OVERVIEW OF CO_2 CAPTURE, TRANSPORT, AND INFRASTRUCTURE IN THE GULF OF MEXICO: OPPORTUNITIES & CHALLENGES

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Partnership for carbon capture & offshore geologic storage GoMCarb

GCCC Gulf Coast Carbon Center

Bureau of Economic Geology

National Energy Technology Laboratory

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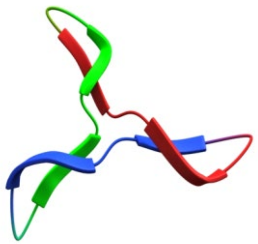
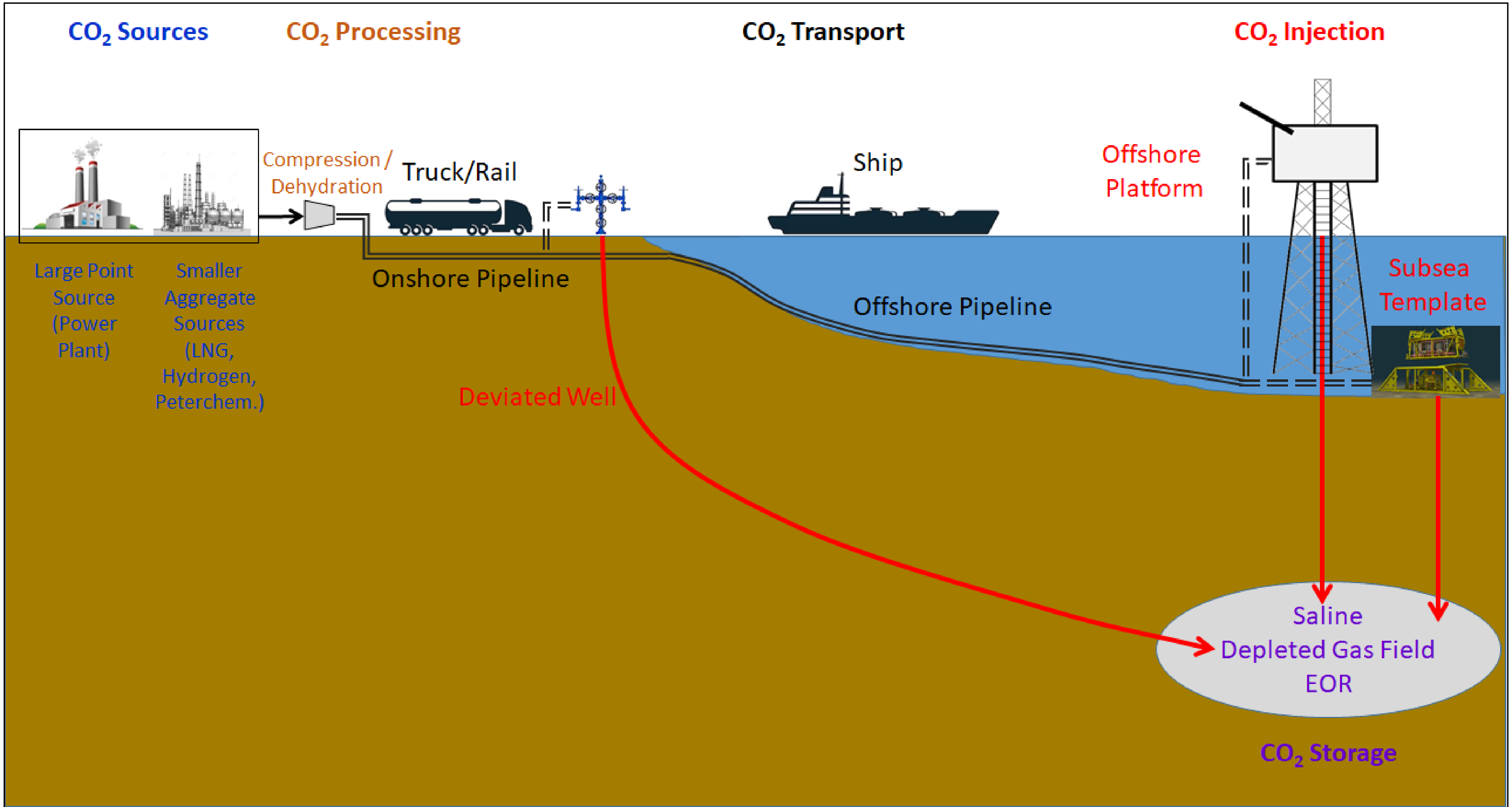
Background

