Establishing CO_2 Utilization, Storage and Pipeline Systems for Oil Fields in Shallow and Deep Waters of the Gulf of Mexico

Prepared for:
2nd International Workshop on Offshore CO_2 Geologic Storage

Session 4: Changing the Game for CO_2-EOR Offshore

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June 19, 2017

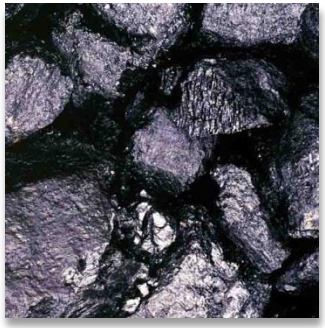
Presentation Outline

	Executive Summary
1	Eastern and East Central GOM Shallow Water CO_2 Pipeline System
2	Eastern and East Central GOM Deepwater CO_2 Pipeline System
3	Next Steps

Executive Summary

The large oil fields in the Eastern and East Central GOM offshore offer significant opportunities for productively utilizing and storing CO_2 while helping increase domestic oil production and Federal revenues.

- The 52 moderate to large oil fields in the shallow Federal waters of the GOM will need a three CO_2 pipeline system to deliver 40 million metric tons per year (2.1 Bcfd) for use and storage by CO_2 enhanced oil recovery,
- The 63 large oil fields in the deep Federal waters of the GOM will need a three CO_2 pipeline system to deliver 57 million metric tons per year (2.9 Bcfd) for use and storage by CO_2 enhanced oil recovery,
- The capital costs for these six CO_2 pipelines is estimated at nearly $6 billion,
- The Federal royalties provided from the recovery of 7.3 billion barrels by CO_2 enhanced oil recovery (assuming all 7.3 B bbls would be economically viable to develop) would equal $104 billion dollars, assuming an $80 per barrel (WTI) oil price, as estimated by EIA for Year 2025.



1. Eastern and East Central GOM Shallow Water CO_2 Pipeline System

Pipeline Systems for Delivering CO_2 to Shallow Water Eastern and East Central GOM Oil Fields

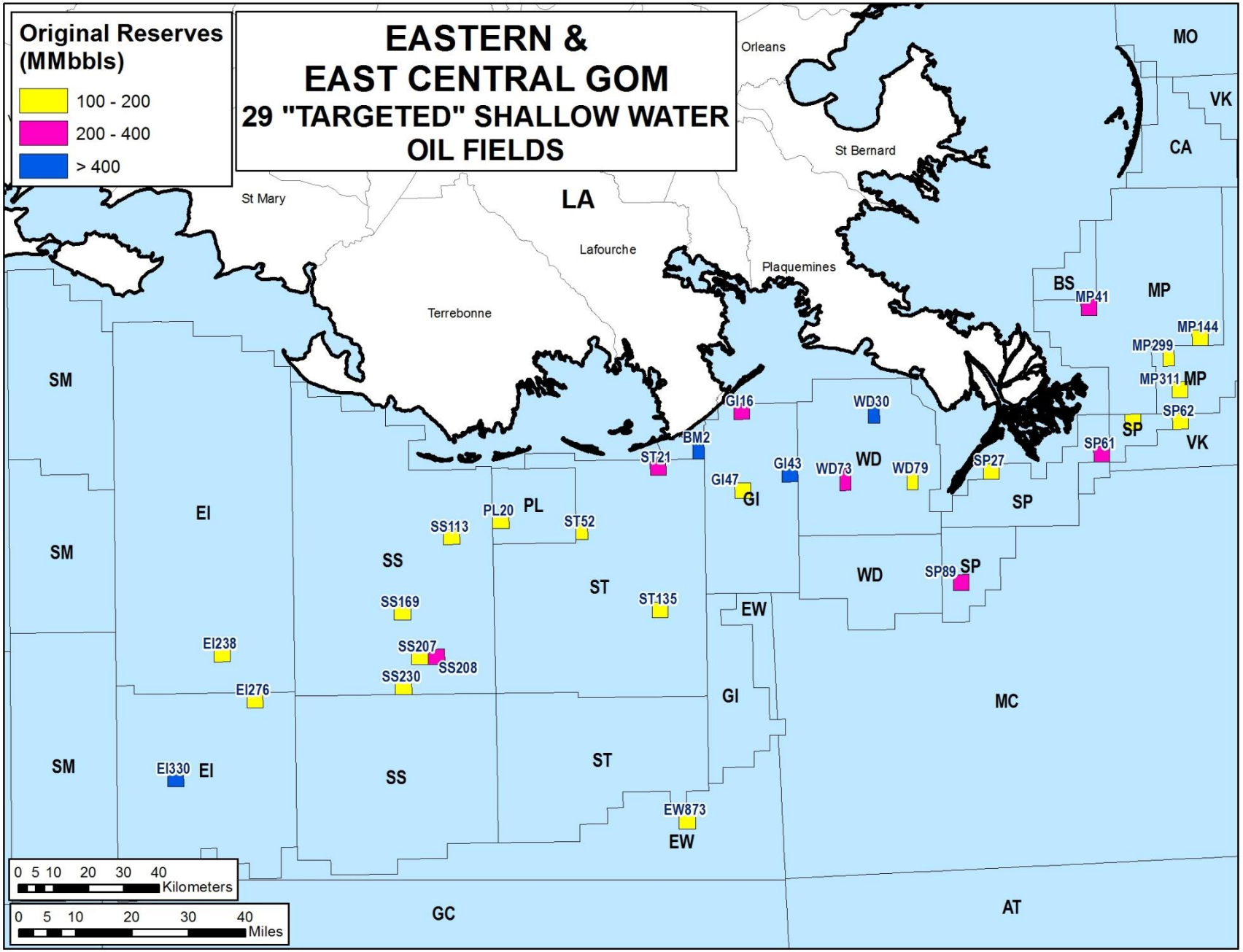
The Eastern and East Central portions of the Gulf of Mexico (GOM) shallow water offshore hold 52 moderate- to large-size oil fields. These oil fields contain 8.2 billion barrels of original oil reserves, with 97% of these original reserves already produced.

