Information Session: Industrial Carbon Management and 45Q Tax Credits

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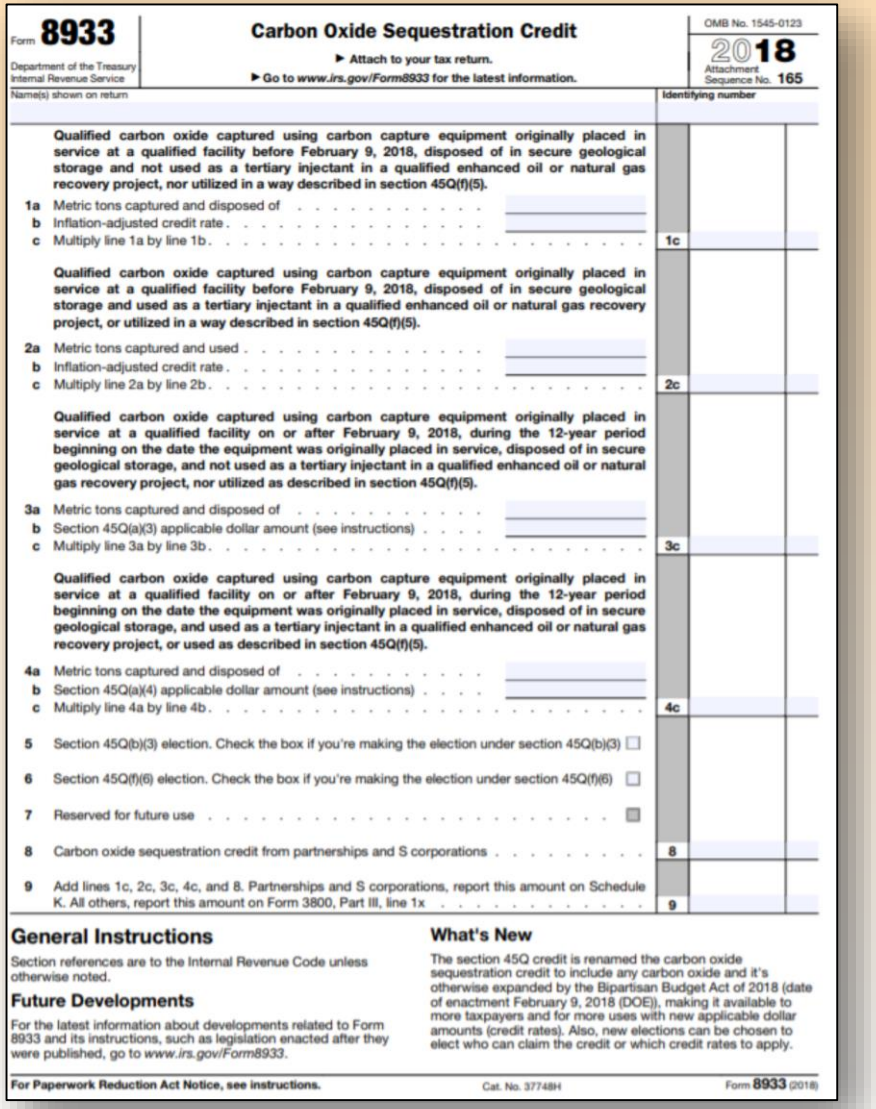
Bureau of Economic Geology -Gulf Coast Carbon Center

June 11, 2019 – Port Arthur Chamber of Commerce

Gulf Coast Carbon Center

TEXAS Geosciences
Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin



Form **8933** — Carbon Oxide Sequestration Credit

Department of the Treasury, Internal Revenue Service

▶ Attach to your tax return.

▶ Go to *www.irs.gov/Form8933* for the latest information.

OMB No. 1545-0123

2018

Attachment Sequence No. 165

Name(s) shown on return | Identifying number

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility before February 9, 2018, disposed of in secure geological storage and not used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, nor utilized in a way described in section 45Q(f)(5).

1a Metric tons captured and disposed of

b Inflation-adjusted credit rate

c Multiply line 1a by line 1b . . . 1c

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility before February 9, 2018, disposed of in secure geological storage and used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, or utilized in a way described in section 45Q(f)(5).

2a Metric tons captured and used

b Inflation-adjusted credit rate

c Multiply line 2a by line 2b . . . 2c

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility on or after February 9, 2018, during the 12-year period beginning on the date the equipment was originally placed in service, disposed of in secure geological storage, and not used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, nor utilized as described in section 45Q(f)(5).

3a Metric tons captured and disposed of

b Section 45Q(a)(3) applicable dollar amount (see instructions)

c Multiply line 3a by line 3b . . . 3c

Qualified carbon oxide captured using carbon capture equipment originally placed in service at a qualified facility on or after February 9, 2018, during the 12-year period beginning on the date the equipment was originally placed in service, disposed of in secure geological storage, and used as a tertiary injectant in a qualified enhanced oil or natural gas recovery project, or used as described in section 45Q(f)(5).

4a Metric tons captured and disposed of

b Section 45Q(a)(4) applicable dollar amount (see instructions)

c Multiply line 4a by line 4b . . . 4c

5 Section 45Q(b)(3) election. Check the box if you're making the election under section 45Q(b)(3) ☐

6 Section 45Q(f)(6) election. Check the box if you're making the election under section 45Q(f)(6) ☐

7 Reserved for future use ■

8 Carbon oxide sequestration credit from partnerships and S corporations . . . 8

9 Add lines 1c, 2c, 3c, 4c, and 8. Partnerships and S corporations, report this amount on Schedule K. All others, report this amount on Form 3800, Part III, line 1x . . . 9

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Future Developments

For the latest information about developments related to Form 8933 and its instructions, such as legislation enacted after they were published, go to *www.irs.gov/Form8933*.

What's New

The section 45Q credit is renamed the carbon oxide sequestration credit to include any carbon oxide and it's otherwise expanded by the Bipartisan Budget Act of 2018 (date of enactment February 9, 2018 (DOE)), making it available to more taxpayers and for more uses with new applicable dollar amounts (credit rates). Also, new elections can be chosen to elect who can claim the credit or which credit rates to apply.

For Paperwork Reduction Act Notice, see instructions. Cat. No. 37748H Form 8933 (2018)

Bureau of Economic Geology

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.