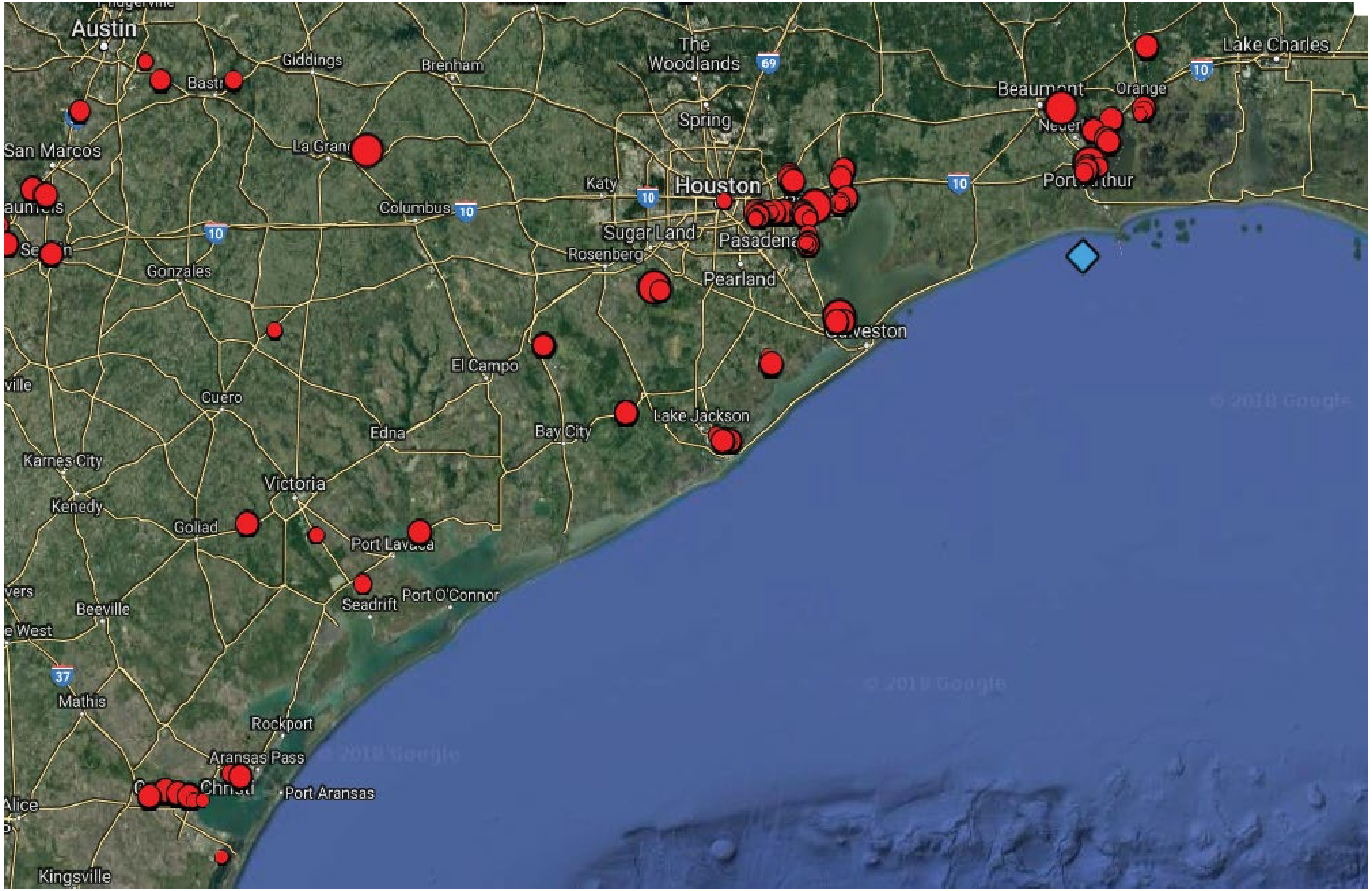
- Gulf of Mexico Partnership for Offshore Carbon Storage
  - A Partnership to ensure the safe, long-term, and economically-viable offshore storage of carbon in the Gulf of Mexico region
- Trimeric
  - We provide Chemical and Process Engineering services to industry, government agencies, and consortia
    - We do not represent any equipment, process, chemical suppliers
    - We are unbiased advocates for our clients
  - 18 Chemical Engineers on regular, full-time staff;7 Senior Associates
  - Founded in 2003
  - Austin / Buda, TX location



Outline of Near-Offshore Storage



Potential CO_2 Sources: Texas Gulf Coast



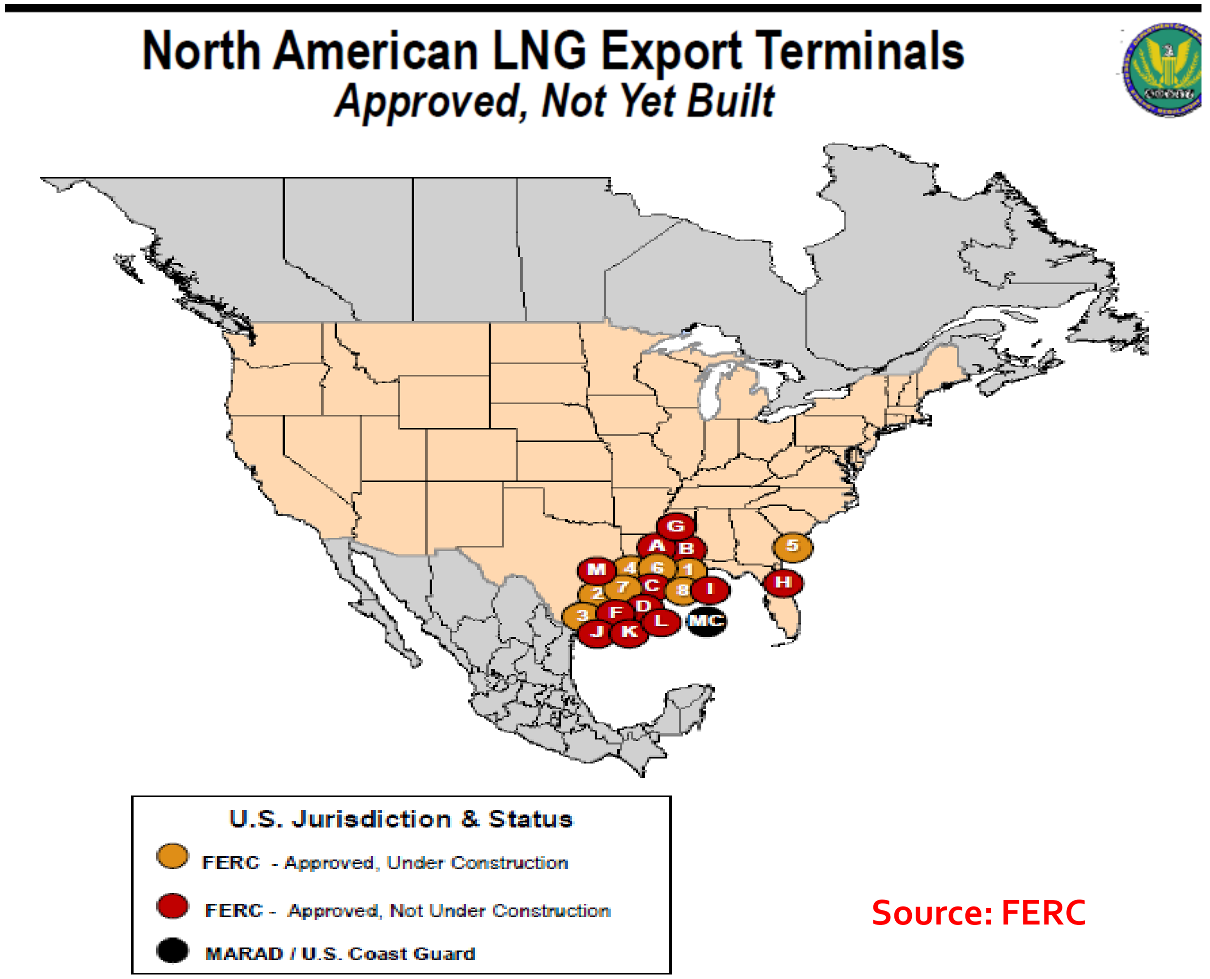
- Large Source = 400k+ tonnes CO_2/yr
  - Size of dot indicates scale of emissions)
- 148 Large Sources in Texas
  - ~75 within 50 miles of coastline
- Regions of Focus
  - Beaumont/Port Arthur
  - Greater Houston
  - Corpus Christi
- Data from EPA GHGRP 2017

CO_2 Sources: 45Q Tax Credits (2018 Revised)