We started our study by targeting the largest 29 of these oil fields, each with original oil reserves of over 100 million barrels.

We plotted the location of each of these 29 oil fields, estimated their technically viable oil recovery potential and CO_2 injection requirements, and then designed three CO_2 pipelines that would connect these 29 oil fields with CO_2 supply from onshore Louisiana and Mississippi.

- Eastern GOM CO_2 Pipeline System
- East Central GOM CO_2 Pipeline System #1
- East Central GOM CO_2 Pipeline System #2

Finally, we prepared an initial estimate of the capital costs of installing these three CO_2 pipeline systems in the shallow waters of Eastern and East Central GOM.


Original Reserves (MMbbls)
100 - 200
200 - 400
> 400
EASTERN &
EAST CENTRAL GOM
29 "TARGETED" SHALLOW WATER OIL FIELDS
Orleans
St Bernard
St Mary
LA
Lafourche
Plaquemines
Terrebonne
MO
VK
CA
BS
MP41
MP
MP144
MP299
MP311
SP62
SP
VK
SP61
SP27
SP
SM
EI
SM
SM
GI16
WD30
BM2
ST21
GI43
WD73
WD
WD79
GI47
GI
PL20
PL
ST52
SS113
SS
ST
ST135
SS169
EW
WD
SP89
SP
EI238
SS207
SS208
SS230
EI276
GI
MC
EI330
EI
SS
ST
EW873
EW
0 5 10 20 30 40 Kilometers
0 5 10 20 30 40 Miles
GC
AT

Initial Eastern and East Central GOM Shallow Water CO_2 Pipeline System

Three CO_2 pipelines would deliver about 1.6 Bcfd of CO_2 (32 million metric tons per year) to 29 "targeted" shallow water Eastern and East Central GOM oil fields.

Pipeline System	No. of Fields	CO_2-EOR Oil Recovery	Total CO_2 Requirements		CO_2 Flow	
	(#)	(MMB)	(Bcf)	(MMmt)	(MMcfd)	(MMmt/yr)
Eastern	**7**	**480**	**4,760**	**252**	**330**	**6.3**
East Central #1						
▪ Part 1	4	450	4,570	242	310	6.1
▪ Part 2	5	600	5,980	316	410	7.9
▪ Part 3	2	130	1,310	69	90	1.7
▪ Part 4	2	130	1,280	68	90	1.7
Total	**13**	**1,310**	**13,140**	**695**	**900**	**17.4**
East Central #2						
▪ Part 1	6	340	3,360	178	230	4.5
▪ Part 2	3	250	2,550	135	180	3.5
Total	**9**	**590**	**5,910**	**313**	**410**	**8.0**
Total	**29**	**2,380**	**23,810**	**1,260**	**1,640**	**31.7**

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- The Eastern CO_2 pipeline system is modest in size, transporting 330 MMcfd (6.3 MMmt/yr) of CO_2.
- The East Central #1 CO_2 pipeline system, the dominant CO_2 system, would transport 900 MMcfd (17.4 MMmt/yr) of CO_2.
- The East Central #2 CO_2 pipeline system would transport 410 MMcfd (8.0 MMmt/yr) of CO_2.
- We estimate these 29 oil fields would provide 2,380 million barrels of oil and require 24 Tcf (1,260 million metric tons) of CO_2 delivered at 1,640 MMcfd (31.7 MMmt/yr) for 40 years.

"Opportunity" Oil Fields Near the Proposed Eastern and East Central GOM Shallow Water CO_2 Pipeline Systems

Twenty three smaller oil fields, located near the three proposed Eastern and East Central GOM CO_2 pipeline systems, could be added to the initial shallow water CO_2 pipeline system.

Pipeline System	No. of Fields	CO_2-EOR Oil Recovery*	Total CO_2 Requirements**		CO_2 Requirements	
	(#)	(MMB)	(Bcf)	(MMmt)	(MMcfd)	(MMt/yr)
Eastern	5	130	1,350	72	90	1.8
East Central #1	11	320	3,140	166	220	4.2
East Central #2	7	190	1,970	104	130	2.5
Total	**23**	**640**	**6,460**	**342**	**440**	**8.5**

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*Technically viable oil recovery is estimated at 15% of OOIP.

**Technically viable CO_2 requirements are estimated using 10 Mcf of CO_2 per barrel of recovered oil.

These 23 oil fields* (each with between 50 and 100 million barrels of original oil reserves) provide additional "opportunities" for storing CO_2 and producing oil with CO_2-EOR.

We estimate that these 23 oil fields could provide 640 million barrels of oil and require about 6.5 Tcf (340 million metric tons) of CO_2 delivered at 440 MMcfd (8.5 million mt/yr) for 40 years.

Final Eastern and East Central GOM Shallow Water CO_2 Pipeline System

Including both the 29 "targeted" oil fields and the 23 "opportunity" oil fields, the three pipelines would deliver about 2.1 Bcfd of CO_2 (40 million tons per year) to 52 shallow water GOM oil fields.