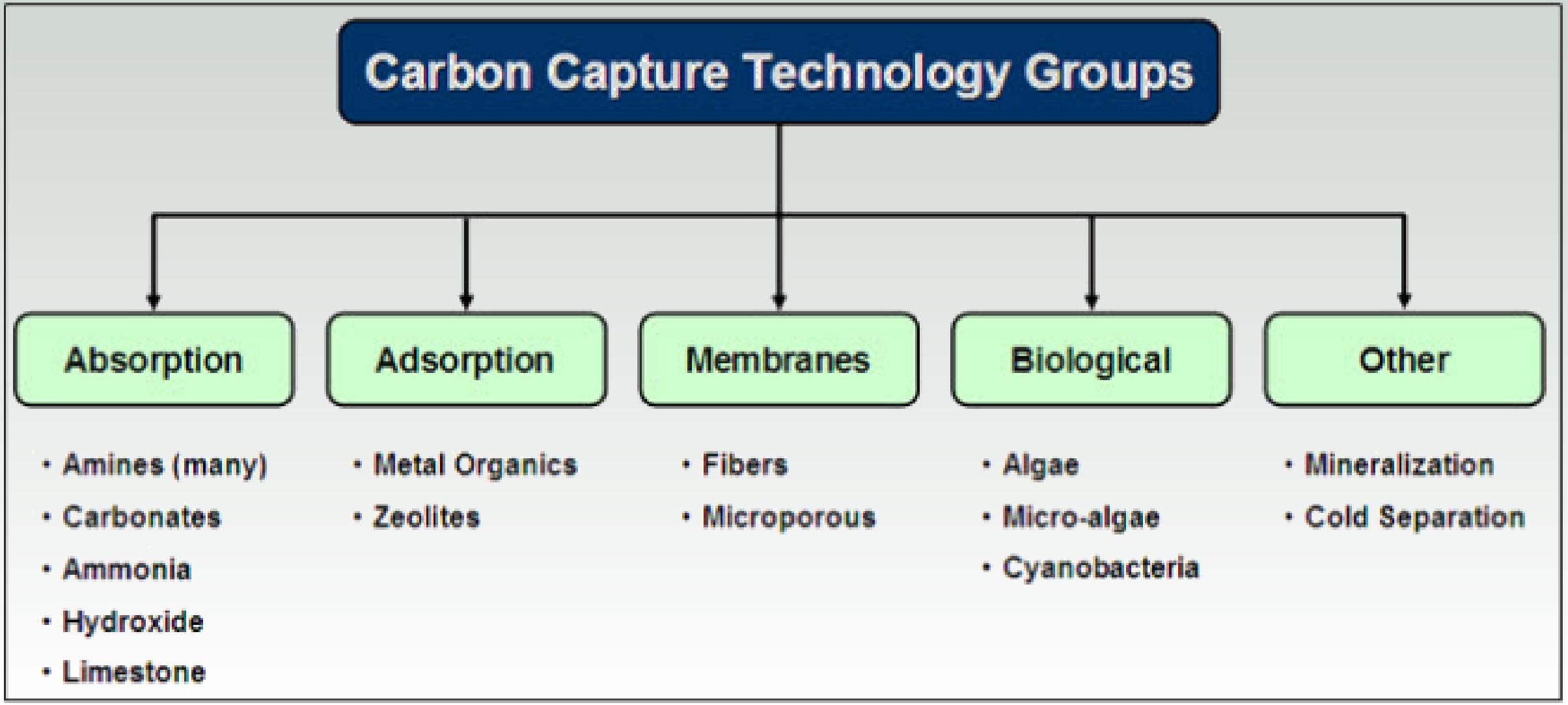
116TH CONGRESS
1ST SESSION

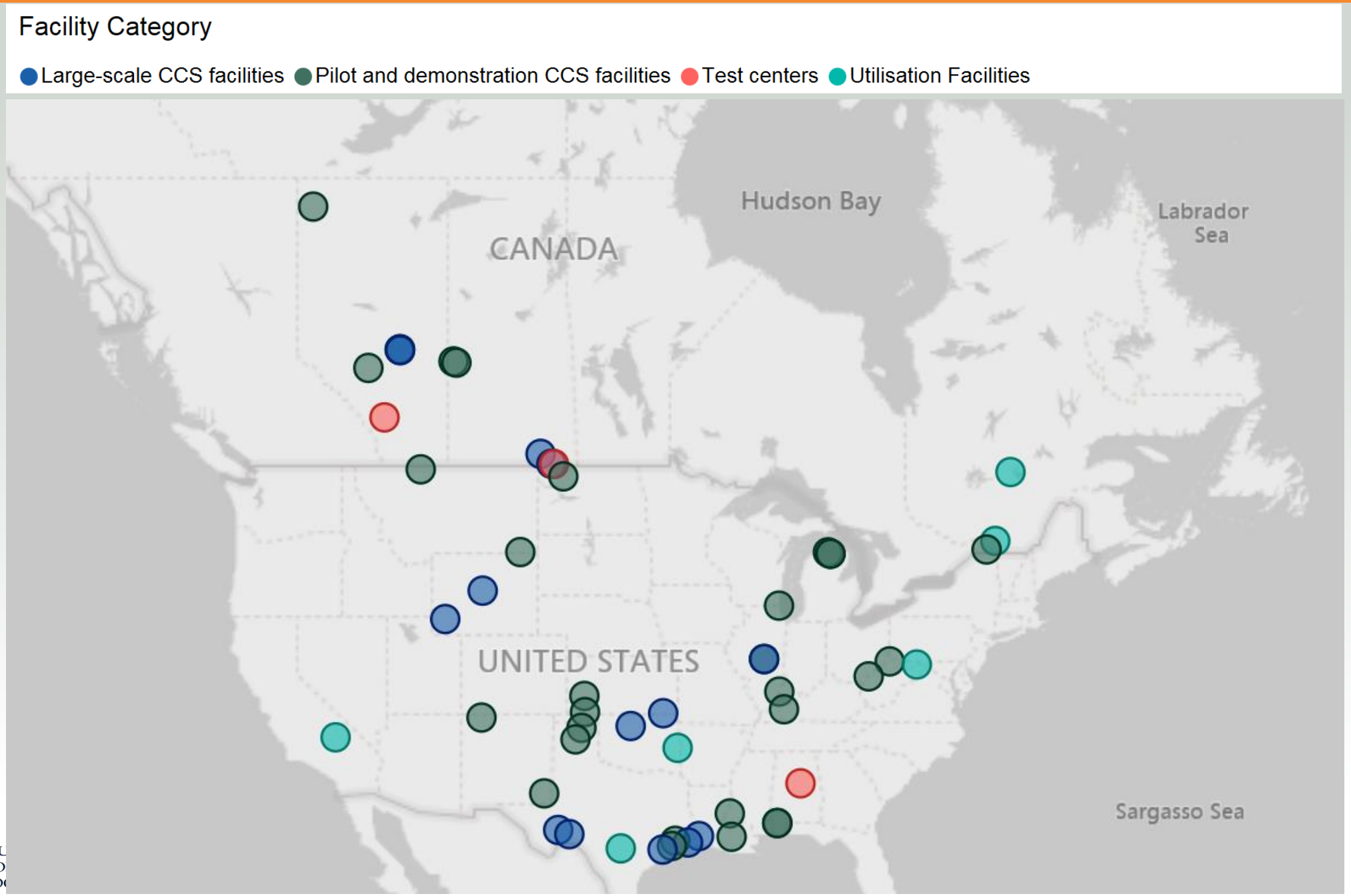
S. 1685

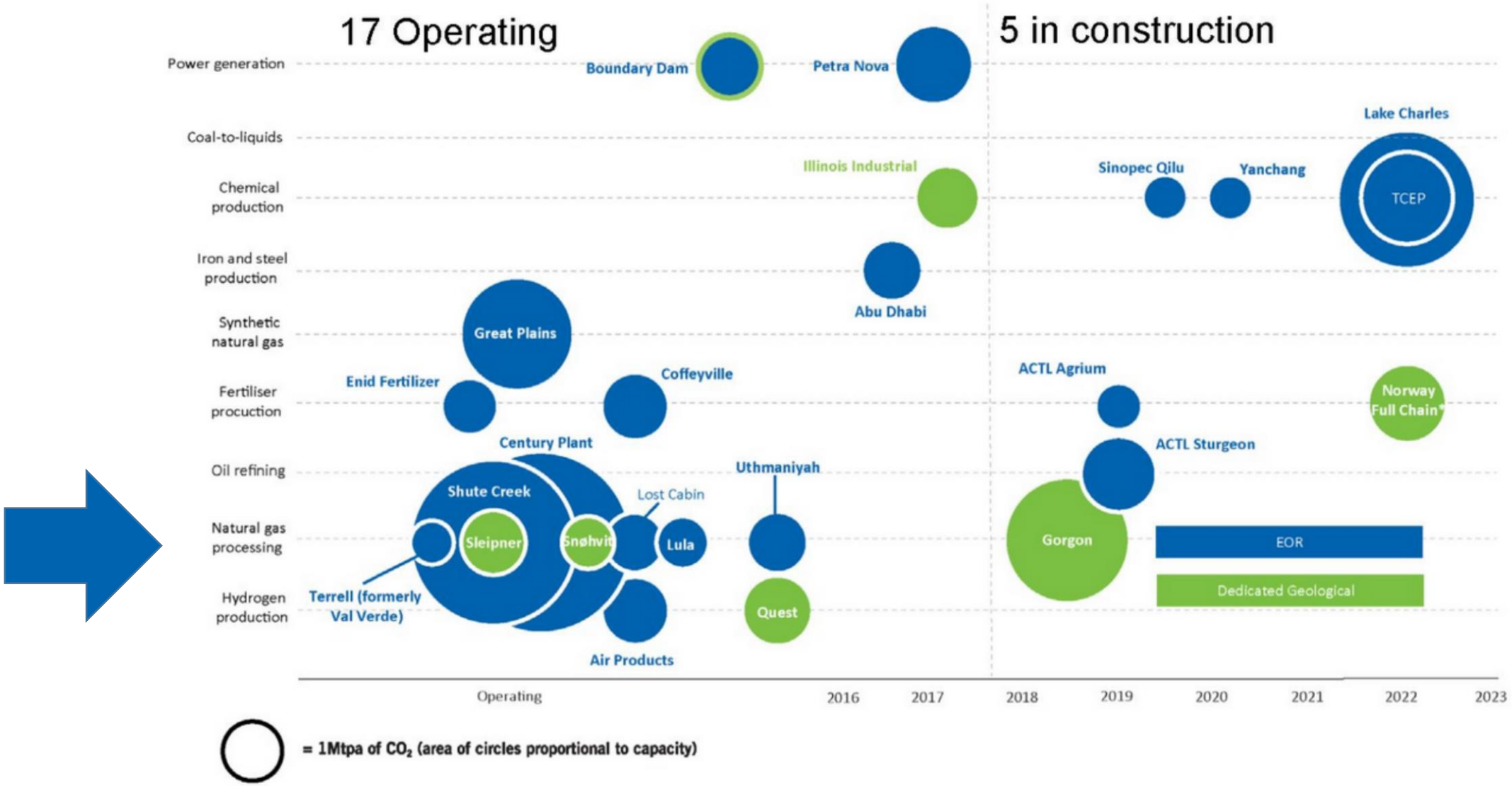
To require the Secretary of Energy to establish a program for the research, development, and demonstration of commercially viable technologies for the capture of carbon dioxide produced during the generation of natural gas-generated power.

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**.


Carbon Capture Technology Groups
Absorption
Adsorption
Membranes
Biological
Other
• Amines (many)
• Carbonates
• Ammonia
• Hydroxide
• Limestone
• Metal Organics
• Zeolites
• Fibers
• Microporous
• Algae
• Micro-algae
• Cyanobacteria
• Mineralization
• Cold Separation

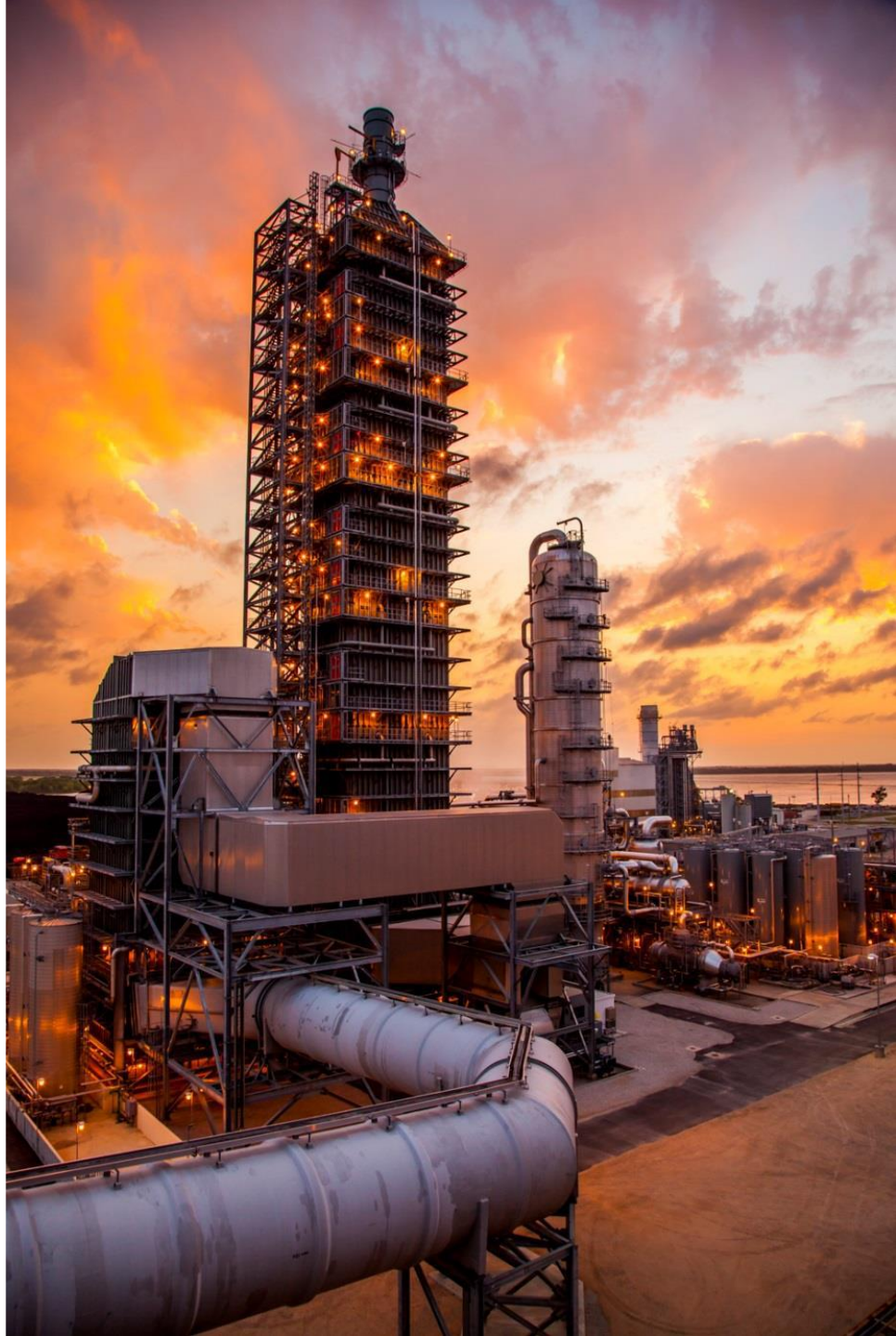

Facility Category
Large-scale CCS facilities
Pilot and demonstration CCS facilities
Test centers
Utilisation Facilities
Hudson Bay
Labrador Sea
CANADA
UNITED STATES
Sargasso Sea



Source: GCCSI

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 CO_2 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 CO_2 per day.
- Probably not going to do this again without major change in capture costs and EOR operations.