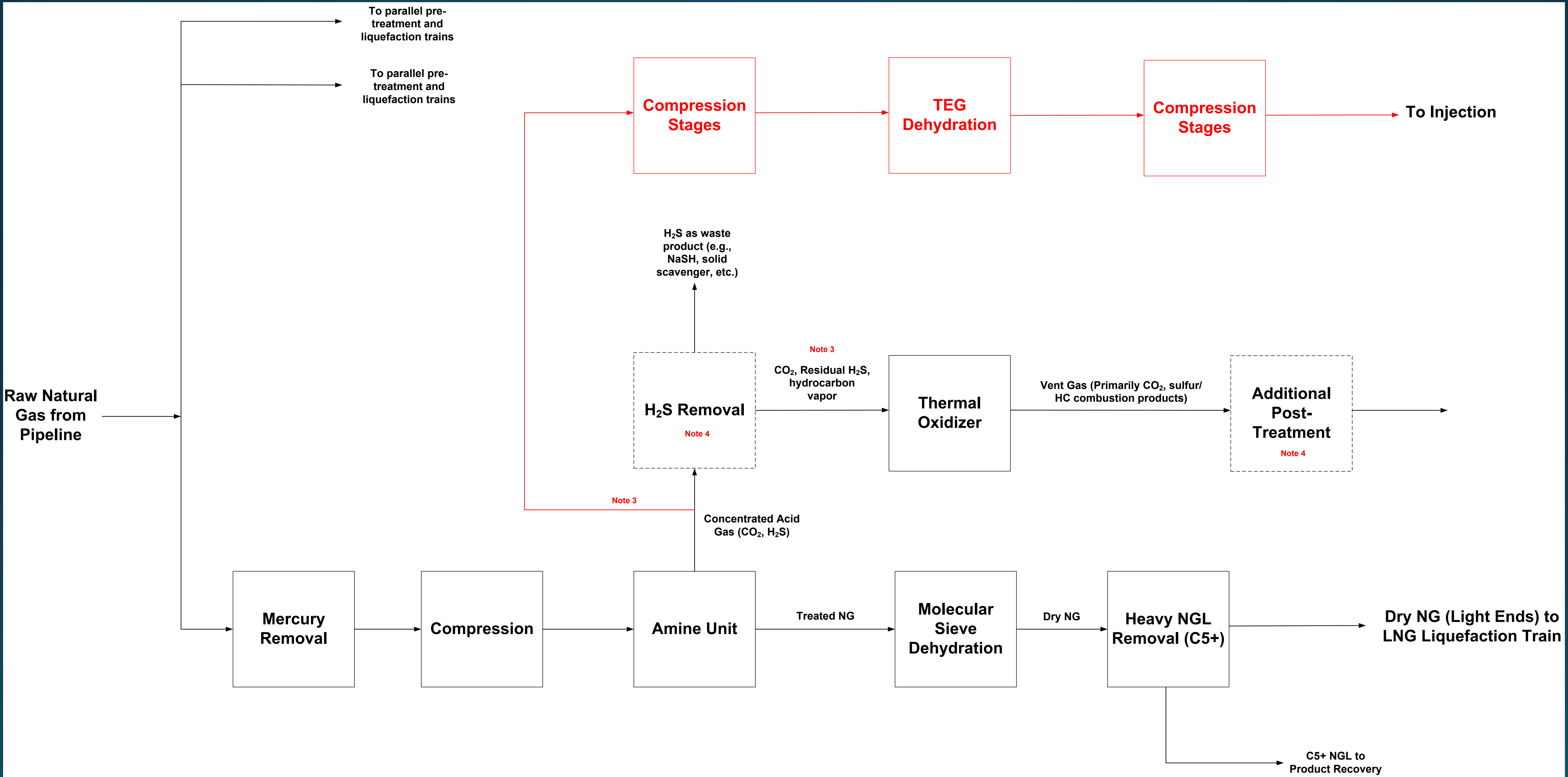
- Capture and Sequestration Requirements
  - 500,000 tonnes/yr (Power Plant)
  - 25,000 tonnes/yr (Utilization)
  - 100,000 tonnes/yr (All Others)
- Progressive Tax Credit
  - U.S. $20 - $35+ for EOR/EGR and Utilization
  - U.S. $32 - $50 for Non-EOR
- Construction must start by 1/1/2024

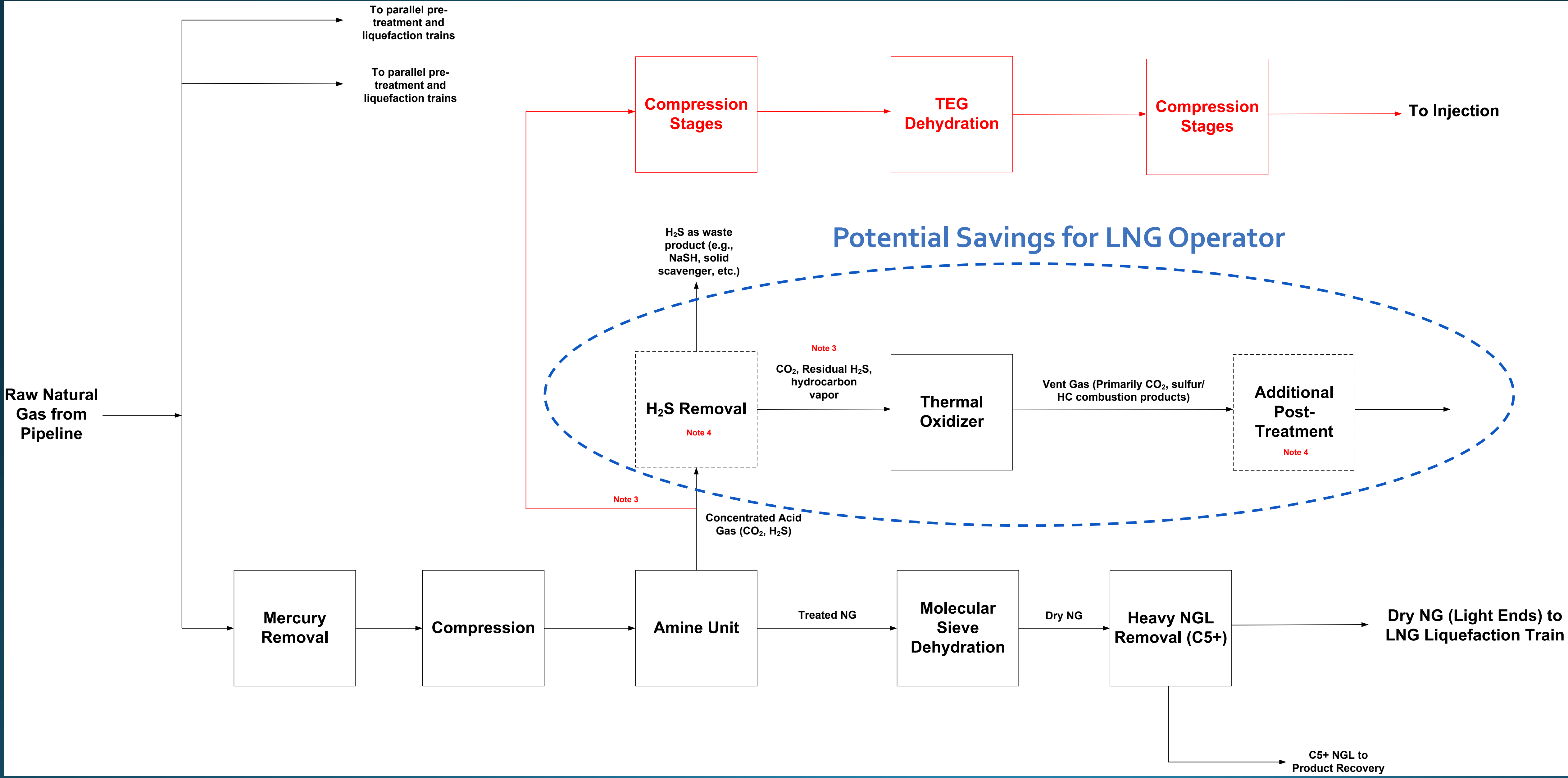
LNG Facilities: Emerging Opportunity?