Pipeline System	No. of Fields	CO_2-EOR Oil Recovery	Total CO_2 Requirements		CO_2 Requirements	
	(#)	(MMB)	(Bcf)	(MMmt)	(MMcfd)	(MMmt/yr)
Eastern	**12**	**610**	**6,110**	**323**	**420**	**8.1**
East Central #1						
▪ Part 1	6	520	5,220	276	360	6.9
▪ Part 2	7	650	6,530	346	450	8.7
▪ Part 3	6	240	2,380	126	160	3.2
▪ Part 4	5	220	2,150	114	150	2.8
Total	**24**	**1,630**	**16,280**	**862**	**1,120**	**21.6**
East Central #2						
▪ Part 1	12	500	5,040	267	350	6.8
▪ Part 2	4	290	2,840	150	190	3.7
Total	**16**	**790**	**7,880**	**417**	**540**	**10.5**
Total	**52**	**3,030**	**30,270**	**1,602**	**2,080**	**40.2**

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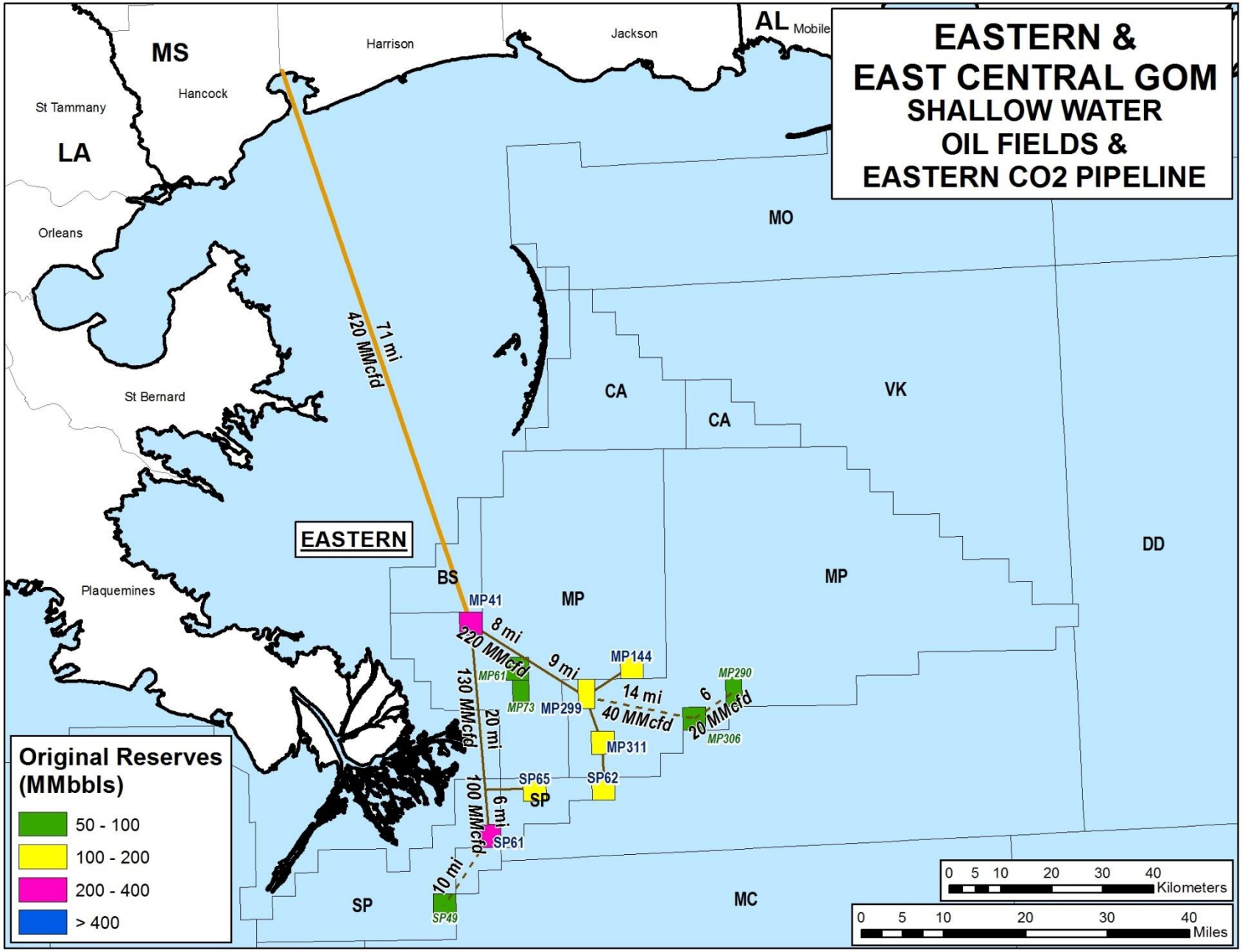
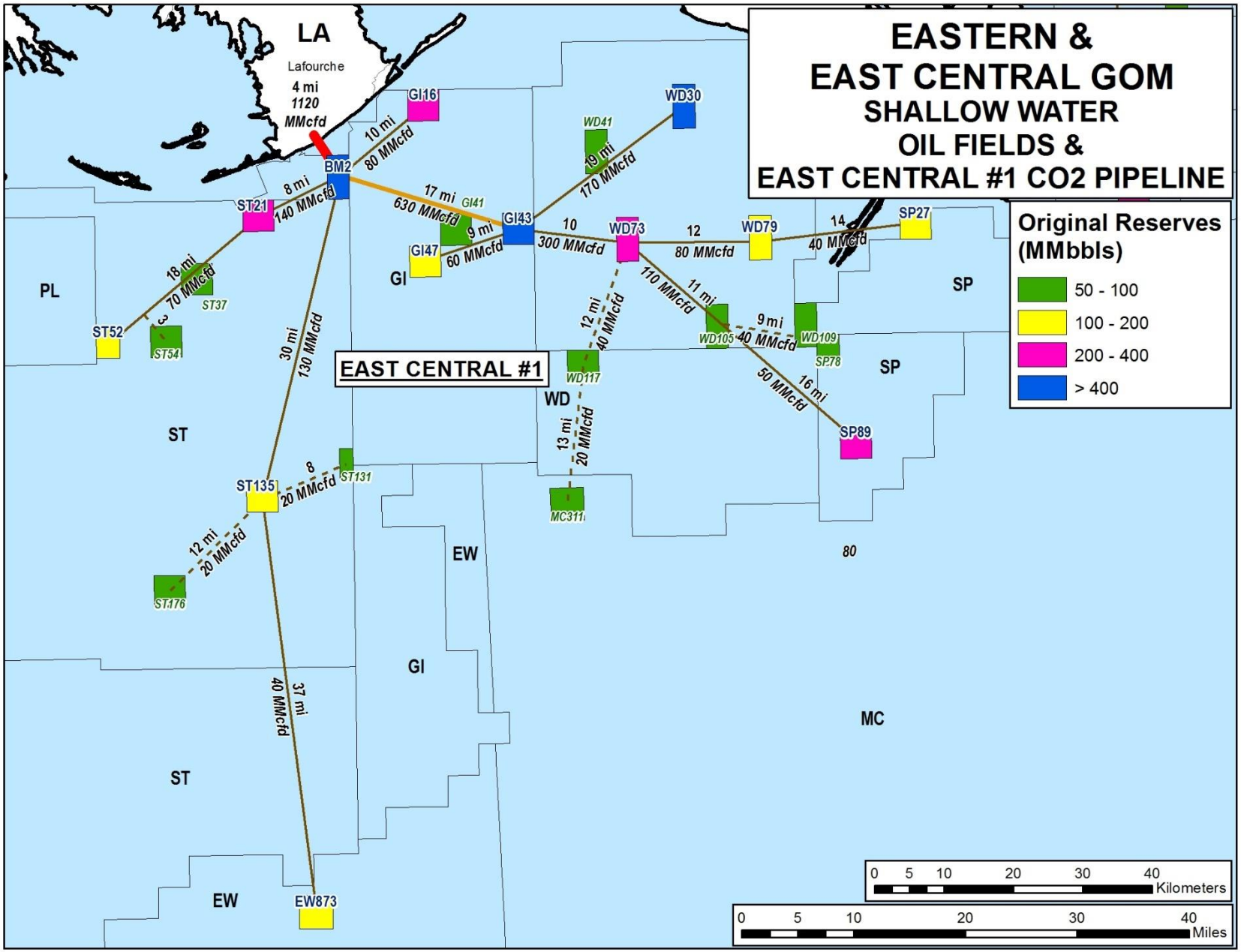
- The Eastern CO_2 pipeline system remains modest in size, transporting 420 MMcfd (8.1 MMmt/yr) of CO_2.
- The East Central #1 CO_2 pipeline system remains the dominant CO_2 system, with 1,120 MMcfd (21.6 MMmt/yr) of capacity.
- The East Central #2 CO_2 pipeline system would have 540 MMcfd (10.5 MMmt/yr) of transportation capacity.