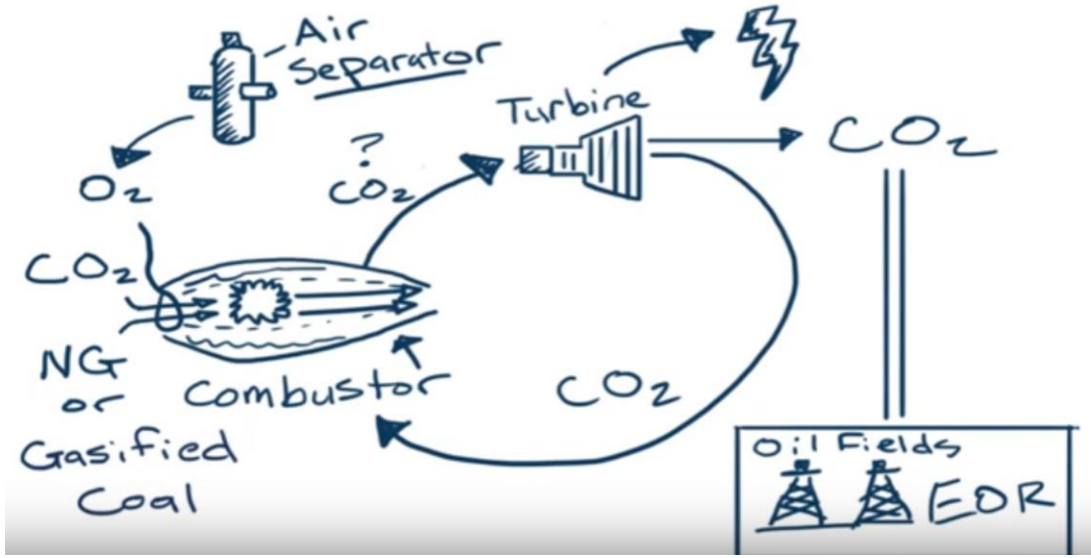


Existing TX Example: Air Products (Port Arthur + Hastings)

- 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.
- CO_2 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 MW_e commercial plants under FEED development. Plan to deploy globally, with some consideration for Gulf Coast.
- High pressure, high purity CO_2 offtake.



ClearPath

https://www.netpower.com/news/

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 CO_2 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 CO_2 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 CO_2 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 CO_2 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 CO_2 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

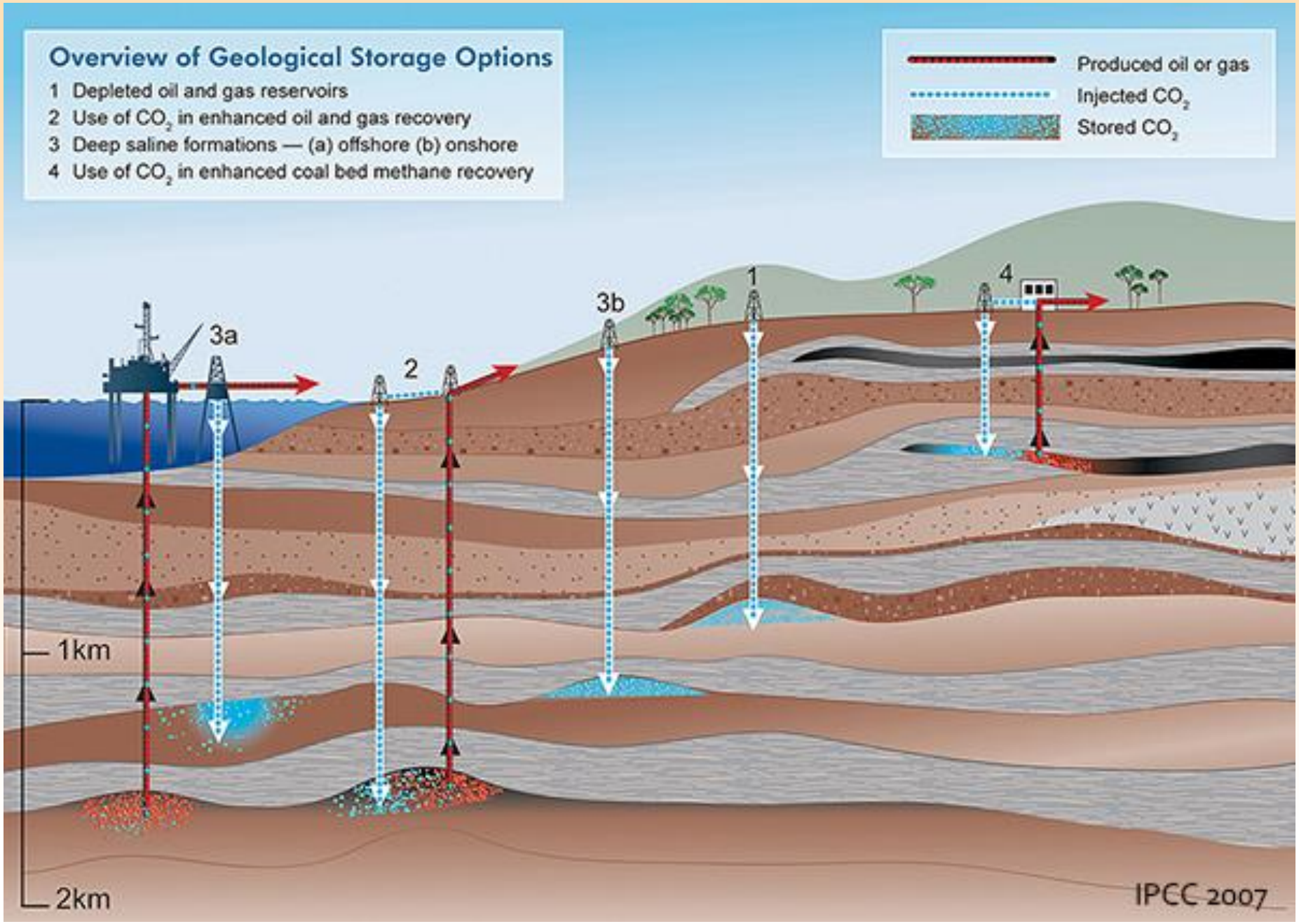
Must provide net reduction of emissions.

- 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.

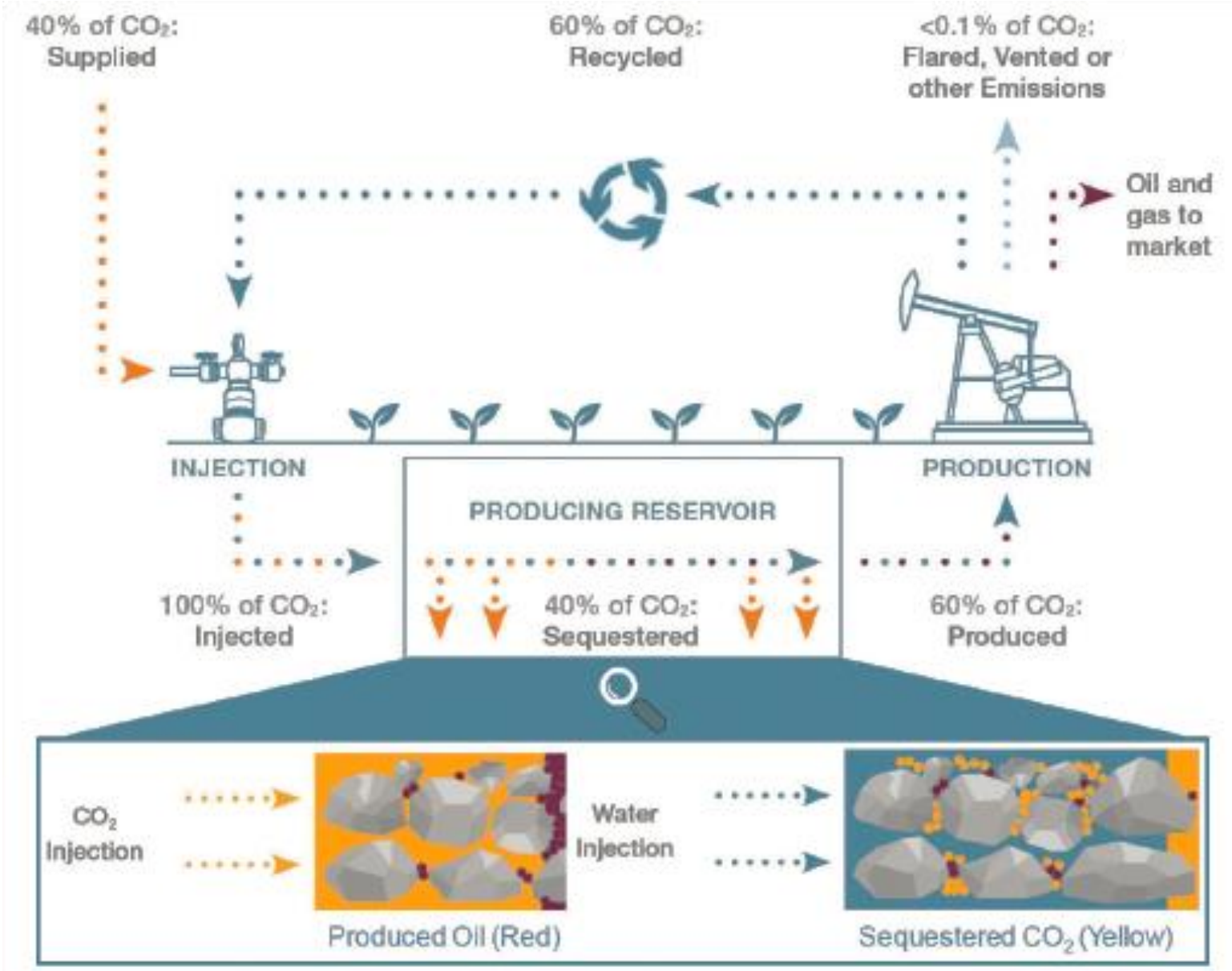
Utilization: Products

- 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.
- **CO_2-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 CO_2 to other substances.
  - Need source of low cost electricity and heat.
- Due to the cost of transport, the re-use of CO_2 will need to take place near sources of captured CO_2, which is a geographic constraint.



