Review of Existing Oil & Gas Infrastructure for Offshore CO_2 Transportation

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Introduction

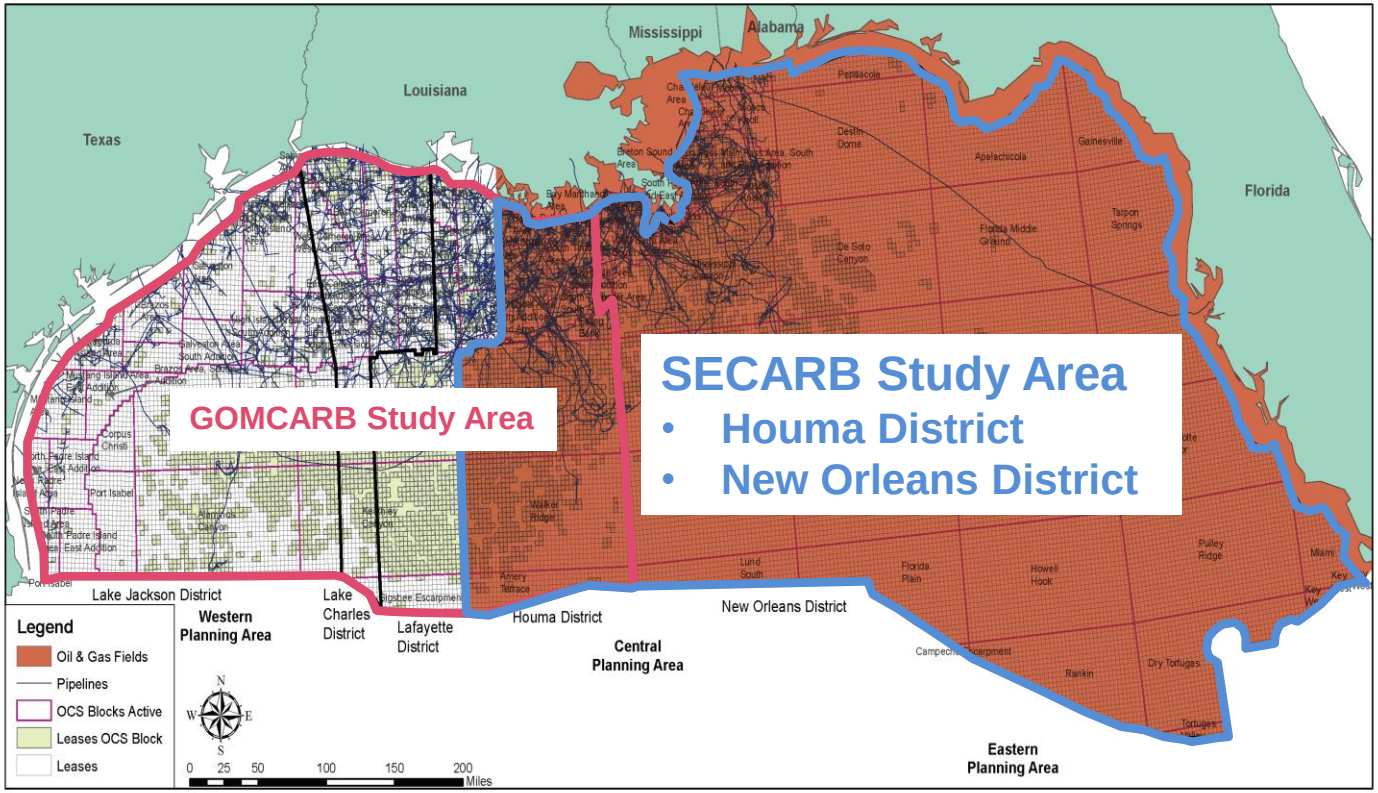
- **This work was performed under SECARB Subtask 6.1: Offshore CO_2 Transport and Delivery Options**
- This presentation will summarize:

1. Results of screening GOM pipeline and platform infrastructure that could be used for offshore CO_2 transport,
2. CO_2 storage opportunities in depleted oil reservoirs, and
3. Infrastructure pathways technically viable for transporting CO_2 from onshore to offshore storage locations.

Review of Existing Offshore Oil & Gas Infrastructure

OBJECTIVE

Compile a database of existing oil and gas infrastructure in the SECARB GOM study area to identify pipelines and platforms that meet technical criteria for offshore CO_2 transport.



Database Development

BOEM
Bureau of Ocean Energy Management

- **Pipeline Data**
- **Platform Data**
- (August, 2021)

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Review of Existing Offshore Oil & Gas Infrastructure

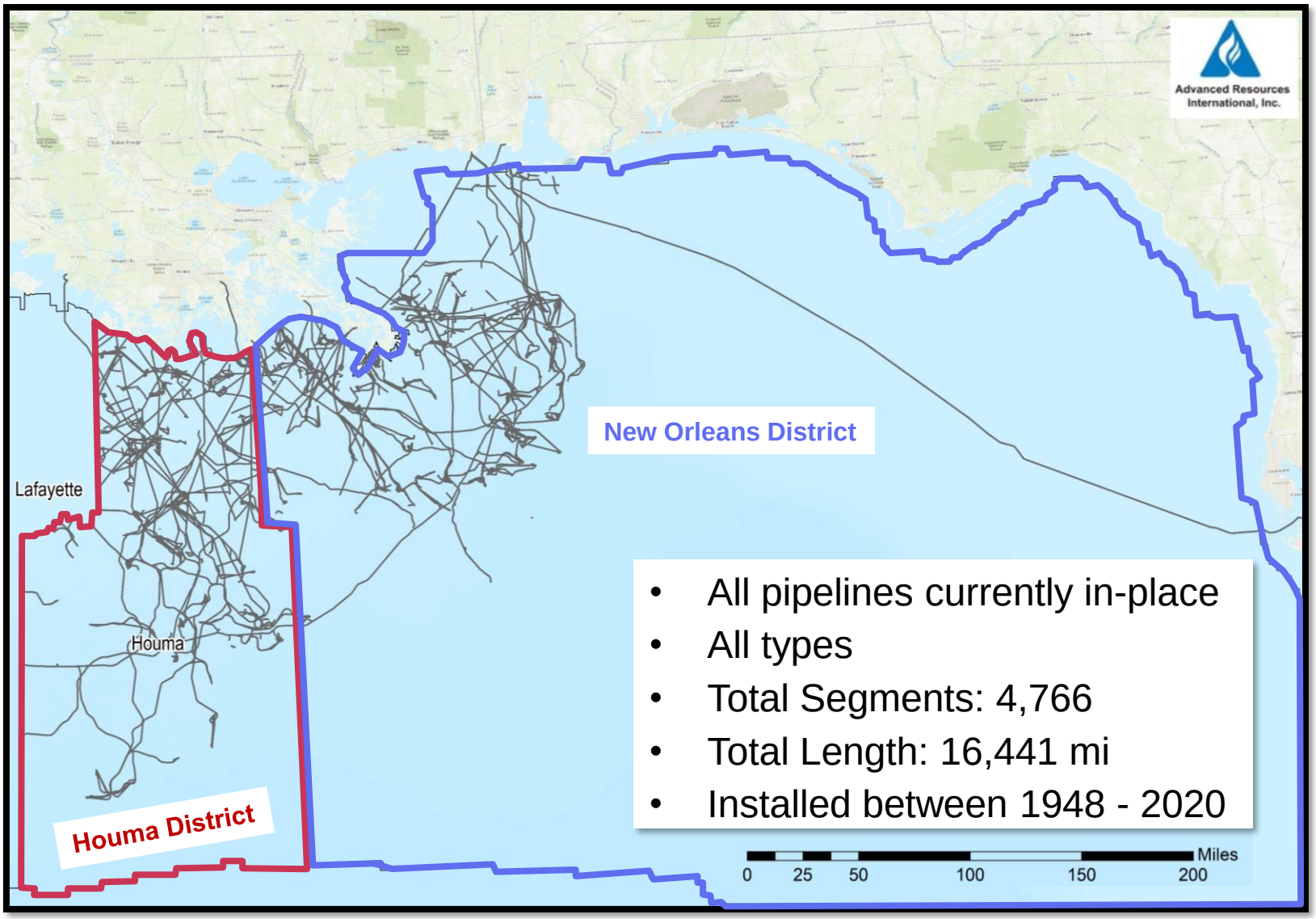
METHODOLOGY

Apply technical screening criteria to the offshore pipeline and platform database based on requirements for large-scale CO_2 transport and delivery.

Pipeline Screening Criteria

- **Status** – identify active pipelines vs decommissioned/shut-in/removed,
- **Type** – identify oil & gas pipelines vs water/service/other,
- **Age** – identify pipelines constructed after 1980,
- **Size** – minimum 8” diameter,
- **Operating Pressure** – minimum of 1,600 psi,
- **Network** – continuous link from onshore inlet location

Existing Offshore Pipeline Infrastructure



Active Oil and Gas (O&G) Pipeline Infrastructure

- Smaller service and disposal pipelines were screened out as they are likely non-viable for CO_2 transportation.