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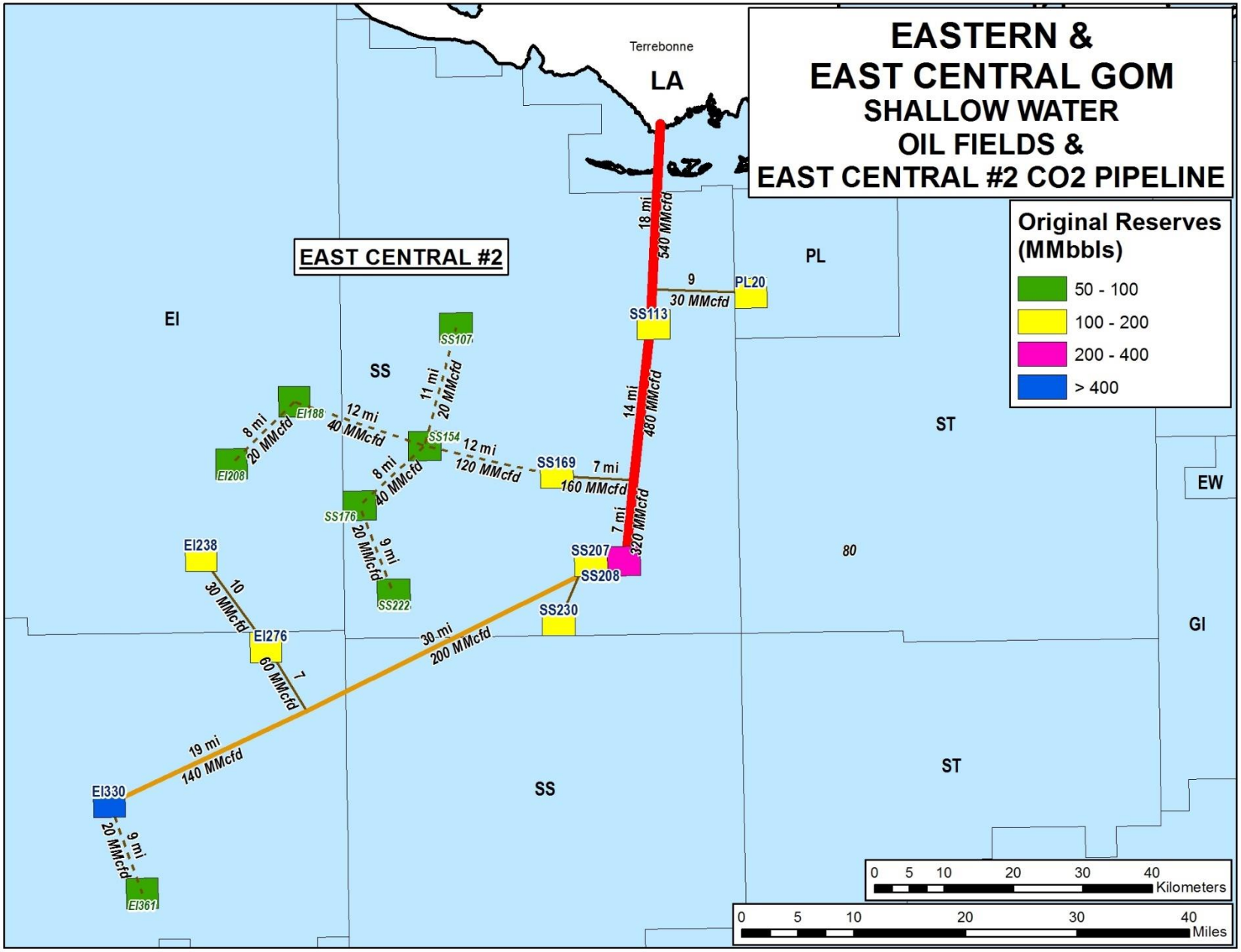

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Eastern and East Central GOM Shallow Water CO_2 Pipeline Investment Costs

Our estimate of installing the three CO_2 pipelines in the shallow waters of the Eastern and East Central Gulf of Mexico is about $1.7 billion.