Bureau of Economic Geology

Enhanced Oil Recovery using CO_2



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 CO_2

Type of CO_2 Storage/Use	Minimum Size of Eligible Carbon Capture Plant by Type ($ktCO_2/yr$)			Relevant Level of Tax Credit in a Given Operational Year ($USD/$tCO_2$)									
	Power Plant	Other Industrial Facility	Direct Air Capture	2018	2019	2020	2021	2022	2023	2024	2025	2026	Beyond 2026
Dedicated Geological Storage	500	100	100	28	31	34	36	39	42	45	47	50	Indexed to Inflation
Storage via EOR	500	100	100	17	19	22	24	26	28	31	33	35	
Other Utilization Processes[1]	25	25	25	17[2]	19	22	24	26	28	31	33	35	

[1] Each CO_2 source cannot be greater than 500 $ktCO_2/yr$

[2] Any credit will only apply to the portion of the converted CO_2 that can be shown to reduce overall emissions

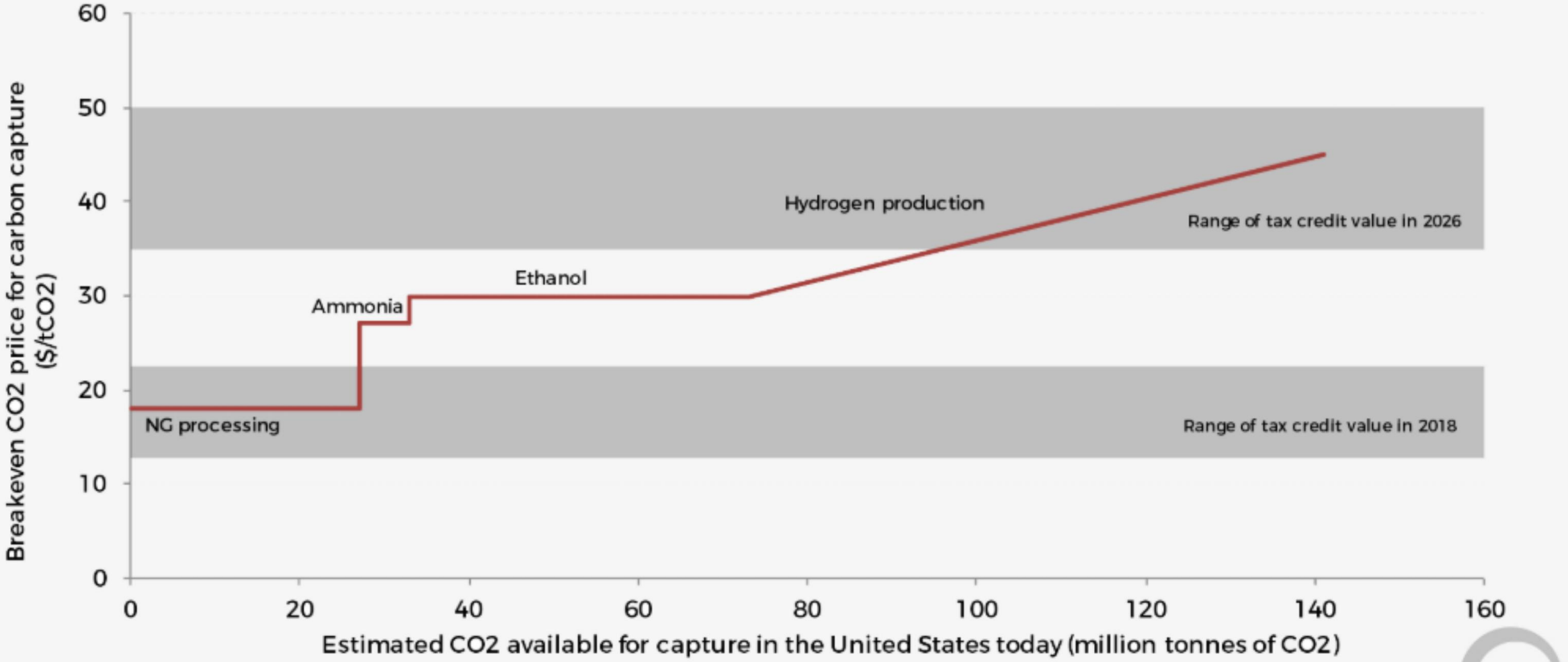
ENERGY FUTURES INITIATIVE

Source: Closely adapted from Simon Bennett and Tristan Stanley, Commentary: US budget bill may help carbon capture get back on track, International Energy Agency.

CREDIT RATE			UTILIZATION (tons/yr)			STORAGE	
YEAR	Utilization	Storage	25,000	100,000	500,000	100,000	500,000
2019	$ 17.76	$ 28.74	$ 444,000	$ 1,776,000	$ 8,880,000	$ 2,874,000	$ 14,370,000
2020	$ 20.22	$ 31.78	$ 505,571	$ 2,022,286	$ 10,111,429	$ 3,177,714	$ 15,888,571
2021	$ 22.69	$ 34.81	$ 567,143	$ 2,268,571	$ 11,342,857	$ 3,481,429	$ 17,407,143
2022	$ 25.15	$ 37.85	$ 628,714	$ 2,514,857	$ 12,574,286	$ 3,785,143	$ 18,925,714
2023	$ 27.61	$ 40.89	$ 690,286	$ 2,761,143	$ 13,805,714	$ 4,088,857	$ 20,444,286
2024	$ 30.07	$ 43.93	$ 751,857	$ 3,007,429	$ 15,037,143	$ 4,392,571	$ 21,962,857
2025	$ 32.54	$ 46.96	$ 813,429	$ 3,253,714	$ 16,268,571	$ 4,696,286	$ 23,481,429
2026	$ 35.00	$ 50.00	$ 875,000	$ 3,500,000	$ 17,500,000	$ 5,000,000	$ 25,000,000
2027	*$ 35.53*	*$ 50.75*	$ 888,125	$ 3,552,500	$ 17,762,500	$ 5,075,000	$ 25,375,000
2028	*$ 36.06*	*$ 51.51*	$ 901,447	$ 3,605,788	$ 18,028,938	$ 5,151,125	$ 25,755,625
2029	*$ 36.60*	*$ 52.28*	$ 914,969	$ 3,659,874	$ 18,299,372	$ 5,228,392	$ 26,141,959
2030	*$ 37.15*	*$ 53.07*	$ 928,693	$ 3,714,772	$ 18,573,862	$ 5,306,818	$ 26,534,089
2031	*$ 37.70*	*$ 53.86*	$ 942,624	$ 3,770,494	$ 18,852,470	$ 5,386,420	$ 26,932,100
2032	*$ 38.27*	*$ 54.67*	$ 956,763	$ 3,827,051	$ 19,135,257	$ 5,467,216	$ 27,336,082
		SUM	**$ 9,859,048**	**$ 39,436,194**	**$ 197,180,970**	**$ 57,059,257**	**$ 285,296,283**

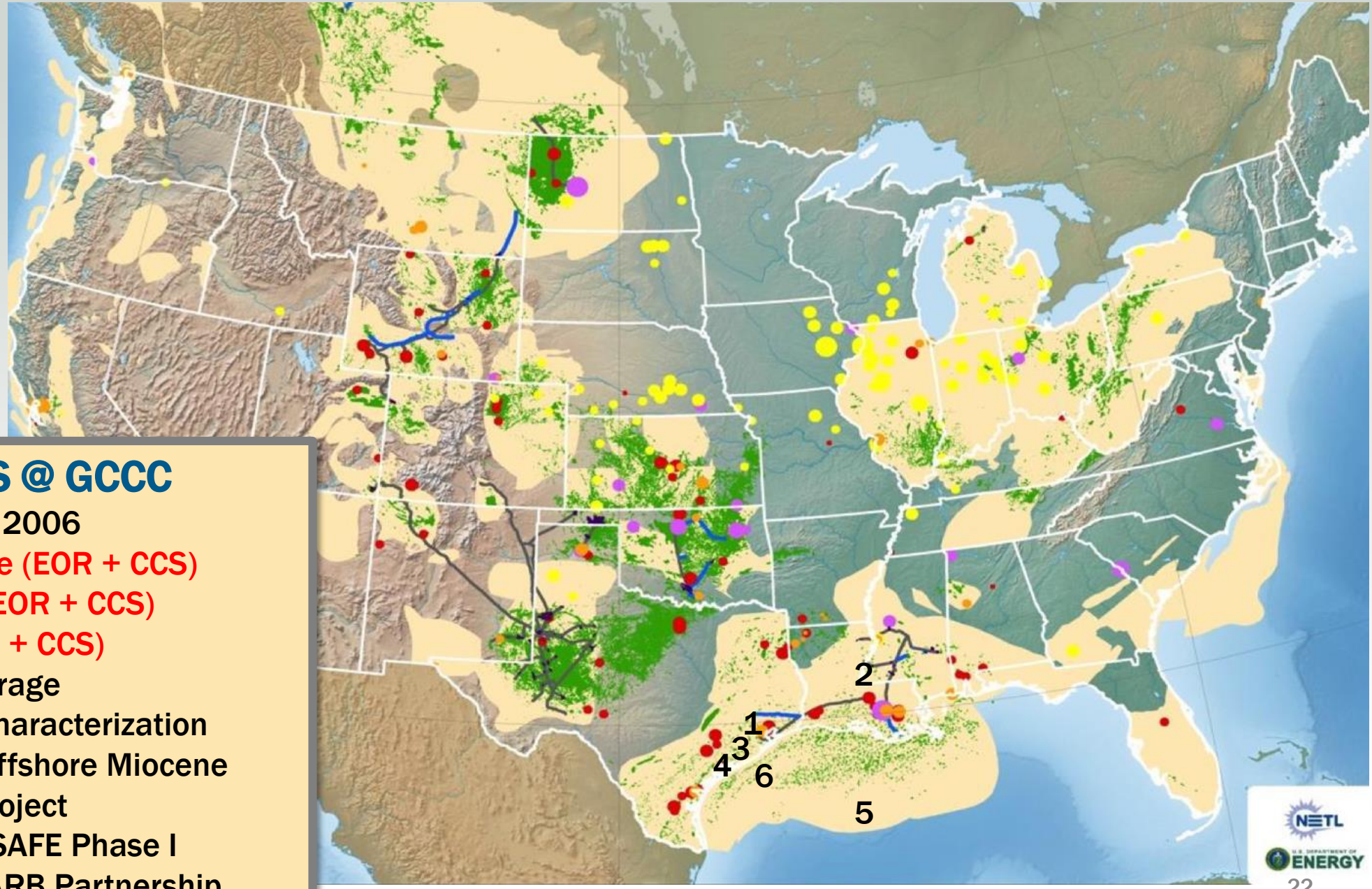
Breakeven CO_2 price vs. estimated CO_2 availability