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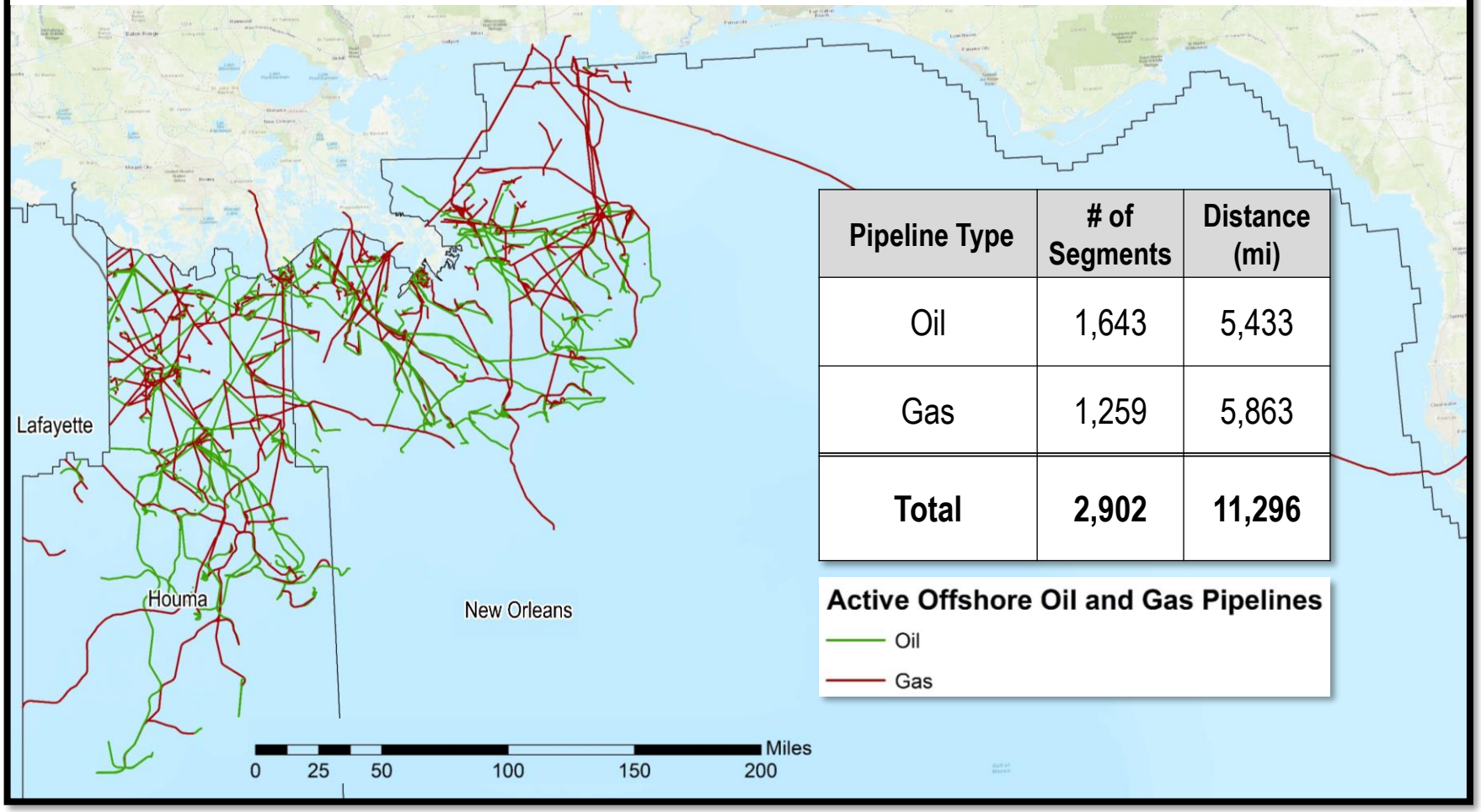

Pipeline Type	# of Segments	Distance (mi)
Oil	1,643	5,433
Gas	1,259	5,863
Total	**2,902**	**11,296**

Active Offshore Oil and Gas Pipelines

Oil

Gas

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Active O&G Pipelines Constructed After 1980

- Pipelines built post-1980 are nearing end-of-life but still viable if repurposed for CO_2 transportation

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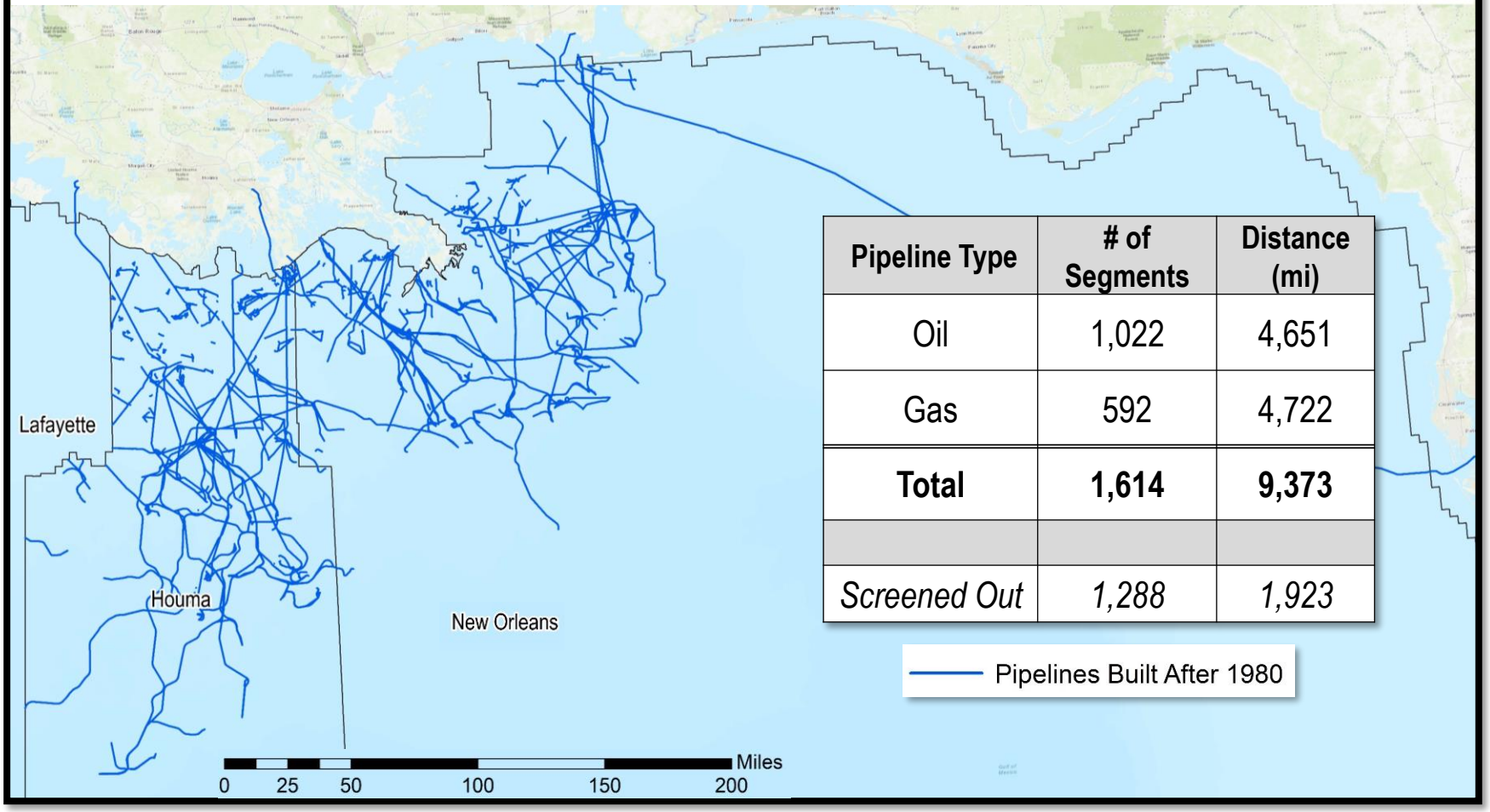

Pipeline Type	# of Segments	Distance (mi)
Oil	1,022	4,651
Gas	592	4,722
Total	**1,614**	**9,373**
Screened Out	*1,288*	*1,923*

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Active O&G Pipelines, Post 1980, 8+ in Diameter

- 8 in diameter pipelines could carry up to about 1.5 million metric tons of CO_2 per year.

