MWe from the WA Parish Unit 8 boiler fueled by Powder River Basin sub-bituminous coal.

• ~1.6 Million tons per year captured and used for enhanced oil recovery.

• Increased production by 5,000 BBL per day.

• Storing ~5,000 tons CO₂ per day.

• Probably not going to do this again without major change in capture costs and EOR operations.
Existing TX Example: Air Products (Port Arthur + Hastings)

• 2013: Gas separation - retrofitted to two existing steam methane reformers (SMRs) used for hydrogen production.

• Utilized significant DOE funding.

• Executed on time and under budget and has delivered over 4.0 MM tons of CO2 as of October 2017.

• Post-combustion (90% capture) using vacuum swing adsorption technology.
  • ~ 1 Million tons per year

• Project has a 30 MWe cogeneration unit to provide steam for SMRs and power to VSA and compressors.

• CO2 piped to southeast Houston for EOR at Hastings Field.
Existing TX Example: Net Power (La Porte)

- Zero emission gas-fired electricity demonstration.
- Private Financing: 8Rivers Capital.
- Novel Allam Cycle: CO$_2$ is working fluid.
- 50 MW$_{th}$ Demo plant in La Porte achieved first-fire in 2018.
- 300 MWe commercial plants under FEED development. Plan to deploy globally, with some consideration for Gulf Coast.
- High pressure, high purity CO$_2$ offtake.

ClearPath

New Example

• A subsidiary of Occidental Petroleum Corp, Oxy Low Carbon Ventures LLC, and Carbon Engineering Ltd. started to design the world's largest plant to remove carbon dioxide from the air.

• The plan envisions starting construction in 2021 on a facility that would use the captured greenhouse gas for enhanced oil recovery in Texas' Permian Basin. The plant would remove 500,000 metric tons of CO₂ annually.

• The companies didn't disclose the cost of the plant but said they would tap federal tax credits to build it. The plant, they said, could be followed by additional ones capturing 1 million metric tons a year.
New Example

• Oil & Gas Climate Initiative (OGCI) announced its latest investment in what will be the largest carbon capture and sequestration project in the United States. Developed by Wabash Valley Resources, will capture and sequester 1.5-1.75 million tons of CO₂ annually and will produce the world’s first ammonia with near zero carbon footprint.

• The CCS project also will receive funding from the US Department of Energy’s Carbon Storage Program.

• Repurposed integrated gasification combined cycle plant (IGCC) to be converted for ammonia production.

• The $450 million plant investment will employ over 500 construction workers in the Terre Haute (IN) area over a 3-year period and over 125 permanent jobs when operating.

• Ethanol produced from corn using WVR's ammonia will benefit from a significantly lower carbon intensity rating, making US ethanol and corn more competitive and valuable in International and California markets.

• Captured CO₂ will be injected into a saline aquifer at about 7,000 ft.

https://www.wvresc.com/
What are 45Q Tax Credits?

• 115th Congress: FUTURE Act (S 1353) and the Carbon Capture Act (HR 3761) - extend and expand Section 45Q of the U.S. tax code.

• The 45Q incentives are comparable to the emissions reductions benefits of the production tax credits for renewable energy.

• Section 45Q provides a performance-based tax credit to power plants and industrial facilities that capture and store CO₂ that would otherwise be emitted into the atmosphere.

• The credit is linked to the installation and use of carbon capture equipment on industrial sources, gas or coal power plants, or facilities that would directly remove CO₂ from the atmosphere.

• Credits go directly to the entity doing the capture (i.e., the owner of the capture facility), but can be transferred to the entity involved in the utilization or storage, and further transferability in discussion.
What are 45Q Tax Credits?

- Construction before January 1, 2024
  - Note: The U.S. Treasury will ultimately set the terms and conditions for what constitutes beginning and active construction.

- Qualified projects can claim the credit for 12 years, starting from the date the equipment was first placed into service.

- Tax credit to be transferred from upstream carbon capture equipment owners to those involved with downstream operations
  - storage in geological formations, EOR, or products.

- 45Q can be further leveraged by combining the tax credit with the DOE Title XVII Loan Guarantee Program.
  - loan guarantees to commercial projects deploying innovative technologies, including advanced fossil energy projects employing CCUS.
  - 45Q improves both the size and the certainty of project revenue streams, enhancing the creditworthiness of projects and ability to secure LPO-guaranteed debt financing and private sector equity investment.
Claims to date...

- About 60 million metric tons of CO$_2$ claimed to IRS as captured for tax credit as of May 14, 2018.
- 3 million metric tons of CO$_2$ reported to EPA for sequestration verification as of August 5, 2017.
- Value of claimed credits: $597 million up to $1.3 billion.
- The majority of these claims are associated with EOR.
Utilization and/or Storage
Must provide net reduction of emissions.