- High-purity CO_2 source
  - CO_2 generated as part of the purification of LNG
- Large CO_2 source
  - Public GHG PSD Application LNG Facility = 3 LNG trains
  - CO_2 emissions > 1.5 million tonnes/year
    - ~2 sources: gas turbines (dilute CO_2), AGRU (concentrated CO_2)
- Several facilities/projects in near-shore GoMCarb region
  - Trimeric tracking >10 facilities/projects
  - Operators have indicated openness to engagement with GoMCarb
- Potential benefits to LNG operators
  - 45Q tax credits
  - Eliminate/reduce load on pre-treatment processes (e.g., thermal oxidizer)



Source: FERC


To parallel pre-treatment and liquefaction trains
To parallel pre-treatment and liquefaction trains
Compression Stages
TEG Dehydration
Compression Stages
To Injection
H$_2$S as waste product (e.g., NaSH, solid scavenger, etc.)
Note 3
CO$_2$, Residual H$_2$S, hydrocarbon vapor
H$_2$S Removal
Note 4
Thermal Oxidizer
Vent Gas (Primarily CO$_2$, sulfur/ HC combustion products)
Additional Post-Treatment
Note 4
Raw Natural Gas from Pipeline
Note 3
Concentrated Acid Gas (CO$_2$, H$_2$S)
Mercury Removal
Compression
Amine Unit
Treated NG
Molecular Sieve Dehydration
Dry NG
Heavy NGL Removal (C5+)
Dry NG (Light Ends) to LNG Liquefaction Train
C5+ NGL to Product Recovery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Potential Savings for LNG Operator
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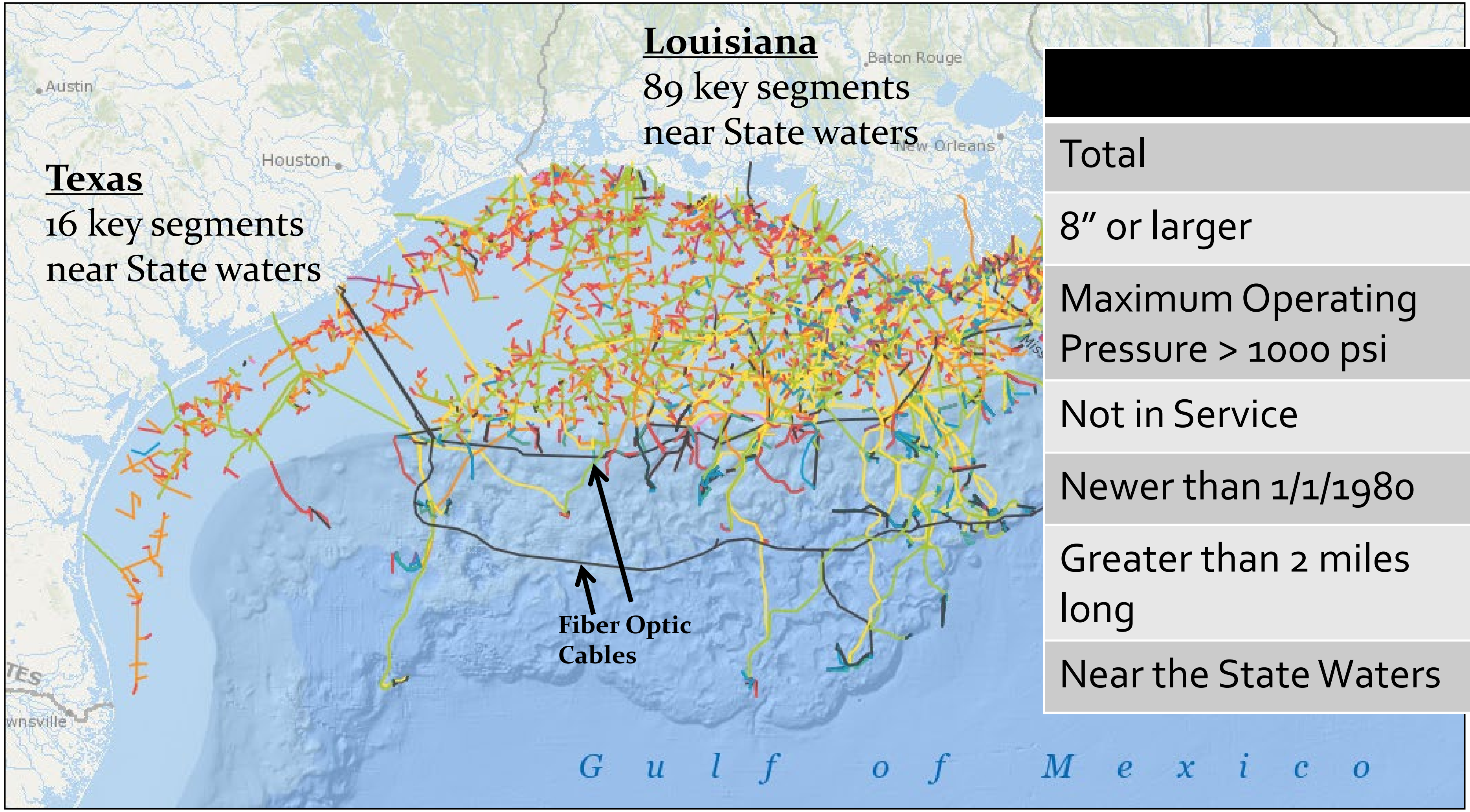
LNG Facilities: Challenges

- Impurities in AGRU CO_2
  - Hydrocarbons (e.g., methane, benzene, etc.), H_2S
  - Additional processing for transport offsets benefits of AGRU gas offtake
- Impact to LNG Facility
  - LNG Operators: Focus is on LNG production – ideally, CO_2 transaction handled separately by third party
    - CO_2 capture plan needs to start early in investment planning for LNG facility
  - Impact to production
    - What happens if CO_2 transport/storage goes offline? Design flare to handle AGRU offgas?