IEA Analysis, NETL, IEAGHG



Regional Gulf Coast setting for rapid large-scale carbon management in U.S. heavy industry

Gulf Coast Carbon Center



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

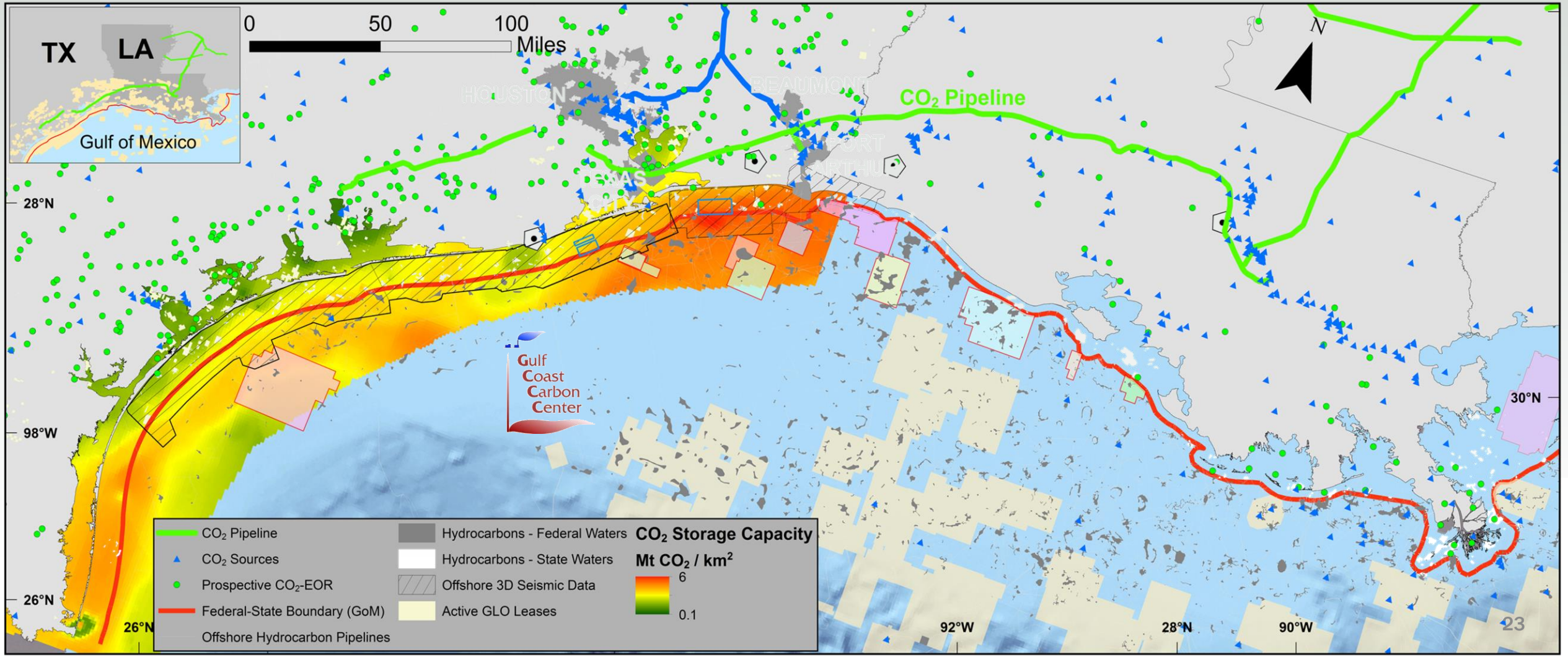
NETL
U.S. DEPARTMENT OF ENERGY

Static Regional Capacity

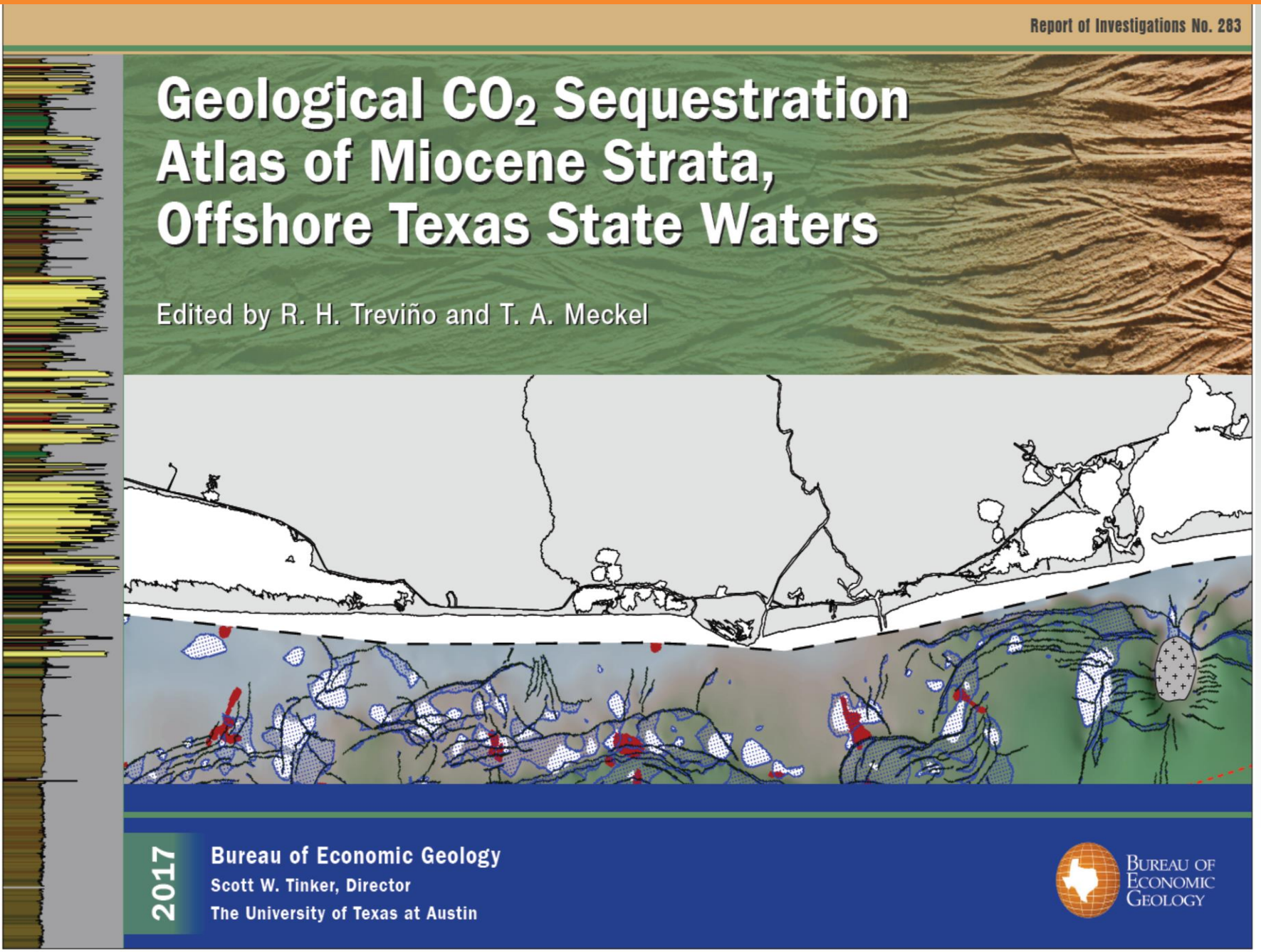
- NETL Methodology
- 40,000 sq. km.