- **UTILIZATION**: utilized as a feedstock or component of products
  - chemicals, construction materials, plastics, biofuels, etc.

- **STORAGE**: A) EOR or B) Saline Formations
  - Multiple successful examples received EPA approval.
  - IRS Guidance remains: Some aspects of permitting subsurface activities; definition of ‘commence construction’.
  - What will the interest be from financial institutions and tax equity groups?
    - Very similar to the renewable tax credit market.
Utilization: Products

- Minerals for concrete and other building materials, biofuels, paint, fertilizers, health supplements, and even toothpaste.
- Carbon nanotubes, which can be used to make environmentally sustainable lithium-ion and sodium-ion batteries.
- CO₂-based methanol, which is a potential drop-in fuel, meaning that it is interchangeable with existing petroleum-based fuels.
  - Low carbon fuels may earn premium prices in markets such as California (Low Carbon Fuel Standards)
- There is an energy penalty associated with the conversion of CO₂ to other substances.
  - Need source of low cost electricity and heat.
- Due to the cost of transport, the re-use of CO₂ will need to take place near sources of captured CO₂, which is a geographic constraint.
Overview of Geological Storage Options

1. Depleted oil and gas reservoirs
2. Use of CO₂ in enhanced oil and gas recovery
3. Deep saline formations — (a) offshore (b) onshore
4. Use of CO₂ in enhanced coal bed methane recovery

Produced oil or gas
Injected CO₂
Stored CO₂

IPCC 2007
Enhanced Oil Recovery using CO₂

Source: https://www.epmag.com/advancing-co2-eor-form-carbon-capture-permian-1720356#p=full
# Tax Credit Value Available for Different Sources and Uses of CO₂

<table>
<thead>
<tr>
<th>Type of CO₂ Storage/Use</th>
<th>Power Plant</th>
<th>Other Industrial Facility</th>
<th>Direct Air Capture</th>
<th>Relevant Level of Tax Credit in a Given Operational Year ($USD/tCO₂)</th>
</tr>
</thead>
</table>

¹ Each CO₂ source cannot be greater than 500 ktCO₂/yr

² Any credit will only apply to the portion of the converted CO₂ that can be shown to reduce overall emissions

Source: Closely adapted from Simon Bennett and Tristan Stanley, Commentary: US budget bill may help carbon capture get back on track, International Energy Agency.
<table>
<thead>
<tr>
<th>YEAR</th>
<th>Utilization</th>
<th>Storage</th>
<th>UTILIZATION (tons/yr)</th>
<th>STORAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>25,000</td>
<td>100,000</td>
</tr>
<tr>
<td>2019</td>
<td>$17.76</td>
<td>$28.74</td>
<td>$444,000</td>
<td>$1,776,000</td>
</tr>
<tr>
<td>2020</td>
<td>$20.22</td>
<td>$31.78</td>
<td>$505,571</td>
<td>$2,022,286</td>
</tr>
<tr>
<td>2021</td>
<td>$22.69</td>
<td>$34.81</td>
<td>$567,143</td>
<td>$2,268,571</td>
</tr>
<tr>
<td>2022</td>
<td>$25.15</td>
<td>$37.85</td>
<td>$628,714</td>
<td>$2,514,857</td>
</tr>
<tr>
<td>2023</td>
<td>$27.61</td>
<td>$40.89</td>
<td>$690,286</td>
<td>$2,761,143</td>
</tr>
<tr>
<td>2024</td>
<td>$30.07</td>
<td>$43.93</td>
<td>$751,857</td>
<td>$3,007,429</td>
</tr>
<tr>
<td>2025</td>
<td>$32.54</td>
<td>$46.96</td>
<td>$813,429</td>
<td>$3,253,714</td>
</tr>
<tr>
<td>2026</td>
<td>$35.00</td>
<td>$50.00</td>
<td>$875,000</td>
<td>$3,500,000</td>
</tr>
<tr>
<td>2027</td>
<td>$35.53</td>
<td>$50.75</td>
<td>$888,125</td>
<td>$3,552,500</td>
</tr>
<tr>
<td>2028</td>
<td>$36.06</td>
<td>$51.51</td>
<td>$901,447</td>
<td>$3,605,788</td>
</tr>
<tr>
<td>2029</td>
<td>$36.60</td>
<td>$52.28</td>
<td>$914,969</td>
<td>$3,659,874</td>
</tr>
<tr>
<td>2030</td>
<td>$37.15</td>
<td>$53.07</td>
<td>$928,693</td>
<td>$3,714,772</td>
</tr>
<tr>
<td>2031</td>
<td>$37.70</td>
<td>$53.86</td>
<td>$942,624</td>
<td>$3,770,494</td>
</tr>
<tr>
<td>2032</td>
<td>$38.27</td>
<td>$54.67</td>
<td>$956,763</td>
<td>$3,827,051</td>
</tr>
<tr>
<td>SUM</td>
<td>$9,859,048</td>
<td>$39,436,194</td>
<td>$197,180,970</td>
<td>$57,059,257</td>
</tr>
</tbody>
</table>
Breakeven CO₂ price vs. estimated CO₂ availability