Infrastructure Re-use

- Wells, Pipelines, and Platforms for Oil and Gas Production = Potential Re-use Targets
- Goals:
  - Develop screening criteria to assess the scale of the opportunity
  - Identify high priority opportunities for more detailed assessment
  - Identify data gaps/needs/challenges
- For today's presentation – Pipelines as an example
  - Represent a high value re-use opportunity
  - Represent general challenges of re-use

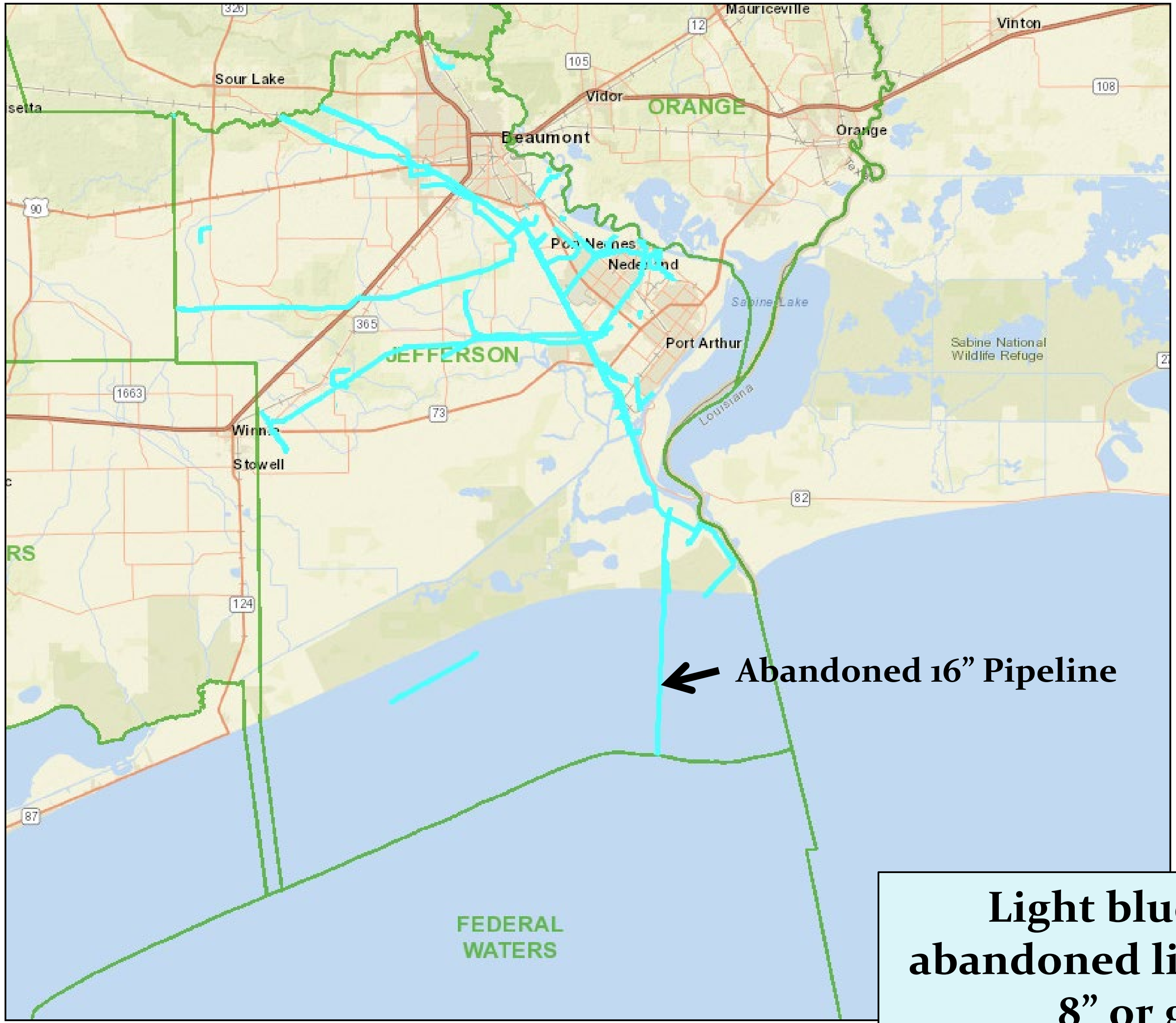
Pipeline Opportunity: Federal Waters

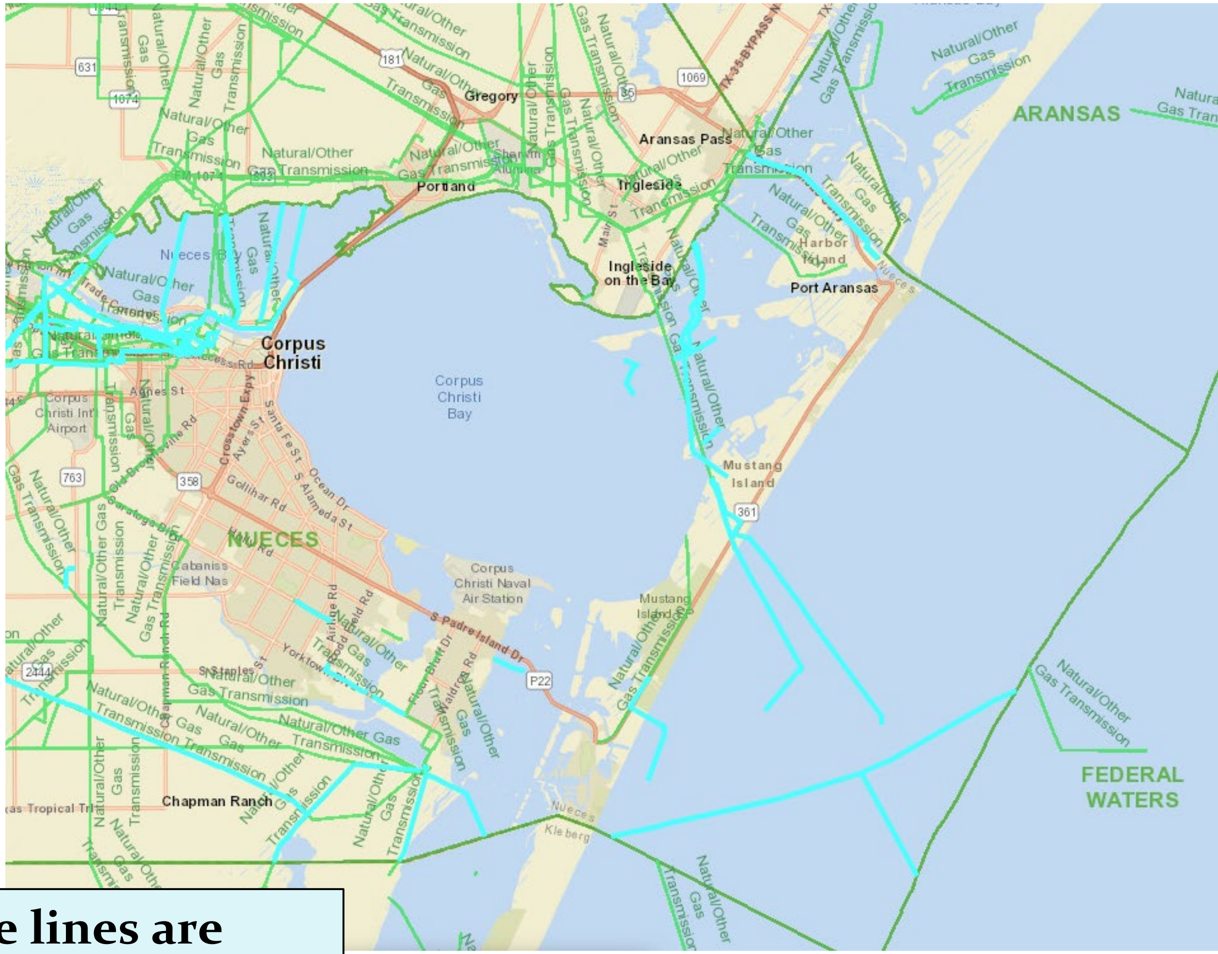


	# Segments
Total	20,274