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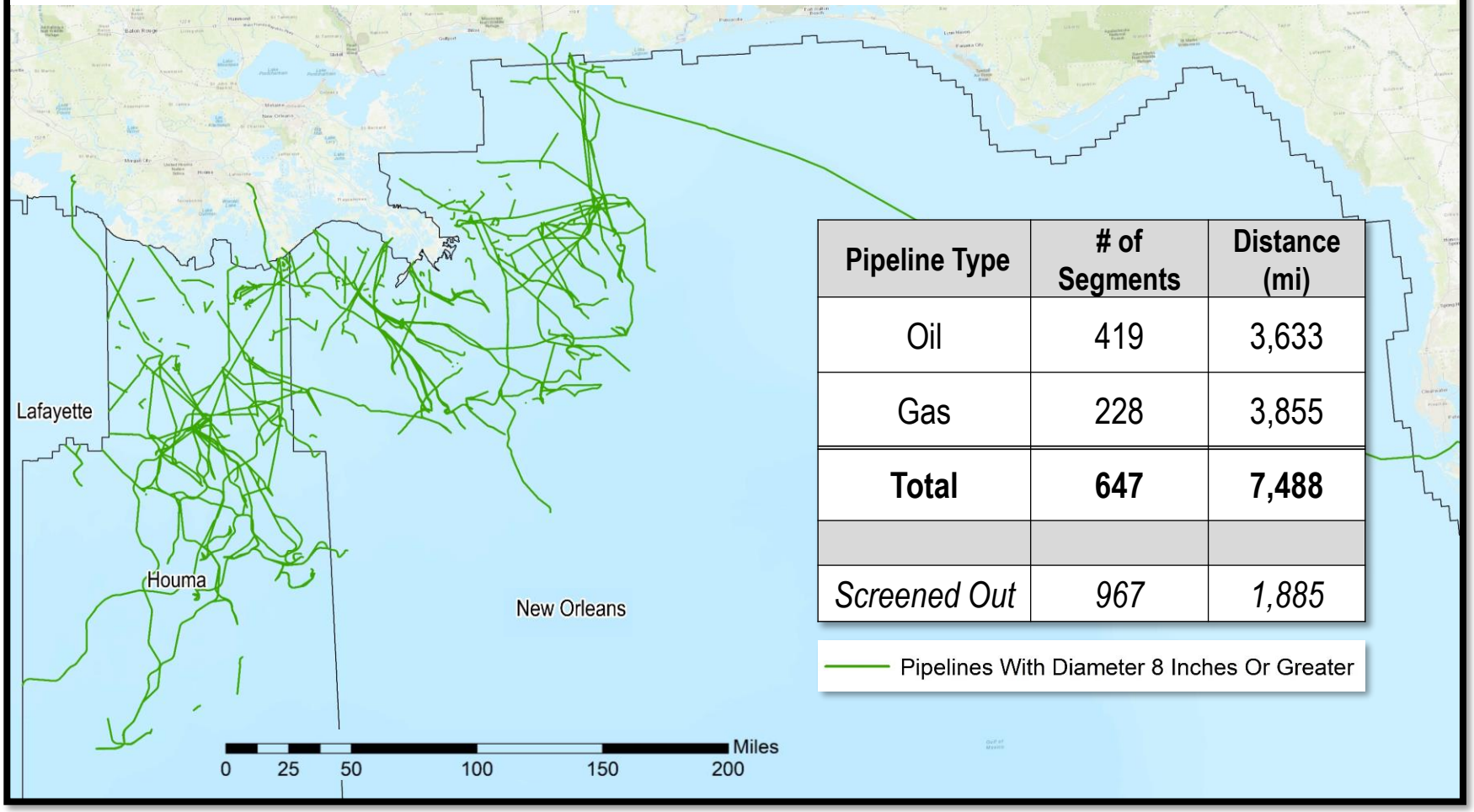

Pipeline Type	# of Segments	Distance (mi)
Oil	419	3,633
Gas	228	3,855
Total	**647**	**7,488**
Screened Out	*967*	*1,885*

Pipelines With Diameter 8 Inches Or Greater

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Active O&G Pipelines, Post 1980, 8+ in, 1,600+ psi

- 1,600 psi is a conservative pressure rating estimate for the ability to transport supercritical CO_2.

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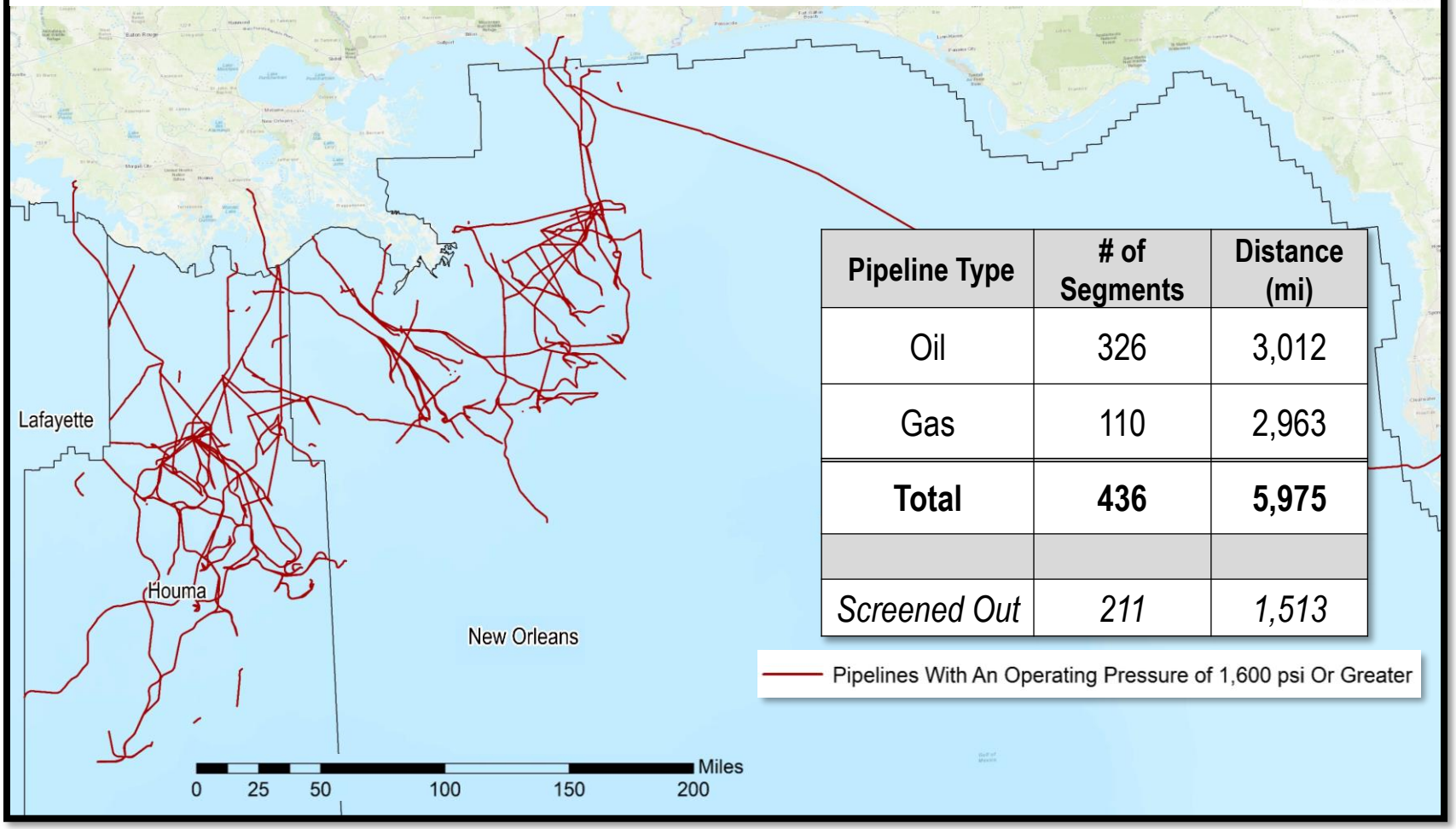

Pipeline Type	# of Segments	Distance (mi)
Oil	326	3,012
Gas	110	2,963
Total	**436**	**5,975**
Screened Out	*211*	*1,513*