Pipeline System	CO_2 Requirements		Pipeline Requirements	Capital Costs*
	(MMcfd)	(MMmt/yr)	(in-mi)	($MM)
Eastern	420	8.1	2,478	$600
East Central #1	1,120	21.6	2,512	$600
East Central #2	540	10.5	2,074	$500
Total	**2,080**	**40.2**	**7,064**	**$1,700**

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*We assume $240,000 per inch-mile for shallow water.

Opportunities for lowering these costs would involve further optimizing the CO_2 pipeline systems and selectively using existing, empty offshore natural gas pipelines, where possible.

Summary of Findings

The prefeasibility study of the Eastern and East Central Gulf of Mexico shallow water CO_2 pipeline system provides the following findings:

1. **Time Urgency for the CO_2 Pipeline System**. The majority of the large shallow water Eastern and East Central Gulf of Mexico oil fields are close to abandonment. Once these fields are abandoned and their platforms removed, the feasibility of conducting CO_2-EOR and storing CO_2 in the offshore becomes much more challenging and costly.
2. **The Eastern and East Central GOM Shallow Water CO_2 Pipeline System**. The three CO_2 pipelines defined by the study would facilitate the implementation of CO_2-EOR and CO_2 storage in 52 large GOM shallow water oil fields. This would involve:
   - Technically feasible oil recovery of over 3 billion barrels,
   - CO_2 demand and storage of over 30 Tcf (1,600 million metric tons),
   - CO_2 delivery (and storage) of 2.1 Bcf per day, equal to 40 million metric tons per year, over a 40 year time period, and
   - Capital costs of $1.7 billion dollars for an all new CO_2 pipeline system.

Time Urgency of the CO_2 Pipeline System for Shallow Water Central GOM Oil Fields

The large shallow water Gulf of Mexico oil fields, located in less than 1,000' of water depth, are rapidly depleting their original reserves and thus approaching abandonment.

Status of Large Shallow Water Oil Fields

Potential Abandonment (Year)	No. of Fields (#)	Original Reserves (MM bbl)	Remaining Reserves* (MM bbl)	Reserve Depletion (%)
2025	40	6,491	131	98%
2030	12	1,684	82	95%
Total	**52**	**8,175**	**213**	**97%**

*As of end of 2014.

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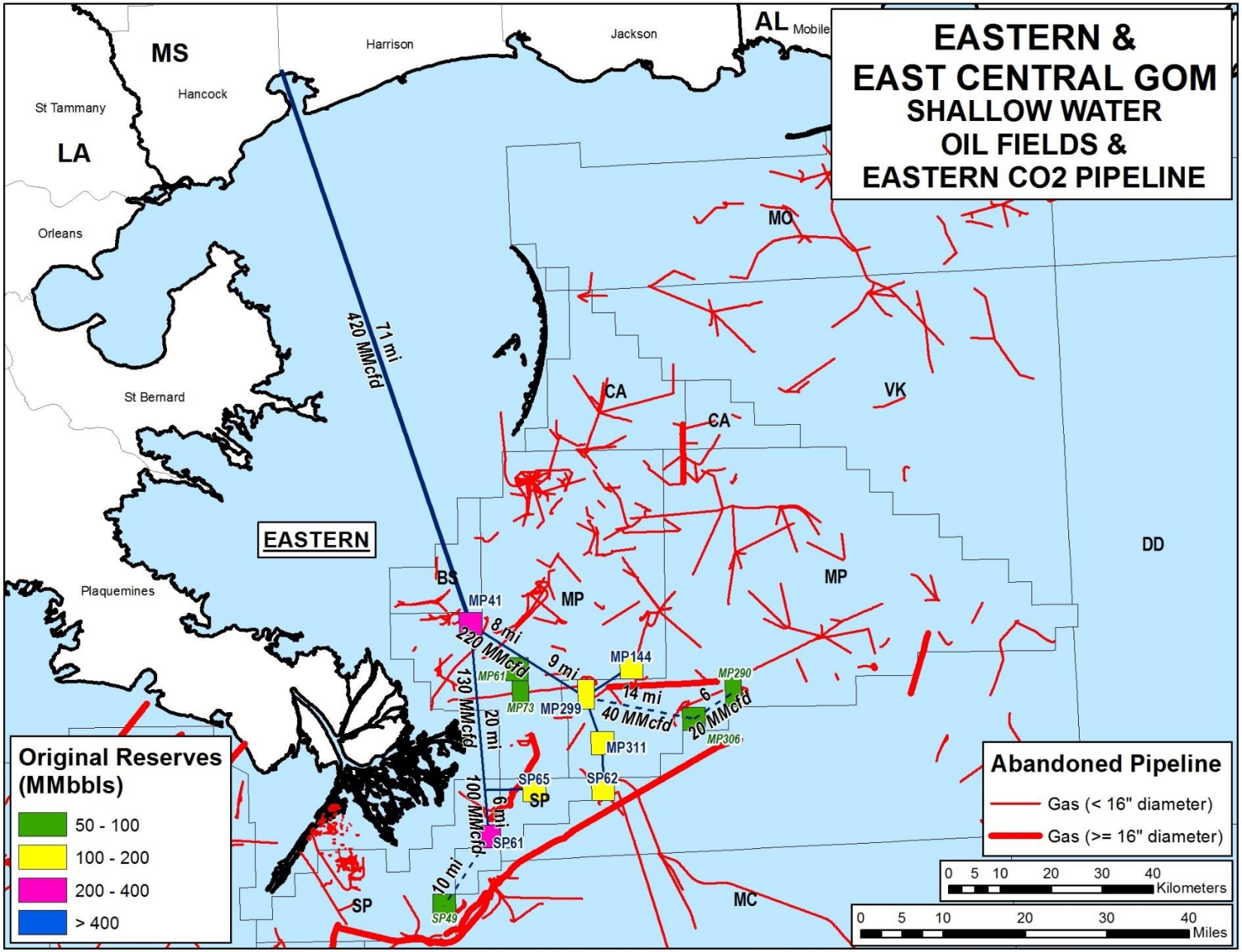
- Of the 52 large shallow water Central GOM oil fields, 40 fields are approaching abandonment by 2025.
- These 40 large oil fields that originally held 6.5 billion barrels of reserves have produced 98% of their original reserves.
- Another 12 oil fields will approach abandonment by 2030.