- 3,300 logs
  - Tops, net sand, porosity

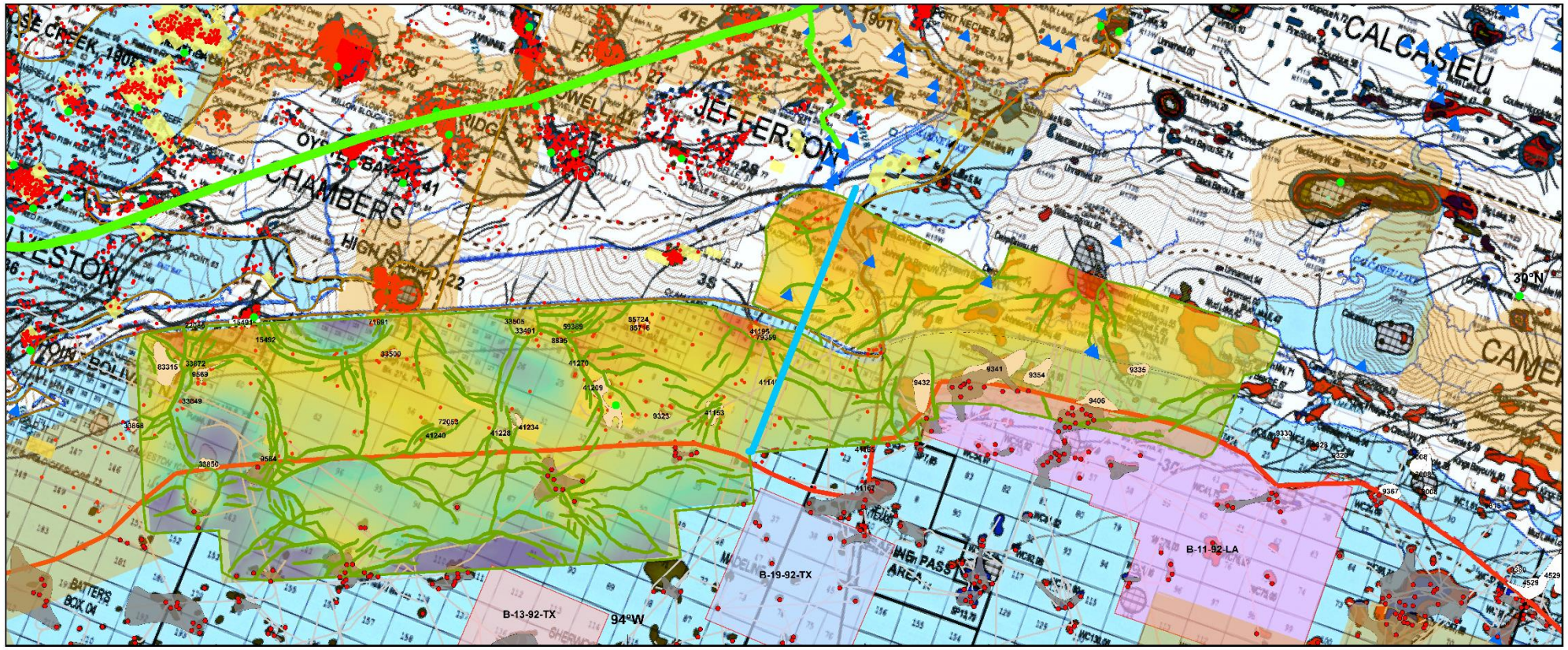
- 172 Gt CO_2 storage total TX State Waters



2017 Comprehensive Study of CO_2 Storage in Texas 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
7. Estimating CO_2 Storage Capacity in Saline Aquifer Using 3D Flow Models, Lower Miocene, Texas Gulf of Mexico
8. Appendix A: Regional Cross Sections, Miocene Strata of Offshore Texas State Waters



- Gulf of Mexico Gas and Oil Sands
- CO_2 Pipeline
- CO_2 Sources
- Prospective CO_2-EOR
- Wells RRC District 3
- Fault Interpretation - Miocene (MFS09)
- 3D Seismic - SEI, Inc.

Miocene Structure (SB_M09)

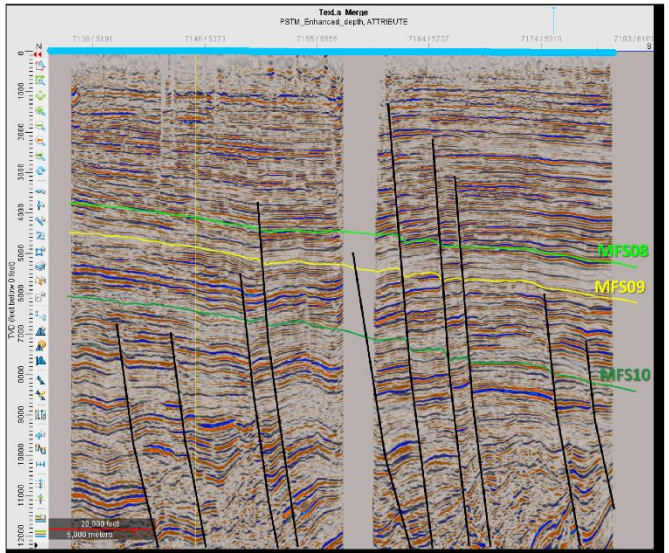
DEEP (2.5 sec TWTT)

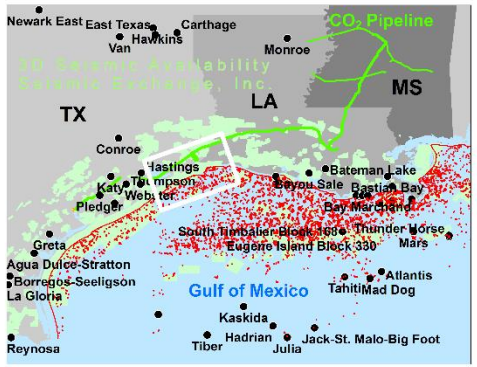
SHALLOW (1.5 sec TWTT)

- Hydrocarbons - State Waters
- Active GLO Leases
- Hydrocarbons - Federal Waters
- Federal-State Boundary (GoM)
- Offshore Hydrocarbon Pipelines
- Federal Lands