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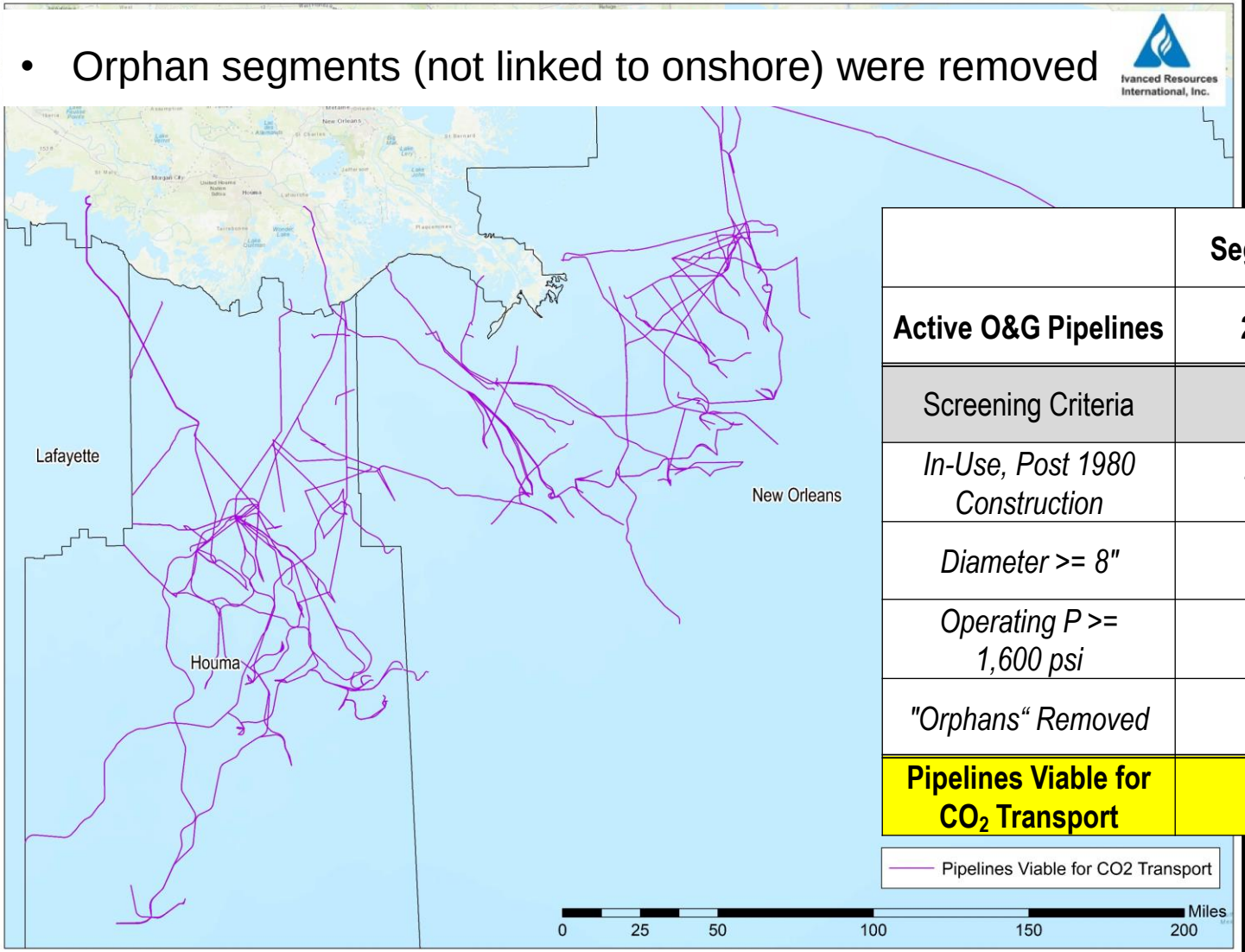
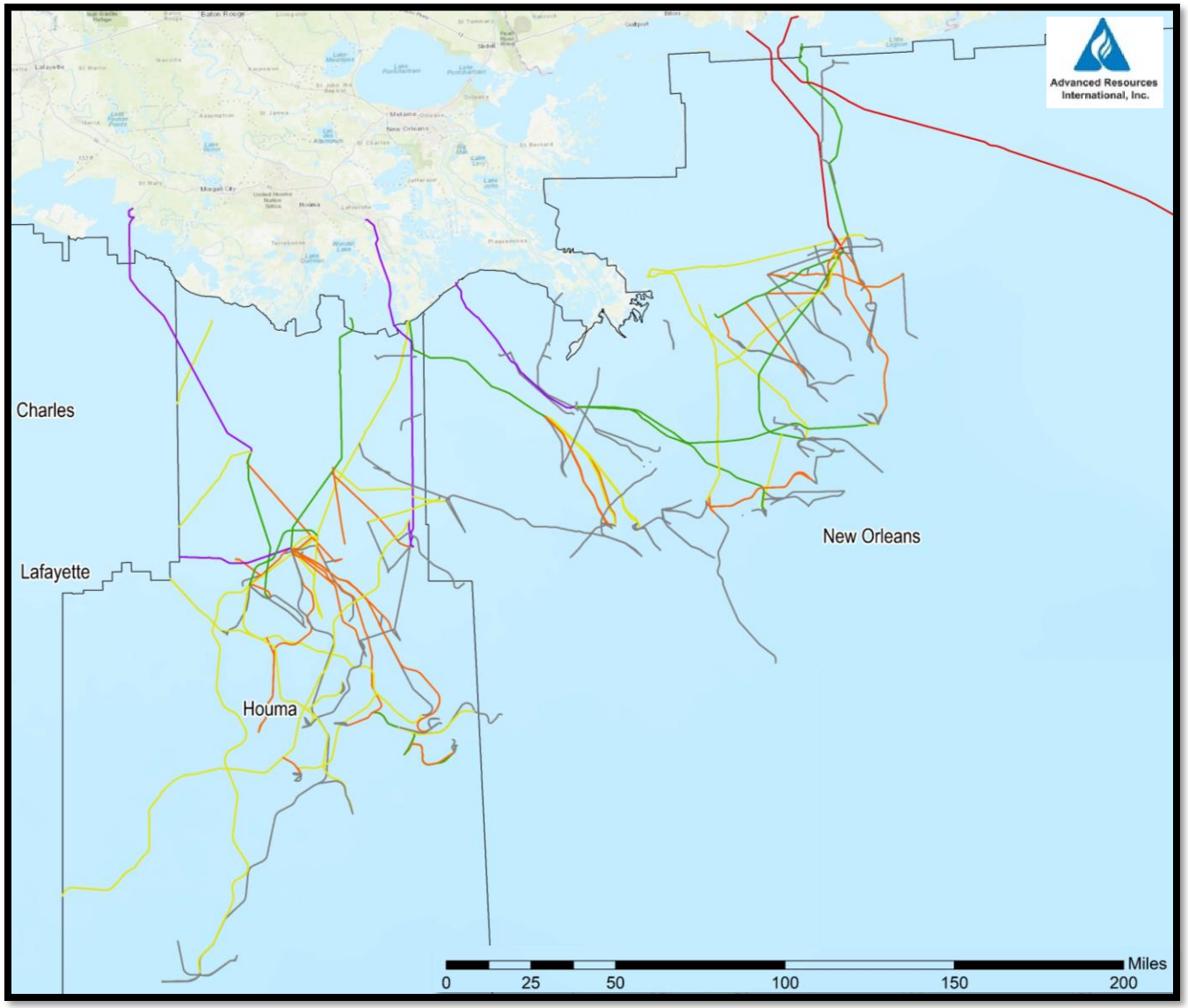
Offshore Pipeline Network Viable for CO_2 Transport

- Orphan segments (not linked to onshore) were removed



	Segments	Distance (mi)
Active O&G Pipelines	**2,902**	**11,296**
Screening Criteria	*Screened Out*	
In-Use, Post 1980 Construction	*1,614*	*9,373*
Diameter >= 8"	*647*	*7,488*
Operating P >= 1,600 psi	*436*	*5,975*
"Orphans" Removed	*25*	*90*
Pipelines Viable for CO_2 Transport	**411**	**5,885**

Offshore Pipeline Network Viable for CO_2 Transport

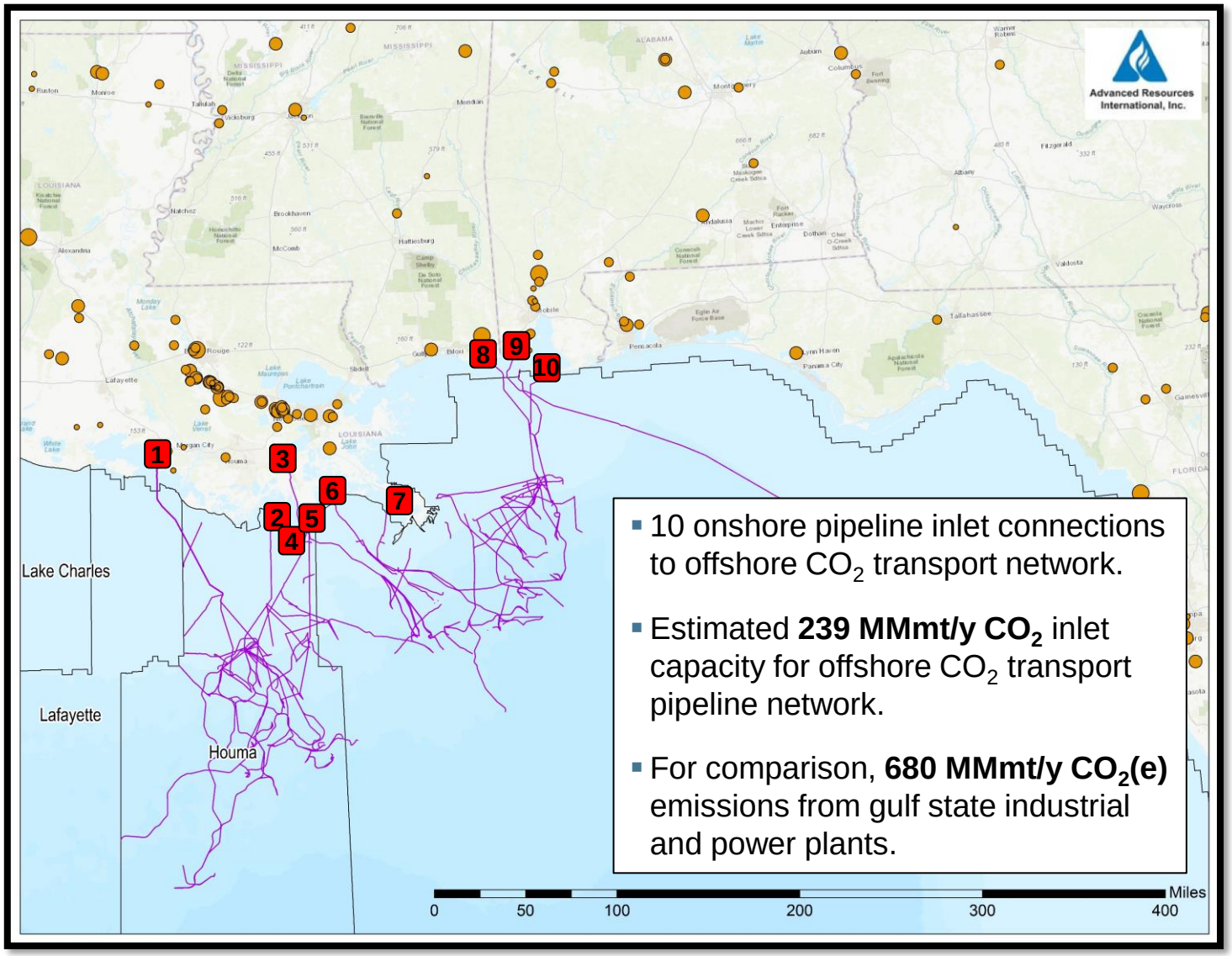


- Large pipelines (32+ MMmt/y) connect onshore sources to the offshore pipeline network.
- Small/medium pipelines (3 to 20 MMmt/y) comprise the offshore pipeline network.