Summary of Findings (Cont'd)

3. **Utilization of Existing Empty Offshore Pipelines.** Given the location of the abandoned natural gas pipelines in the Eastern and East Central GOM, there does not appear to be any obvious candidates that could deliver CO_2 to shallow water oil fields, as illustrated for the Eastern CO_2 Pipeline System. A more in-depth analysis might show promise.

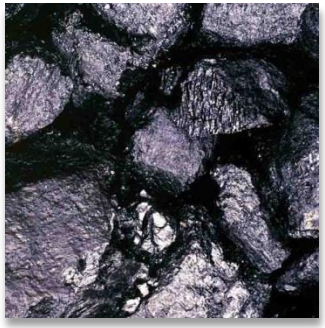
4. **Pipeline Delivery Costs for CO_2.** Using a capital cost of $1.7 billion, a 14% capital charge, and an O&M charge of 5% of capital, the annual costs (including the capital charge) for the CO_2 pipeline system would be about $320 million.

   With annual delivery of 40 million metric tons, the CO_2 transportation costs for the GOM Shallow Water CO_2 Pipeline System would be about $8 per metric ton. Assuming 0.5 metric tons of CO_2 per barrel of recovered oil, the CO_2 transportation cost would be about $4 per barrel of oil.



Summary of Findings (Cont'd)

5. **GOM Shallow Water CO_2 Pipeline Benefits**. With potential oil recovery of 3 billion barrels, an oil price of $80 per barrel (EIA AEO 2017 projected oil price (WTI) for Year 2025, in real 2016 dollars), and a shallow water GOM royalty rate of 16.7%, the Federal Government would receive about $40 billion dollars of royalty revenues from the oil produced using the GOM Shallow Water CO_2 Pipeline System (assuming all of the technically recoverable oil would be developed).