N

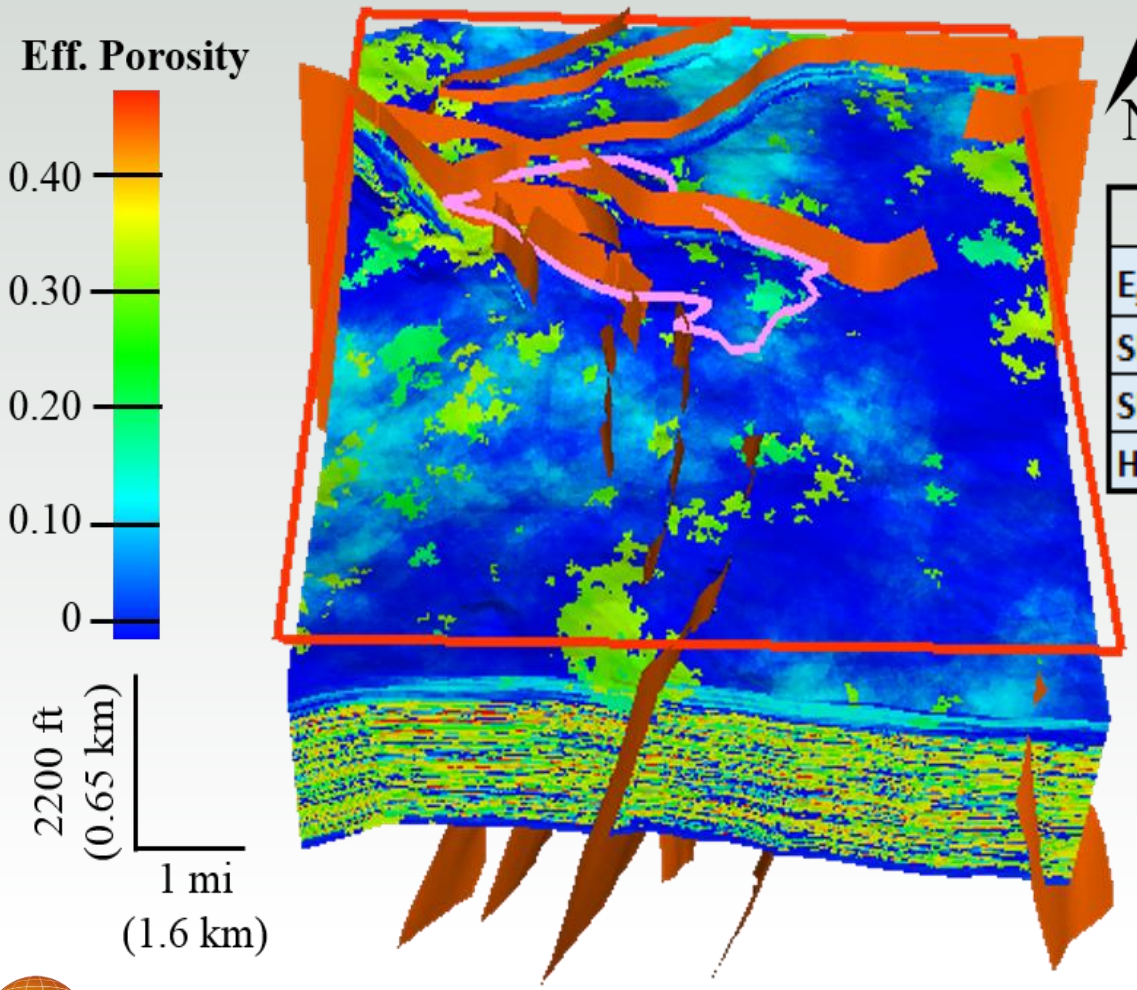
0 5 10 Miles





RESERVOIR PERFORMANCE

Approximately 12 Mt in 200’ sand, maybe 100 Mt in thickest intervals



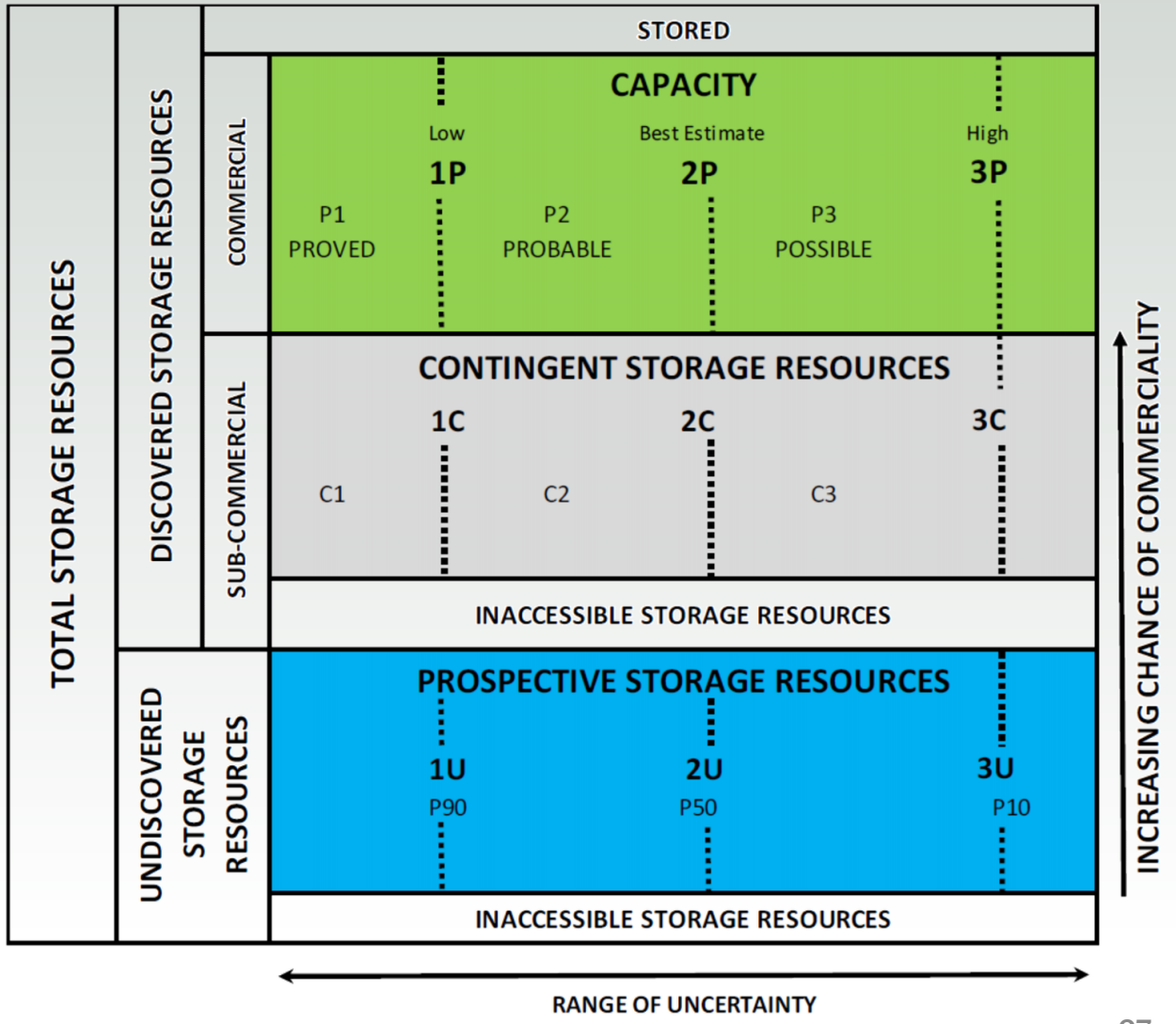
STATIC VOLUMETRIC CALCULATIONS

	P10	P50	P90
$E_{saline} = E_v E_d$	7.4%	14%	24%
SIOI: NETL CO2 Screen (Mt)	63	120	206
SIOI: 3-D Eff. Porosity Model (Mt)	57	108	185
HC Sand: 3-D Constant Avg. Eff. Porosity Model (Mt)	6	12	20

Geologic geocellular effective porosity model used for calculating CO_2 storage capacity in the SIOI. The AOI is outlined in red, SIOI structural footprint in pink, and faults are in orange.

SPE Storage Resources Management System (SRMS)

- Uniformity, clarity, familiarity
- ‘Bankable’ storage – financing.
- Similar to PRMS
  - SRMS exists
  - https://www.spe.org/industry/CO2-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!!

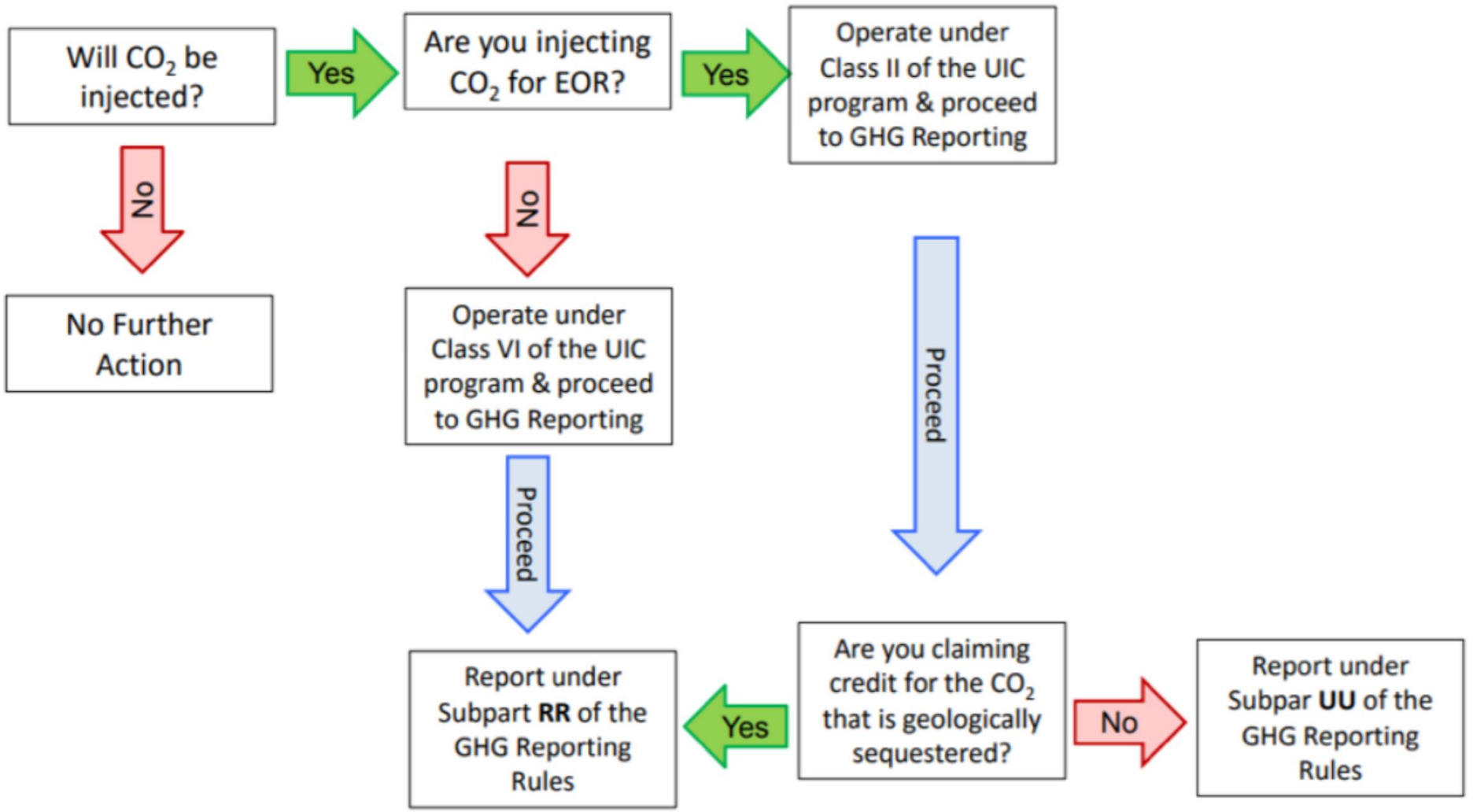
Needed IRS Guidance:

- **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_x** 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