8" or larger	4,819
Maximum Operating Pressure > 1000 psi	3,926
Not in Service	2,658
Newer than 1/1/1980	1,381
Greater than 2 miles long	708
Near the State Waters	10

Source: Prepared by Darrell Davis for Trimeric Corporation

Pipeline Opportunity: Texas State Waters

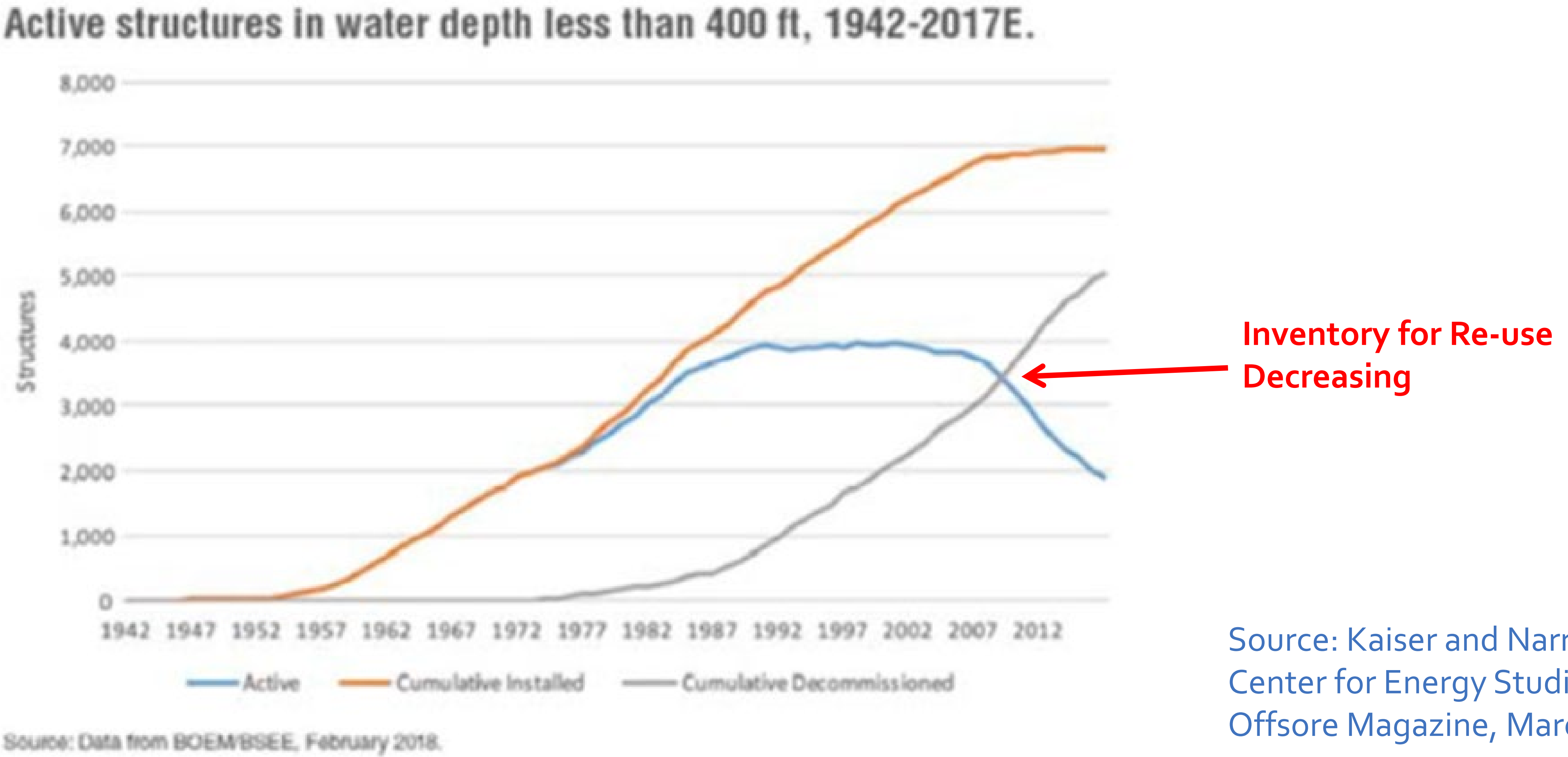




Light blue lines are abandoned lines which are 8” or greater

Source: Prepared by Darrell Davis for Trimeric Corporation

Re-Use Challenges–
Future Stock of Reusable Infrastructure



Source: Kaiser and Narra, LSU Center for Energy Studies; Offsore Magazine, March 2018