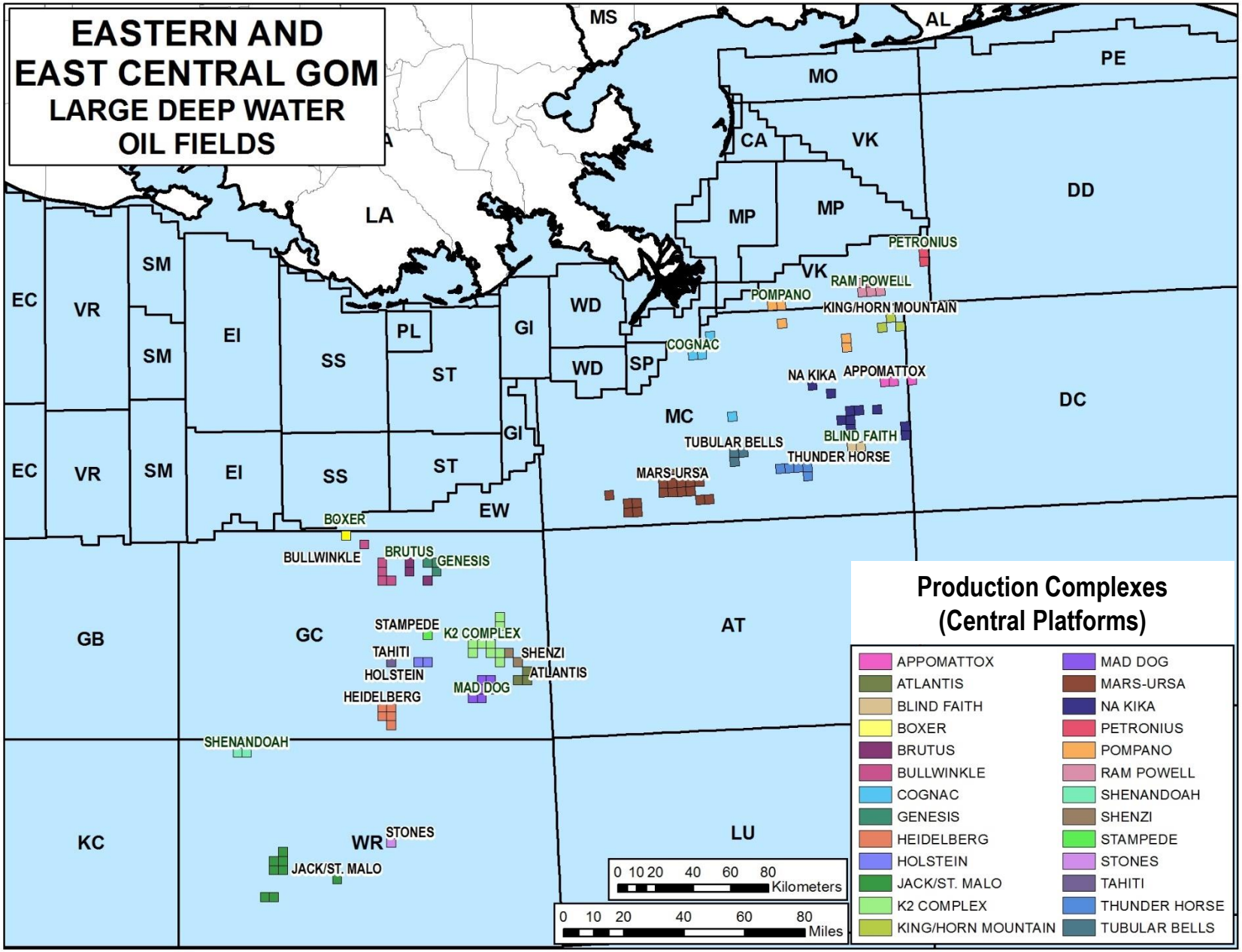


2. Eastern and East Central GOM Deepwater CO_2 Pipeline System

Pipeline Systems for Delivering CO_2 to Deepwater Eastern and East Central GOM Oil Fields

The 63 large deepwater Eastern and East Central GOM oil fields, concentrated in Green Canyon and Mississippi Canyon, offer considerable potential for CO_2 storage and technically viable oil recovery using CO_2-EOR.

- These 63 large deepwater oil fields contain 8.6 billion barrels of original oil reserves, with about half of these original reserves already produced.
- We plotted the location of these 63 large deepwater oil fields and 26 Production Complexes (central platforms). We then estimated their oil recovery potential and CO_2 requirements for CO_2-EOR.
- We established seven major CO_2 Hubs served by three Deepwater CO_2 Pipeline Systems to link these 63 large oil fields with CO_2 supplies delivered from onshore Louisiana, Mississippi and Alabama.



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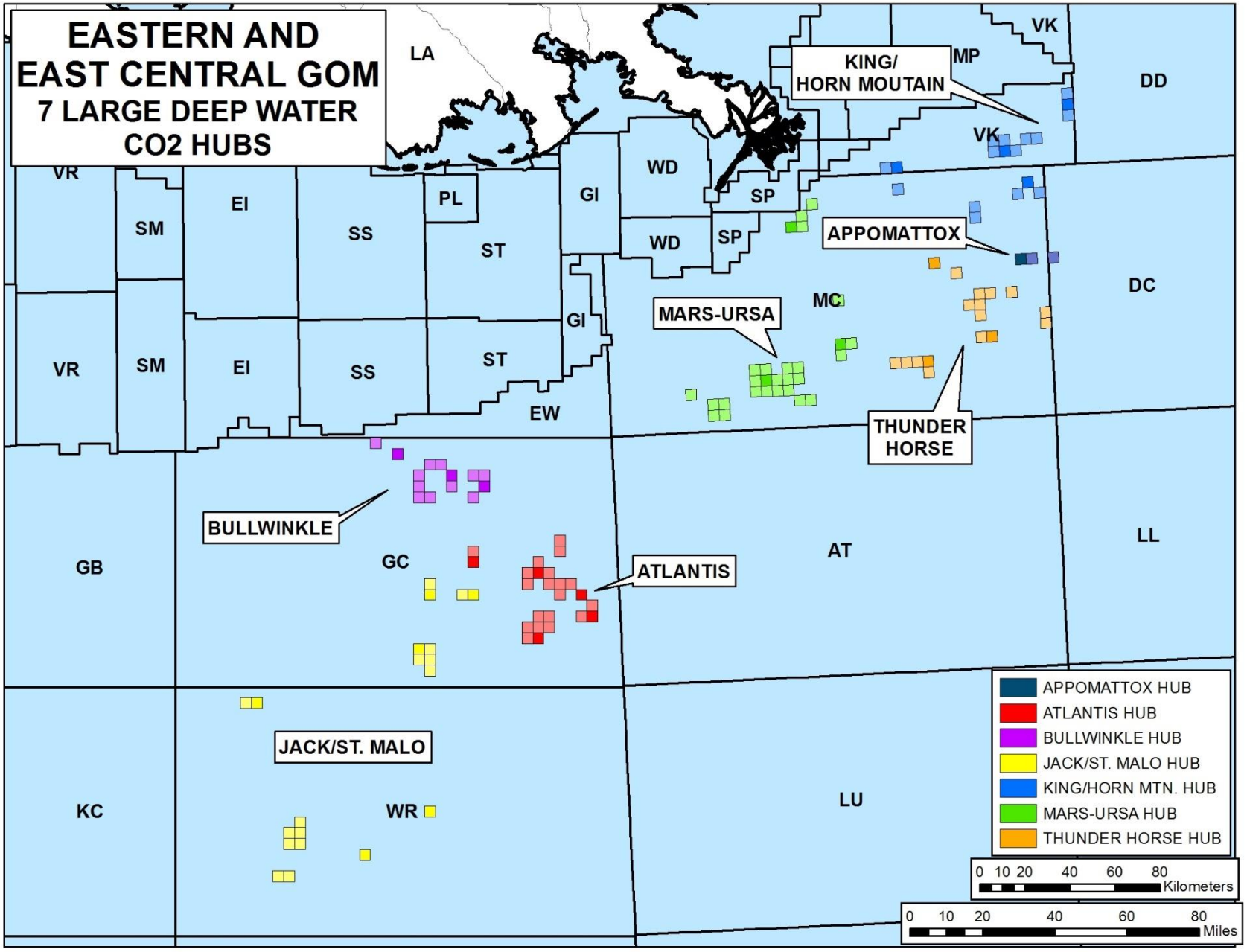