IEA Analysis, NETL, IEAGHG

- Hydrogen production
- Range of tax credit value in 2026
- Ammonia
- Ethanol
- Range of tax credit value in 2018
- NG processing

Estimated CO₂ available for capture in the United States today (million tonnes of CO₂)
Regional Gulf Coast setting for rapid large-scale carbon management in U.S. heavy industry

Gulf Coast CCS @ GCCC

1) Frio Saline tests 2004 & 2006
2) Cranfield stacked storage (EOR + CCS)
3) Air Products - Hastings (EOR + CCS)
4) NRG – West Ranch (EOR + CCS)
5) BOEM BPM Offshore Storage
6) Offshore GoM Storage Characterization
   A. 2009-2014 Texas Offshore Miocene
   B. 2015-2018 TXLA Project
   C. 2016-2018 CarbonSAFE Phase I
   D. 2018–2023 GoMCARB Partnership
- NETL Methodology
- 40,000 sq. km.
- 3,300 logs
  - Tops, net sand, porosity
- 172 Gt CO$_2$ storage total
  TX State Waters
1. Regional Geology of the Gulf of Mexico and the Miocene Section of the Texas Near-offshore Waters

2. Implications of Miocene Petroleum Systems for Geologic CO$_2$ Storage beneath Texas Offshore Lands

3. Evaluation of Lower Miocene Confining Units for CO$_2$ Storage, Offshore Texas State Waters, Northern Gulf of Mexico, USA

4. Capillary Aspects of Fault-Seal Capacity for CO$_2$ Storage, Lower Miocene, Gulf of Mexico

5. Regional CO$_2$ Static Capacity Estimate, Offshore Saline Aquifers, Texas State Waters

6. Field-scale Example of Potential CO$_2$ Sequestration Site in Miocene Sandstone Reservoirs, Brazos Block 440-L Field


8. Appendix A: Regional Cross Sections, Miocene Strata of Offshore Texas State Waters
Geologic geocellular effective porosity model used for calculating CO₂ storage capacity in the SIOI. The AOI is outlined in red, SIOI structural footprint in pink, and faults are in orange.

Approximately 12 Mt in 200’ sand, maybe 100 Mt in thickest intervals.
• Uniformity, clarity, familiarity
• ‘Bankable’ storage – financing.
• Similar to PRMS
  • SRMS exists
  • https://www.spe.org/industry/C02-storage-resources-management-system.php
• Guidelines currently being drafted
• Training workshops to come.
Timing is right for project development

• The clock is ticking...

• Fully private

• Partnership / consortia approach

• Leverage Federal funding – Pros and Cons
THANK YOU

QUESTIONS?

Let’s get crackin!!
Needed IRS Guidance:

- **Defining when construction begins** is absolutely necessary to ensure that a project developer knows what has to be done before January 1, 2024, to ensure their project qualifies for the new credit.

- **Defining the terms** carbon capture equipment, qualified carbon oxide, direct air capture facility, qualified facility, tertiary injectant utilization, and lifecycle greenhouse gas emissions.

- The Treasury/IRS is required by the statute to establish an appropriate framework and **process for demonstrating secure geological storage of qualified CO\(_2\)** captured from the qualified facility. The Treasury/IRS issued interim guidance for demonstrating secure geologic storage under the original 45Q statute and will need to re-evaluate that guidance, given the significant changes to the operation of the credit.

- Clear **guidance on the election to transfer the credit** in 45Q(f)(3), including the factors that should be considered in determining the time and manner of making the election, will be necessary to promote efficient monetization of the credit.

- The Treasury/IRS are required to issue regulations providing for **recapturing the benefits** of the tax credit when the qualified carbon oxides cease to be sequestered in secure geological storage. The Treasury/IRS will need to evaluate provisions that will ensure the ability of a company to rely on receiving the value of these credits.

- Guidance will be required to establish **boundaries for lifecycle emissions analysis** to determine the amount of qualified carbon oxide that qualifies under the utilization provisions and any issues that may arise under those provisions.