Pipeline Diameter and Estimated CO_2 Transport Capacity

- 8 - 12 in (1.1 - 3.3 MMmt/yr)
- 13 - 16 in (3.3 - 6.7 MMmt/yr)
- 17 - 20 in (6.7 - 12.3 MMmt/yr)
- 21 - 24 in (12.3 - 19.7 MMmt/yr)
- 25 - 28 in (19.7 - 32.0 MMmt/yr)
- 29 - 32 in (32.0 - 44.0 MMmt/yr)
- 33 - 36 in (44.0 - 56.5 MMmt/yr)

Offshore CO_2 Pipeline Network Inlet Capacity



- 10 onshore pipeline inlet connections to offshore CO_2 transport network.
- Estimated **239 MMmt/y CO_2** inlet capacity for offshore CO_2 transport pipeline network.
- For comparison, **680 MMmt/y CO_2(e)** emissions from gulf state industrial and power plants.

Inlet #	CO_2 Transport Capacity (MMmt/yr)
1	35
2	20
3	35
4	12
5	20
6	35
7	3
8	56
9	20
10	3
Total	**239 MMmt/yr**

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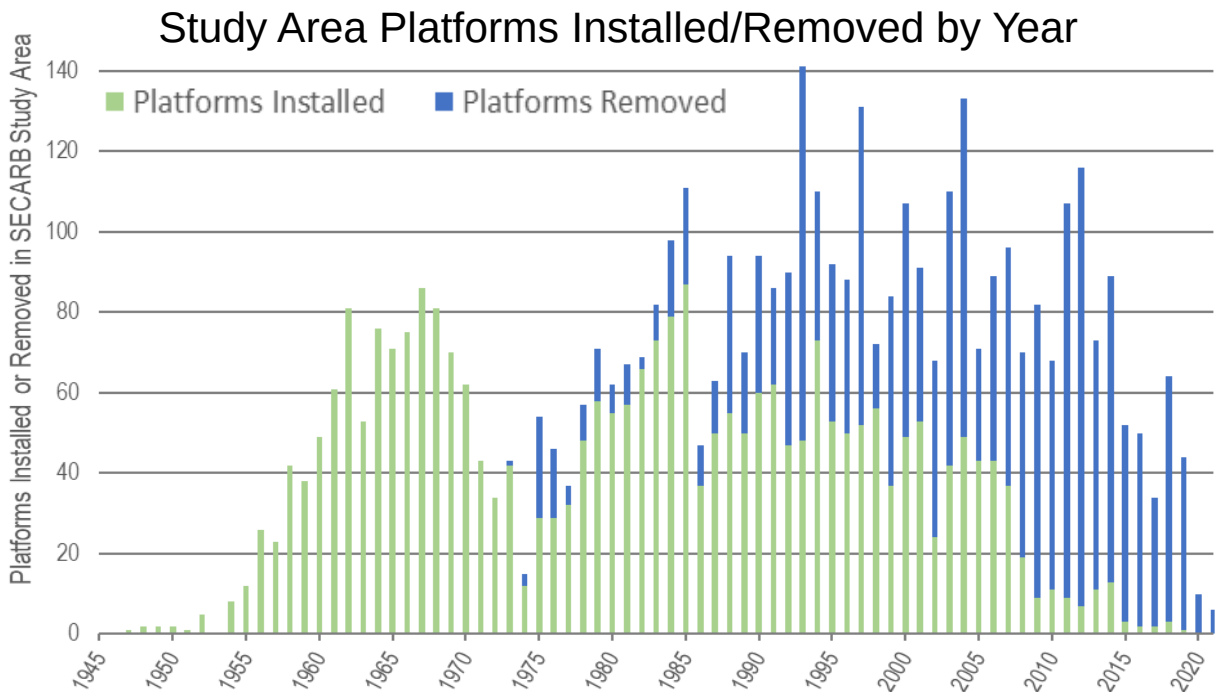
Review of Existing Offshore Oil & Gas Infrastructure

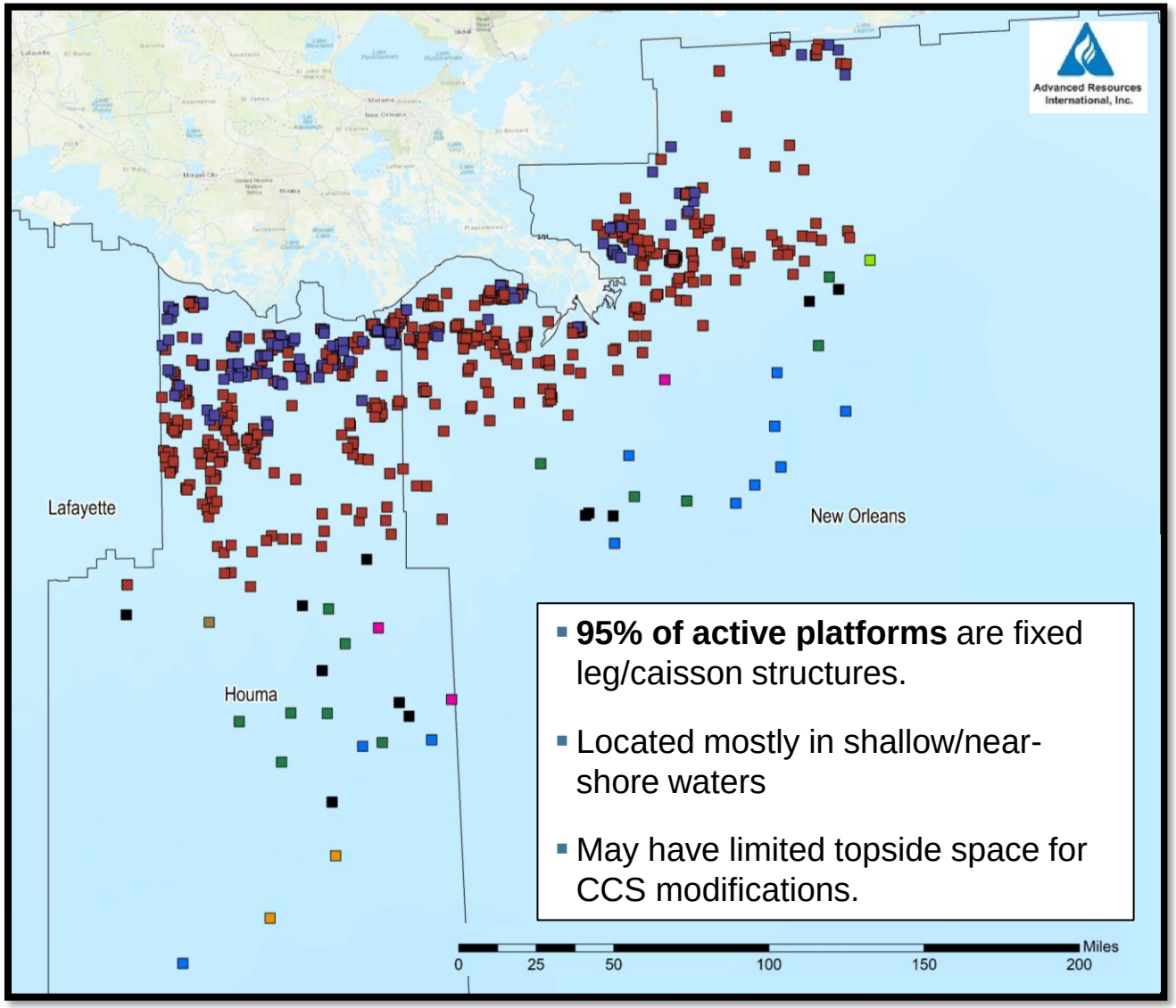
Platform Screening Criteria

- **Type** – includes both shallow water and deep water structures,
- **Status** – active vs decommissioned/removed,
- **Location** – within 2 miles of candidate pipelines,



- 2,831 platforms installed since 1948.
- Two-thirds of installed platforms have been removed.
- 979 active platforms.
- **Critical to utilize platforms prior to decommissioning.**