GoMCarb Next Steps

- LNG Case Study and Industry Engagement
- Summarize Scale of Infrastructure Re-Use Opportunity
- Use screening methods to identify high priority infrastructure opportunities
- Use analog sites in GoM to perform detailed assessments/optimization of source to sink

Thank You

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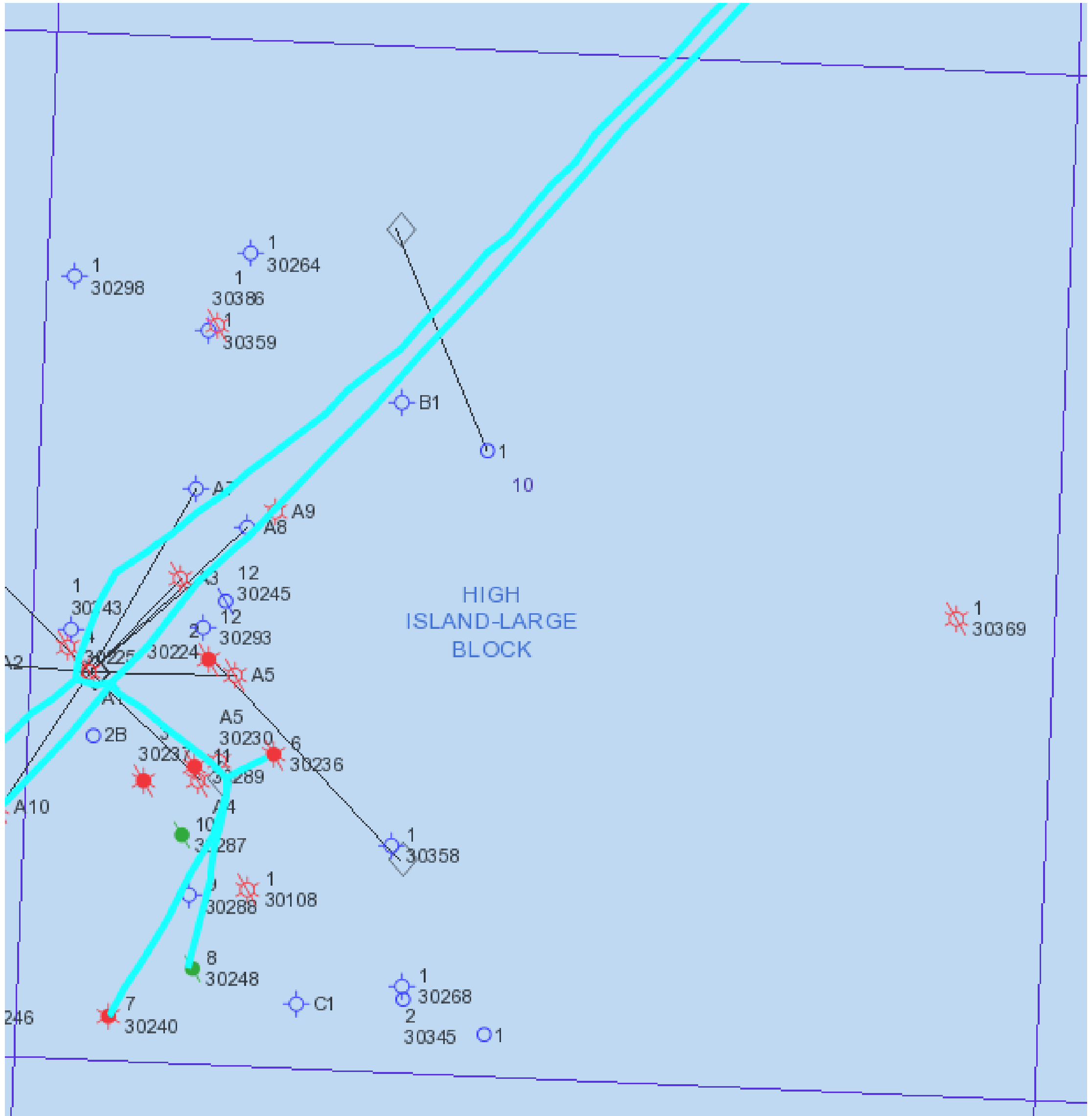
HI-10L Wells



- Well map from TX RRC GIS
- TX RRC database is not complete and not easy to search
- UT has access to proprietary databases that are more complete
- HI-10L
  - 34 wells in TXRRC
  - 9 additional wells listed in UT database
  - None are operational
  - Half are plugged
  - Half are dry holes

Well Screening Criteria

1st Pass Criteria: Readily Available, such as from Databases	
Construction Date > 1970	Modern well construction HI-10L: 13 of 43 wells were pre-1970
Full API Number	Older wells do not have full API number HI-10L: 11 wells did not have full API in RRC GIS
Total Vertical Depth	Deeper wells = more expensive HI10L: wells terminate at 5,800-14,000 ft
Casing Diameter	Larger diameter accommodates modern tools HI10L: 5.5” to 10.8”, 5.5” sufficient for 3/8” tubing
2nd Pass Criteria: Available with more effort, such as Permit Searches	
Well design/completion history	Determine pressure specification Look for problems in completion
3rd Pass Criteria: Incur Significant Costs, such as Well Integrity Tests	
Well integrity tests: Make measurement/re-test upon re-entering well	All wells in field must have integrity assured Fewer wells reduces cost for assuring well integrity

Platform Re-Use

- Repurposing platforms for CO_2 storage could help offset cost of decommissioning idled platforms
- Potential platform re-use criteria
  - Location/proximity to preferred injection site
  - Age/general condition of platform
  - Space on platform (including slots for wells)
  - Regulatory/legal considerations
    - How does liability/decommissioning responsibility transfer?
    - "Rigs to Reefs" and other programs may be starting point
- Platform re-use unlikely to be a project driver
  - Reservoir, pipeline, and in some cases, wells will be prioritized ahead of platforms