https://www.irs.gov/pub/irs-drop/n-19-32.pdf

Federal CO_2 Injection Requirement Flow Chart



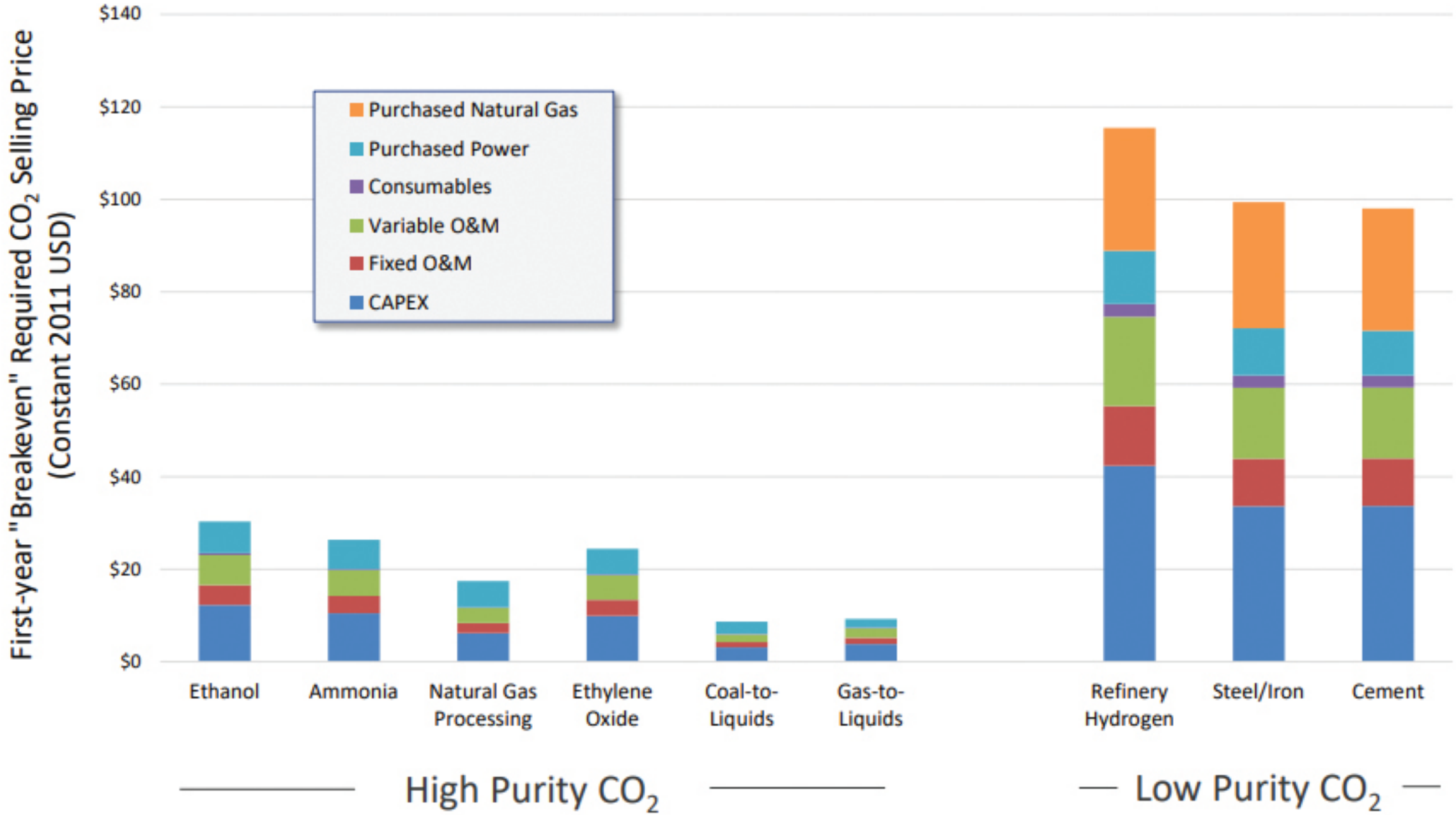
EPA's Suggested Outline for MRV Plans

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

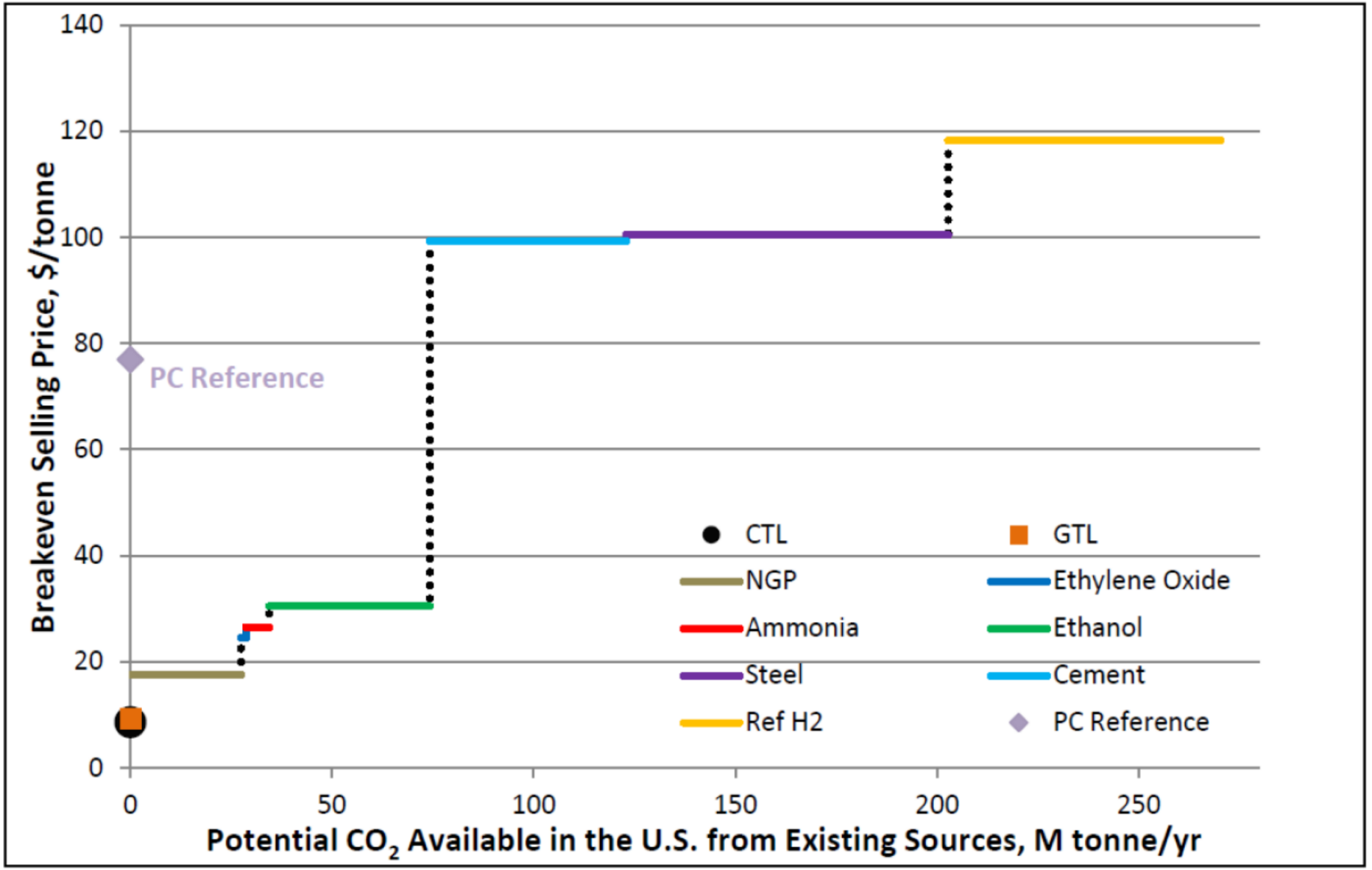
Source: U.S. EPA, Office of Air and Radiation, "General Technical Support Document for Injection and Geologic Sequestration of Carbon Dioxide: Subparts RR and UU – Greenhouse Gas Reporting Program," November 2010.

Table 3: Active CCUS Projects in the United States as of 2015 (adapted from the GCCSI database)

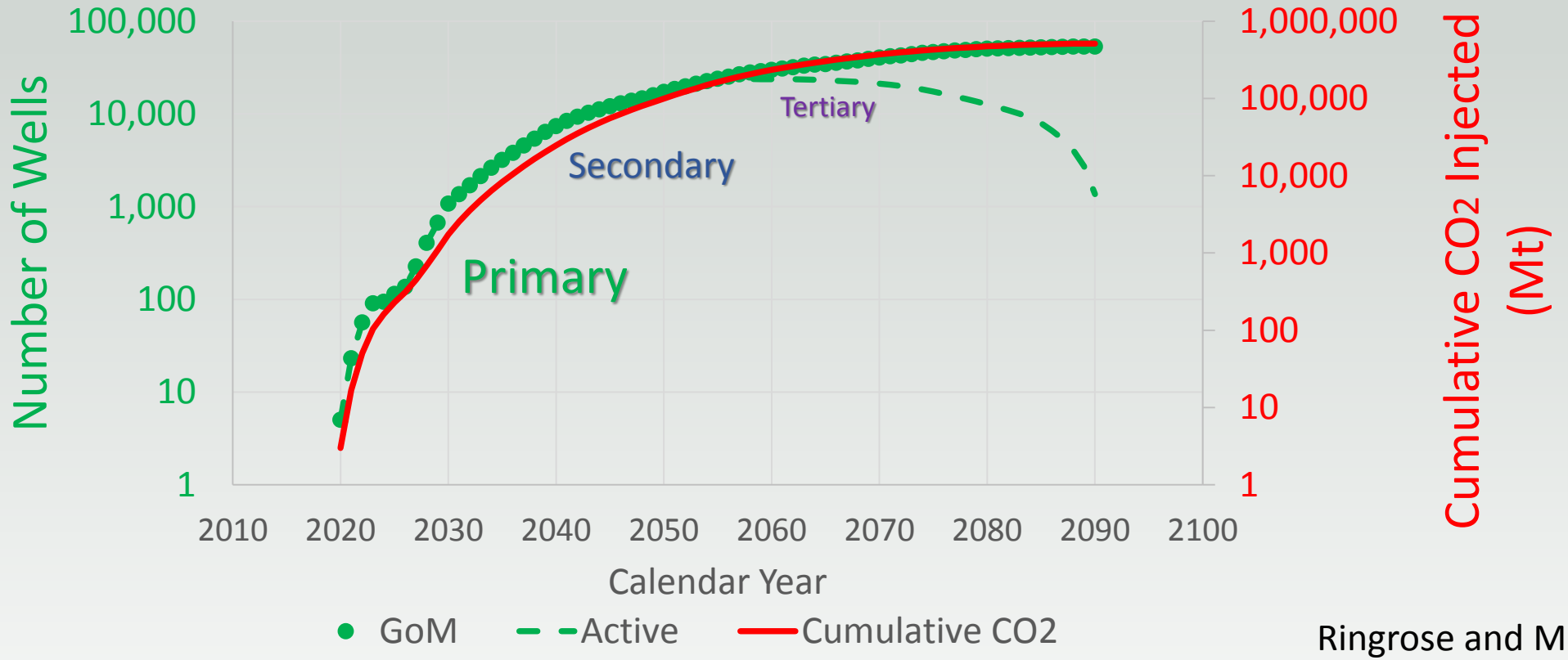
	Active Projects	State	Primary Industry	Year of Operation	Capture Capacity (Metric tons per year)	Transport Distance (miles)
Operate	Coffeyville Gasification Plant	KS	Fertilizer Production	2013	1	70
	Air Products Steam Methane Reformer EOR Project	TX	Hydrogen Production	2013	1	98
	Century Plant	TX	Natural Gas Processing	2010	8.4	>158
	Val Verde Natural Gas Plants	TX	Natural Gas Processing	1972	1.3	221
	Shute Creek Gas Processing Facility	WY	Natural Gas Processing	1986	7	Multiple Pipelines, Max of 286
	Lost Cabin Gas Plant	WY	Natural Gas Processing	2013	0.9	232
	Great Plains Synfuel Plant and Weyburn-Midale Project	ND	Synthetic Natural Gas	2000	3	204
	Enid Fertilizer CO_2-EOR Project	OK	Fertilizer Production	1982	0.7	140
Execute	Illinois Industrial Carbon Capture and Storage Project	IL	Chemical Production	2016	1	1
	Petra Nova Carbon Capture Project	TX	Power Generation	2016	1.4	82
	Kemper County Energy Facility	MS	Power Generation	2016	3	60
Define	Riley Ridge Gas Plant	WY	Natural Gas Processing	2020	2.5	Not Specified


First-year "Breakeven" Required CO_2 Selling Price (Constant 2011 USD)
$140
$120
$100
$80
$60
$40
$20
$0
Purchased Natural Gas
Purchased Power
Consumables
Variable O&M
Fixed O&M
CAPEX
Ethanol
Ammonia
Natural Gas Processing
Ethylene Oxide
Coal-to-Liquids
Gas-to-Liquids
Refinery Hydrogen
Steel/Iron
Cement
High Purity CO_2
Low Purity CO_2

Cost Analysis for Industrial Carbon Capture



Gulf of Mexico – CO_2 well development scenario



Ringrose and Meckel, in review

2020+ SCENARIO	Avg. Well Inj. Rate Mt/yr	Number of active wells in 2050	Incremental Rate in 2050 Mt/yr	Cumulative Mass in 2050 Mt CO2	Comment
GoM	0.6	17,175	10,305	99,946	Unlikely one region will develop this aggressively; Incremental goal exceeded; Close to cumulative goal
GoM	0.41	17,175	7,000	67,891	Injection rate low, not cost effective; Cumulative goal not met