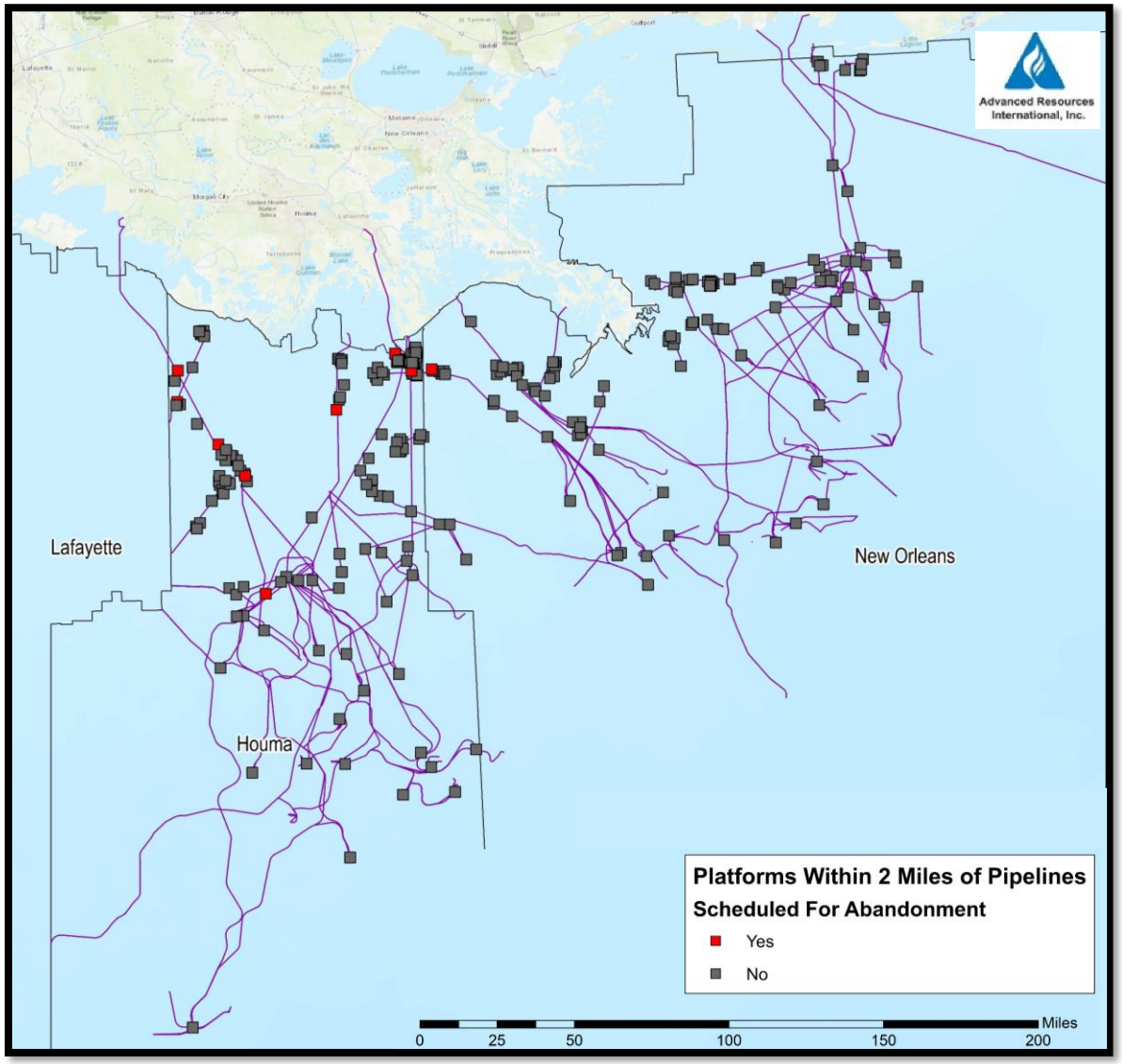
Active Offshore Platforms



- **95% of active platforms** are fixed leg/caisson structures.
- Located mostly in shallow/near-shore waters
- May have limited topside space for CCS modifications.

Platform Structure	Total
Fixed Leg	707
Caisson	230
SPAR	12
Tension Leg	12
Semi-submersible FPS	11
Mini Tension Leg	3
Floating Production Unit	2
Compliant Tower	1
Mobile Production Unit	1
Total	**979**

Platforms Near Potential CO_2 Transport Pipelines



Platforms Scheduled for Abandonment?	Total
Scheduled for Abandonment	9
Not Scheduled for Abandonment	322
Total Platforms Within 2 Miles of Viable Pipeline	**331**

- One-third of active platforms are within 2 miles of the CO_2 pipeline network
- Platforms scheduled for abandonment may be prioritized for utilization.
- Multiple platforms may be used to service the same storage location.

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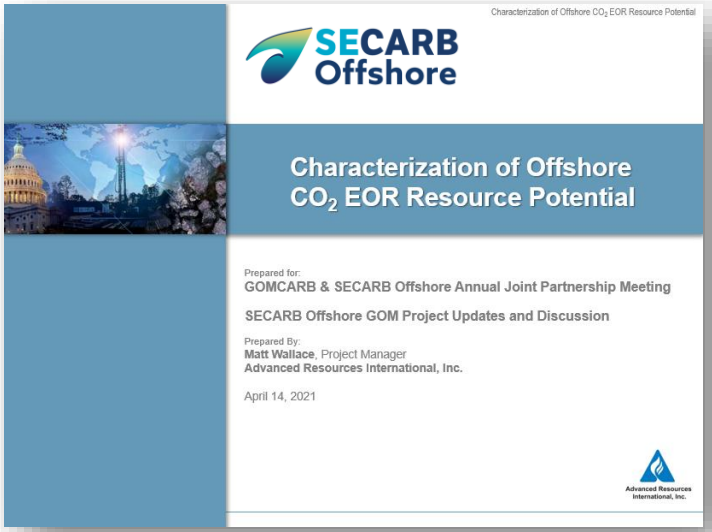
CO_2 Storage Potential in Offshore Oil Reservoirs

- Previous SECARB work performed by ARI characterized the potential for CO_2 storage in depleted offshore GOM OCS reservoirs using CO_2 EOR.
- The study identified "optimal" reservoirs with large volume storage capacity that fit the technical requirements for CO_2 EOR.
- 168 reservoirs have technical storage capacity of 3.1 billion metric tons of CO_2.



Resource Area	Fields	Reservoirs	OOIP (MMB)	CO_2 Storage Potential* (MMmt)
Shallow Water	44	82	7,740	510
Deep Water	44	86	26,540	2,630
Total	88	168	34,280	3,140

* Lake Charles, Lafayette, Houma, and New Orleans districts

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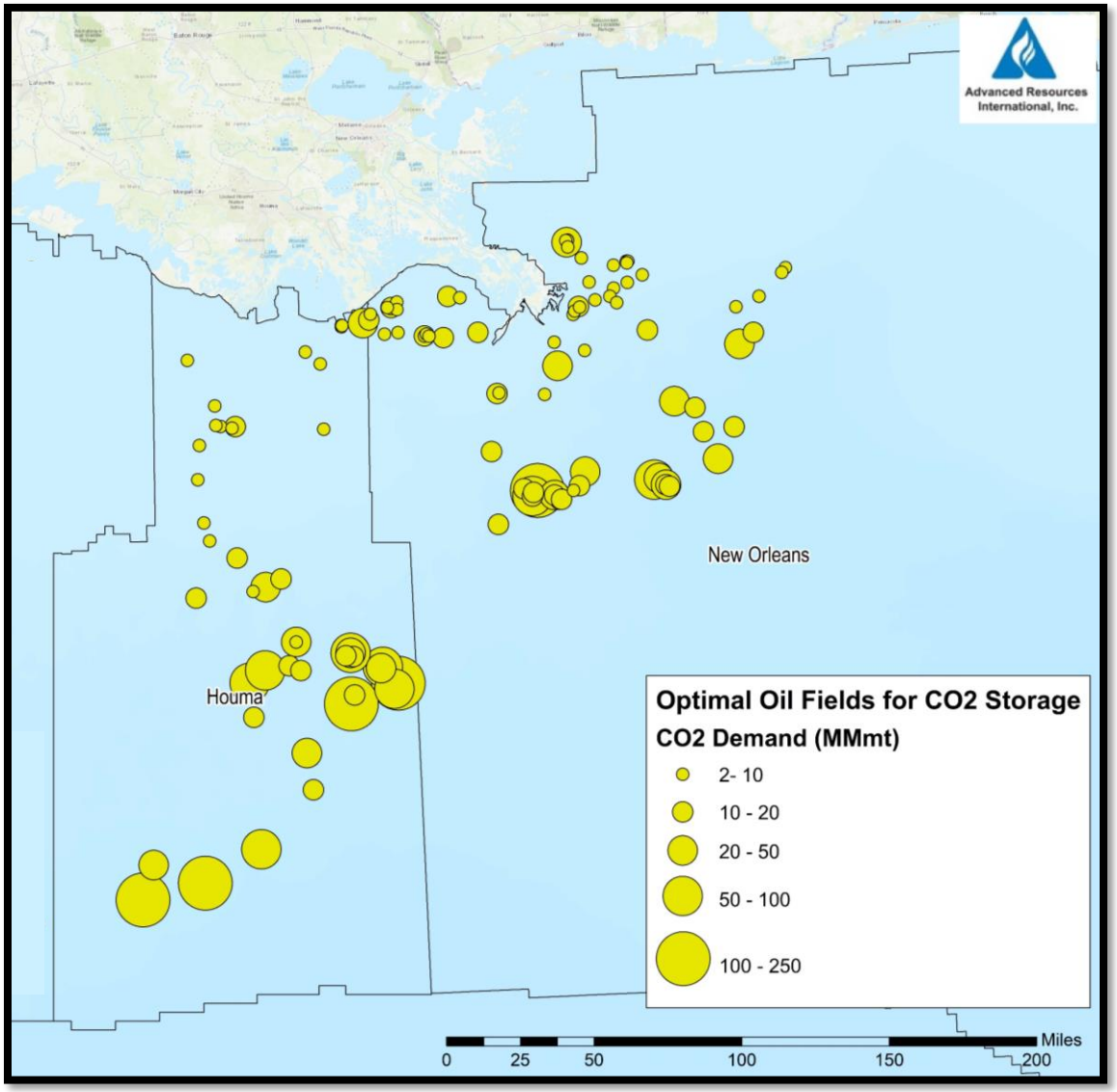
CO_2 Storage Potential in Offshore Oil Reservoirs