Idle Iron Data – Existing Stock of Reusable Infrastructure

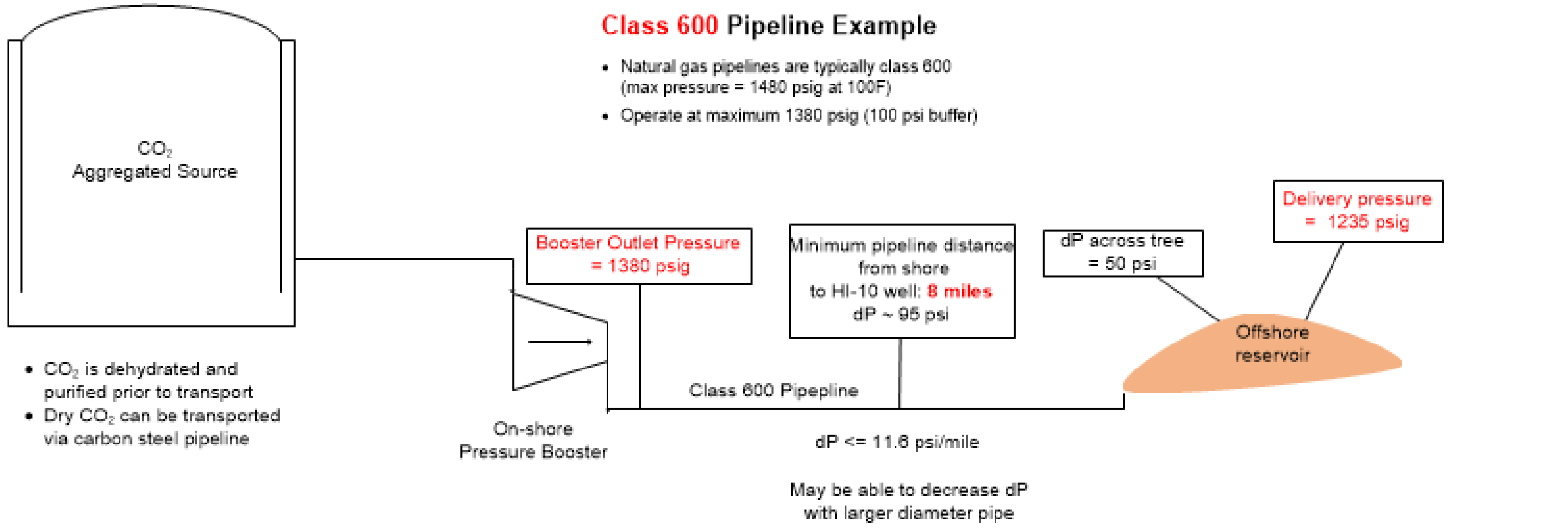
- Red Triangles = "Idle Iron"
- Yellow Dots = All other standing platforms
- Federal water only; state does not have robust platform data

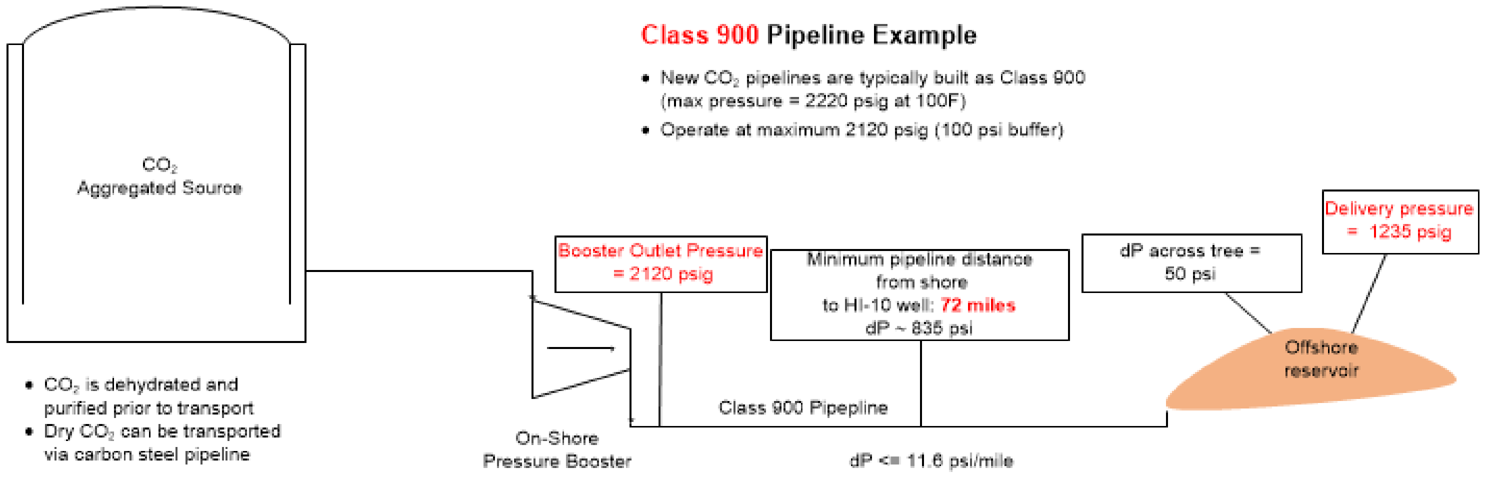
Source: Plough, A. (2017, August 3). American Idle: Decommissioning costs sink offshore drillers into latest crisis. Debtwire Investigations.

Pipeline Opportunity: New Offshore Pipeline Costs

Source	Fluid	Cost ($/in-mile)		Offshore Multiplier
		Onshore	Offshore	
NATGAS.INFO website	Natural Gas		$40,000 - $64,000	
Kaiser 2016	Oil, Natural Gas		$45,000 - $418,333	
JRC (Serpa, Morbee and Tzimas 2011)	CO_2		$67,600 - $89,600	
USAID and SARI/Energy 2006	Oil, Natural Gas			1.96
Brito and Sheshinski 1997	Natural Gas	$40,000	$100,000	2.50
Global CCS (Vermeulen 2011)	CO_2	$103,000	$144,800	1.41
Scottish Power Longannet	CO_2	$12,900	$49,900	3.87
IPCC 2005	CO_2			2
ZEP 2011	CO_2			1.38
JRC 2011	CO_2			2
NETL 2013 via Kinder Morgan	CO_2	$50,000	$700,000	14
			Average	**3.64**

Pipeline Challenges: Pressure Rating





GoMCarb Overview

- Bring data and expertise in the region together to address:
  - Knowledge Gaps
  - Regulatory Issues
  - Infrastructure Requirements (this presentation)
  - Geologic and engineering technical challenges of storing CO_2
- **Motivation**: Recent advances and knowledge of opportunities and advantages of offshore storage a kilometer or more beneath the seafloor of the Gulf of Mexico
- **Focus**: Near Offshore CO_2 Storage in Gulf of Mexico