- Guidance concerning **structuring of partnerships** between project developers and investors and allocation of the credit and potential recapture of credit among partners will be necessary to promote financial investment.

---

**IRS Notice 2019-32, Request for Comments on Credit for Carbon Oxide Sequestration**

Federal CO₂ Injection Requirement Flow Chart

Will CO₂ be injected?

No

No Further Action

Yes

Are you injecting CO₂ for EOR?

Yes

Operate under Class II of the UIC program & proceed to GHG Reporting

No

Operate under Class VI of the UIC program & proceed to GHG Reporting

Proceed

Report under Subpart RR of the GHG Reporting Rules

Yes

Are you claiming credit for the CO₂ that is geologically sequestered?

No

Report under Subpart UU of the GHG Reporting Rules

Proceed
EPA’s Suggested Outline for MRV Plans

1. Facility Information
2. Project Description
3. Delineation of the monitoring areas
4. Evaluation of Leakage Pathways
5. Detection, Verification and Quantification of Leakage
6. Determination of Expected Baselines
7. Site Specific Modifications to the Mass Balance Equation
8. Estimated Schedule for implementation of MRV plan
9. Quality Assurance Program
10. Records Retention
11. Appendices

<table>
<thead>
<tr>
<th>Active Projects</th>
<th>State</th>
<th>Primary Industry</th>
<th>Year of Operation</th>
<th>Capture Capacity (Metric tons per year)</th>
<th>Transport Distance (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffeyville Gasification Plant</td>
<td>KS</td>
<td>Fertilizer Production</td>
<td>2013</td>
<td>1</td>
<td>70</td>
</tr>
<tr>
<td>Air Products Steam Methane Reformer EOR Project</td>
<td>TX</td>
<td>Hydrogen Production</td>
<td>2013</td>
<td>1</td>
<td>98</td>
</tr>
<tr>
<td>Century Plant</td>
<td>TX</td>
<td>Natural Gas Processing</td>
<td>2010</td>
<td>8.4</td>
<td>&gt;158</td>
</tr>
<tr>
<td>Val Verde Natural Gas Plants</td>
<td>TX</td>
<td>Natural Gas Processing</td>
<td>1972</td>
<td>1.3</td>
<td>221</td>
</tr>
<tr>
<td>Shute Creek Gas Processing Facility</td>
<td>WY</td>
<td>Natural Gas Processing</td>
<td>1986</td>
<td>7</td>
<td>Multiple Pipelines, Max of 286</td>
</tr>
<tr>
<td>Lost Cabin Gas Plant</td>
<td>WY</td>
<td>Natural Gas Processing</td>
<td>2013</td>
<td>0.9</td>
<td>232</td>
</tr>
<tr>
<td>Great Plains Synfuel Plant and Weyburn-Midale Project</td>
<td>ND</td>
<td>Synthetic Natural Gas</td>
<td>2000</td>
<td>3</td>
<td>204</td>
</tr>
<tr>
<td>Enid Fertilizer CO₂-EOR Project</td>
<td>OK</td>
<td>Fertilizer Production</td>
<td>1982</td>
<td>0.7</td>
<td>140</td>
</tr>
<tr>
<td>Illinois Industrial Carbon Capture and Storage Project</td>
<td>IL</td>
<td>Chemical Production</td>
<td>2016</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Petra Nova Carbon Capture Project</td>
<td>TX</td>
<td>Power Generation</td>
<td>2016</td>
<td>1.4</td>
<td>82</td>
</tr>
<tr>
<td>Kemper County Energy Facility</td>
<td>MS</td>
<td>Power Generation</td>
<td>2016</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>Riley Ridge Gas Plant</td>
<td>WY</td>
<td>Natural Gas Processing</td>
<td>2020</td>
<td>2.5</td>
<td>Not Specified</td>
</tr>
</tbody>
</table>
Gulf of Mexico – CO₂ well development scenario

Ringrose and Meckel, in review

<table>
<thead>
<tr>
<th>2020+ SCENAR IO</th>
<th>Avg. Well Inj. Rate</th>
<th>Number of active wells in 2050</th>
<th>Incremental Rate in 2050</th>
<th>Cumulative Mass in 2050</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoM</td>
<td>0.6</td>
<td>17,175</td>
<td>10,305</td>
<td>99,946</td>
<td>Unlikely one region will develop this aggressively; Incremental goal exceeded; Close to cumulative goal</td>
</tr>
<tr>
<td>GoM</td>
<td>0.41</td>
<td>17,175</td>
<td>7,000</td>
<td>67,891</td>
<td>Injection rate low, not cost effective; Cumulative goal not met</td>
</tr>
</tbody>
</table>