District	Technical Storage Reservoirs	CO_2 Storage Potential (Bmt)
New Orleans	75	1.1
Houma	47	1.8
Total	**122**	**2.9**

- 2.9 Bmt of technical storage capacity in Houma and New Orleans districts.
- Shallow water reservoirs range from 2 to 20 MMmt CO_2 storage capacity.
- Deep water reservoirs range from 6 to 250 MMmt CO_2 storage capacity.

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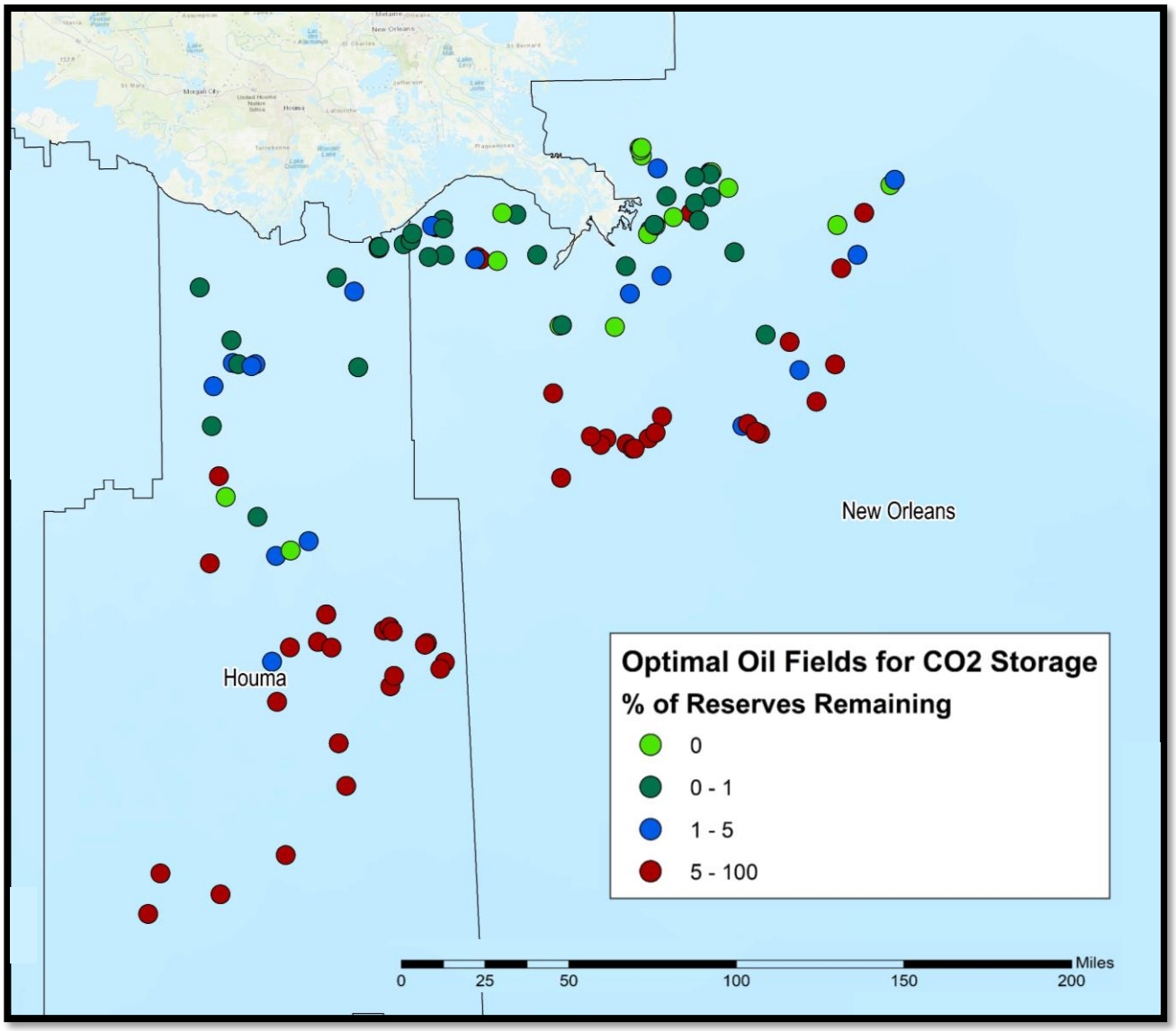
Oil Reservoirs Approaching End-of-Life



% ROR	Reservoir Count
0%	17
0% - 1%	33
1% - 5%	21
+5%	51
Total	**122**

- More depleted oil fields in near-shore, shallow water, but smaller storage volume opportunity.
- Geologic assessment of depleted oil fields should be performed prior to closure.

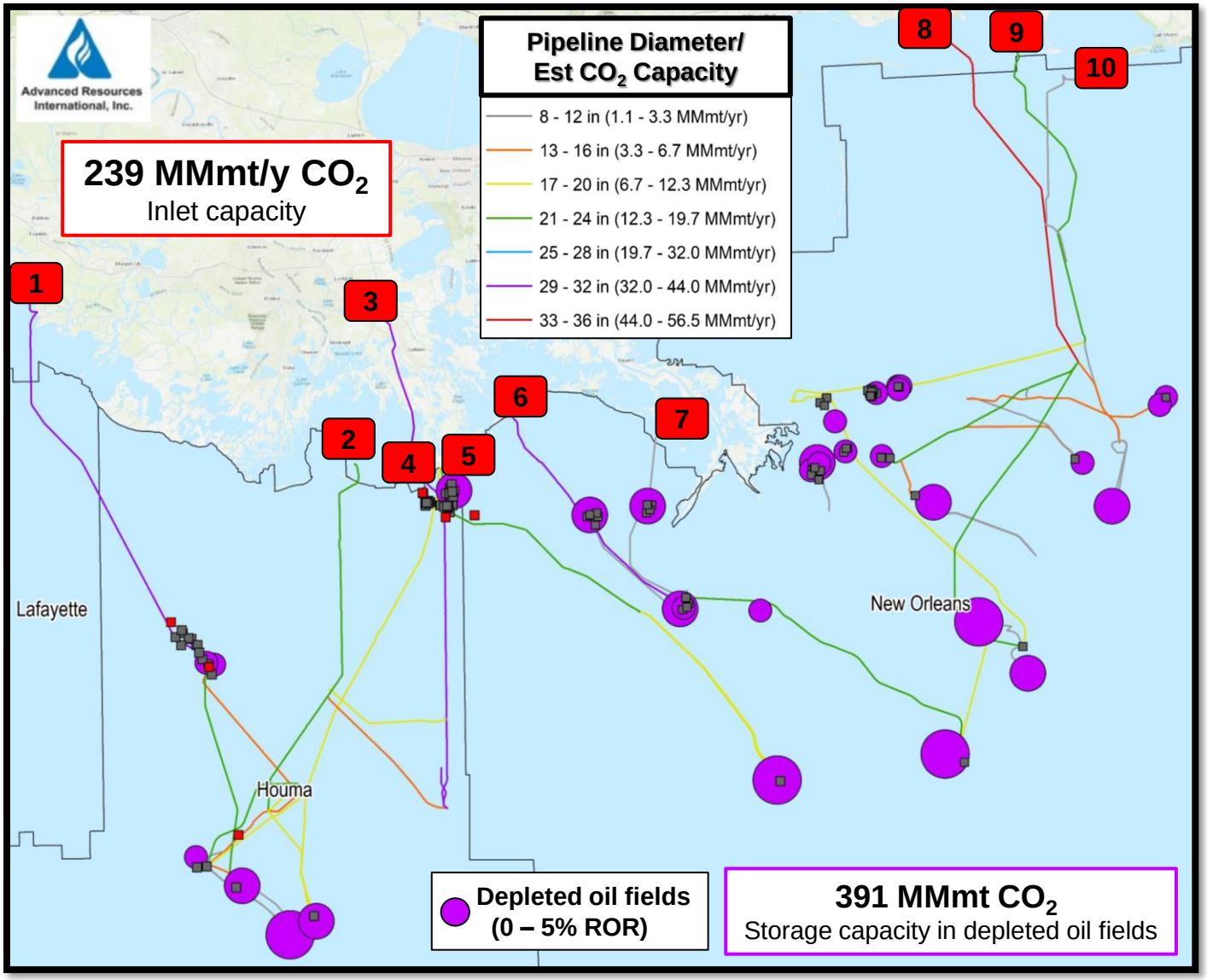
Offshore CO_2 Storage Pathway Criteria

- Offshore CO_2 storage pathway criteria includes:
  - Continuous connection from onshore pipeline inlet to offshore storage location.
  - Pipeline network terminates at a depleted oil field with CO_2 storage capacity.
  - At least one active platform structure within 2 miles of the pipeline network/depleted oil field location.

CAVEATS

- Pathway transport capacity is limited by the smallest diameter pipeline in the connection from onshore to storage reservoir.
- Additional investigation of individual asset components is required to determine viability for offshore CO_2 transport.

Potential Offshore CO_2 Storage Pathways



Viable Pathway Statistics

- 82 pipeline segments totaling 1,784 miles,
- 125 offshore platforms; 6 scheduled for abandonment.
- **239 MMmt CO_2 inlet capacity** at 10 onshore pipeline connections.
- A total of **391 MMmt of CO_2 storage capacity** in 31 depleted oil reservoirs.

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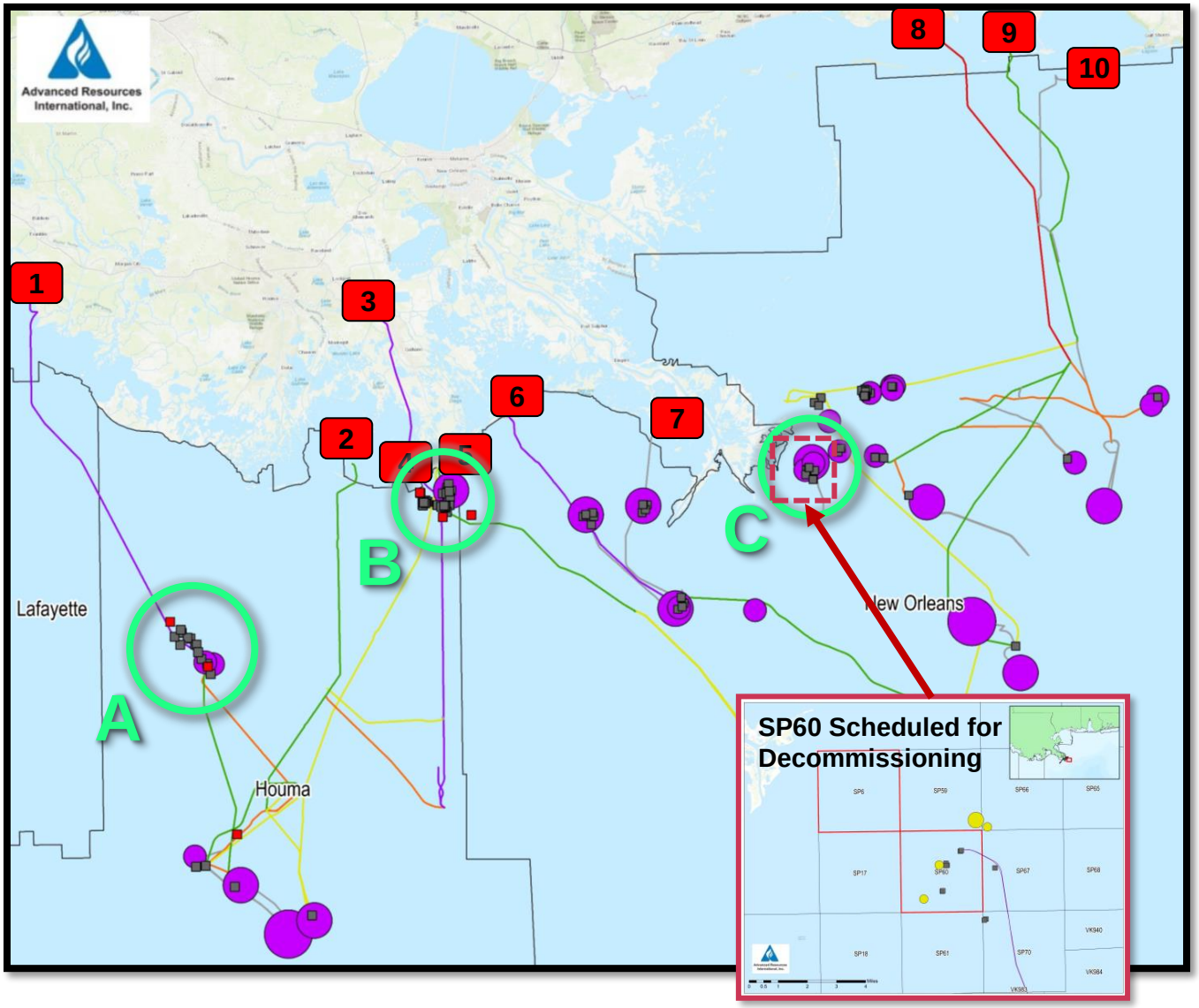
Prioritizing Pathways for Offshore CCS Projects

	Shallow Water	Deep Water
ADVANTAGE	• Reduced transportation and pipeline operating cost. • Many oil/gas fields approaching end-of-life. • Possible to combine multiple structures for topside CO_2 storage operations.	• Larger reservoirs offer greater CO_2 storage capacity. • Larger platform structures for topside CO_2 storage operations. • Multiple pipeline route options for CO_2 transportation.
DISADVANTAGE	• Smaller reservoir capacity for CO_2 storage overall • Smaller/older platforms may not be suitable for CO_2 storage operations. • Older well completions may require significant workovers.	• Possibly greater storage $/mt compared to shallow water. • Most large oil & gas reservoirs not yet at end-of-life. • Greater logistical hurdles for pre-storage permitting and operations.

Prioritizing Pathways for Offshore CCS Projects



Possible CCS Locations

A
- Multiple platforms (some scheduled for abandonment).
- Large CO_2 transport pipeline.

B
- Multiple platforms (some scheduled for abandonment).
- Near-shore.
- Multiple inlet pipeline options.

C
- Near-shore.
- South Pass 60 announced for decommissioning (May, 2022)
- Multiple storage reservoirs.

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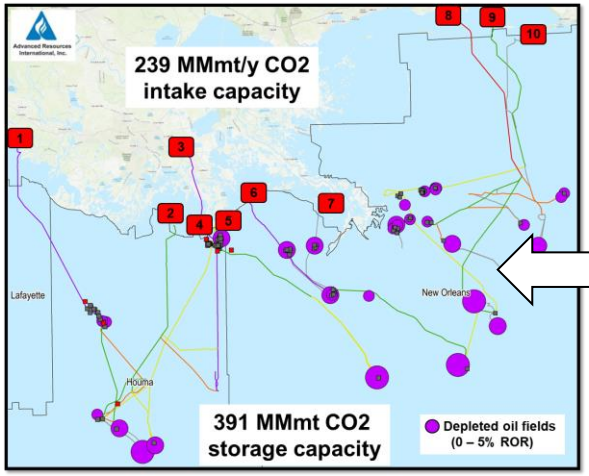
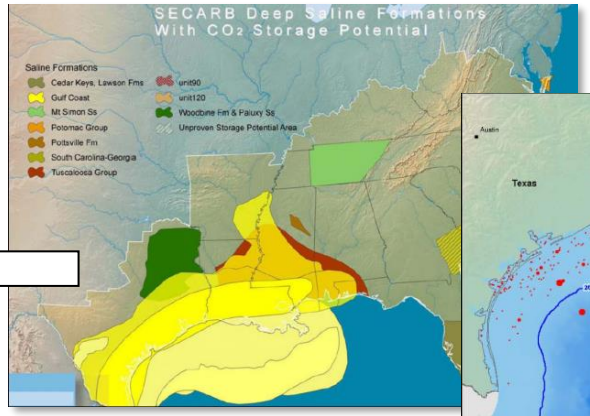
Next Steps

- Investigate the individual pathway assets to identify potential obstacles to CO_2 transport and delivery i.e., pipeline mechanical integrity concerns, platform topside space constraints, well completions, etc.
- Incorporate CO_2 storage potential in saline reservoirs and depleted gas fields to understand the overall potential for CO_2 transport in the GOM OCS using existing infrastructure.

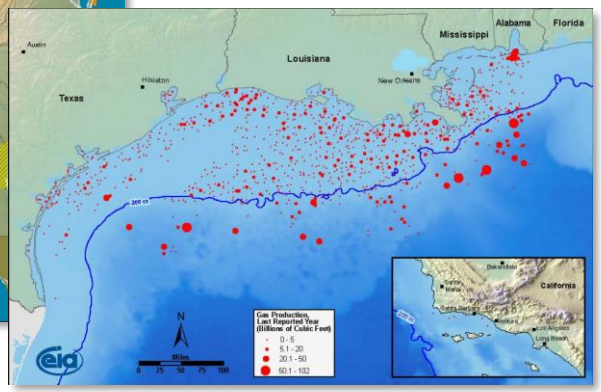
Offshore CCS Pathways



Saline Storage Potential



Depleted Gas Fields



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