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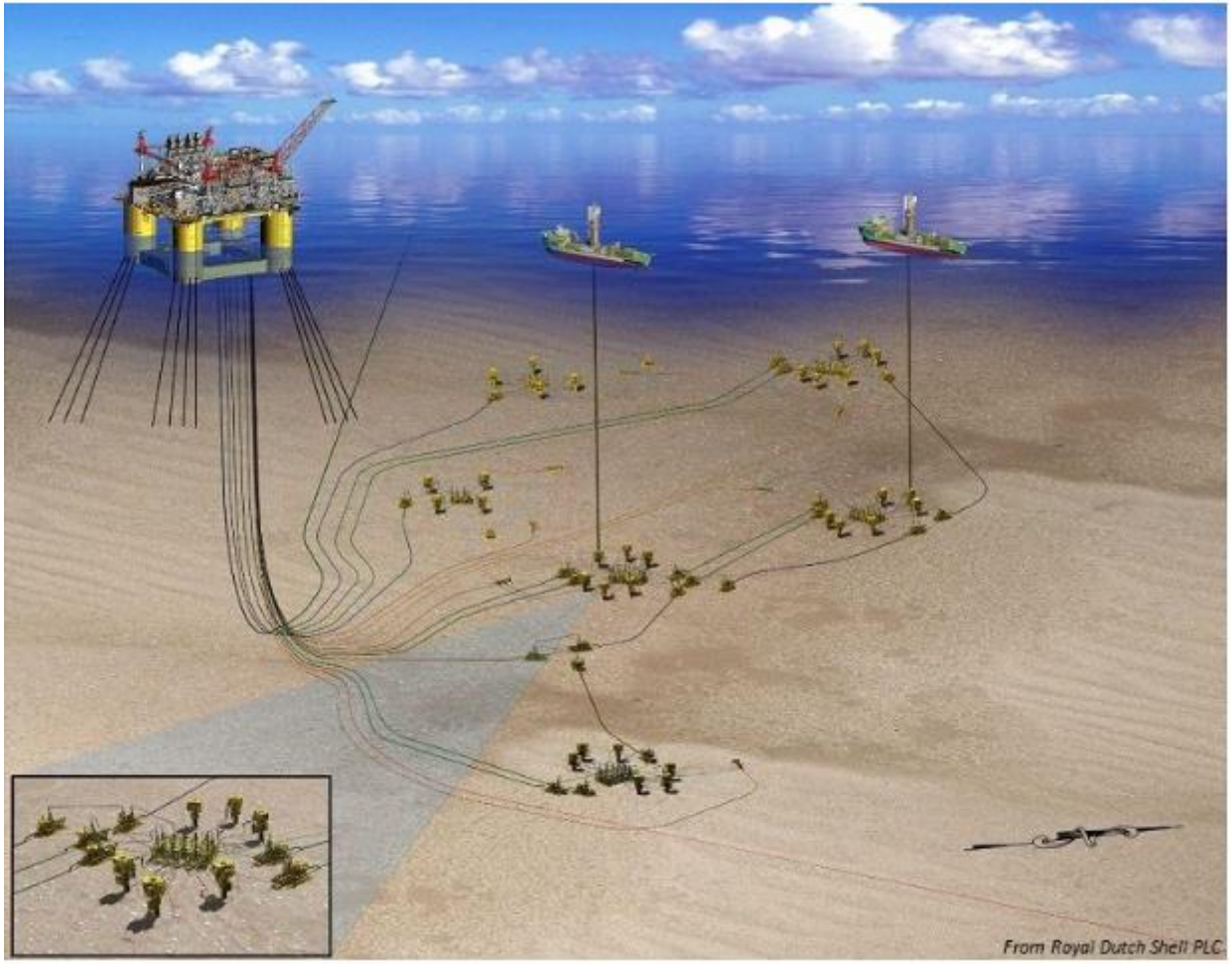
Appomattox CO_2 Hub and Production Complexes

The Appomattox CO_2 Hub and Production Complex is linked to the Appomattox (MC391) and Vicksburg (DC353) oil fields located in about 7,300 feet of water depth. Vicksburg was discovered by Shell in 2013 with Appomattox discovered, also by Shell, in 2016. Both fields are projected to be placed on production in 2020.

Subsequently, Shell announced the Appomattox deepwater platform would also provide tieback opportunities for the nearby Gettysburg, Ryberg and other prospects.

Shell has proposed building a 24-inch pipeline, called the Mattox Pipeline, to transport crude oil from the Appomattox host platform to a shallow water offshore structure and from there to the onshore using existing infrastructure.

Appomattox CO_2 Hub



The Appomattox deepwater semi-submersible production platform will be located in 7,200 feet of water, 80 miles south of Mobile, Alabama. It will contain six drill centers, 15 producing sub-sea wells and five water injection wells.

The production platform is scheduled to be placed on-stream in 2020.

Source: OGJ On-Line, 07/01/2015

Eastern Deepwater GOM CO_2 Pipeline System

The Eastern Deepwater Gulf of Mexico CO_2 Pipeline System links three deepwater CO_2 Hubs: (1) King/Horn Mt. CO_2 Hub (King/Horn Mt., Petronius, Pompano and Ram-Powell Production Complexes); (2) Thunder Horse CO_2 Hub (Thunder Horse, Blind Faith and NaKita Production Complexes); and (3) Appomattox CO_2 Hub (Appomattox Production Complex).

The 23 oil fields linked to the King/Horn Mt., Thunder Horse, and Appomattox CO_2 Hubs offer the technical potential for: (1) 1,280 million barrels of CO_2-EOR based oil recovery; (2) 12,790 Bcf (677 MMmt) of CO_2 use and storage; and (3) CO_2 requirements of 880 MMcfd (17 MMmt/yr) of CO_2 for 40 years.

Eastern GOM Deepwater CO_2 Pipeline System

CO_2 Hubs	No. of Fields	CO_2-EOR Oil Recovery	Total CO_2 Demand/Storage		CO_2 Flow Requirements	
	(#)	(MMB)	(Bcf)	(MMmt)	(MMcfd)	(MMmt/yr)
King/Horn Mt.	9	280	2,770	147	190	3.7
Thunder Horse	12	600	6,040	319	420	8.1
Appomattox	2	400	3,980	211	270	5.2
Total	23	1,280	12,790	677	880	17.0

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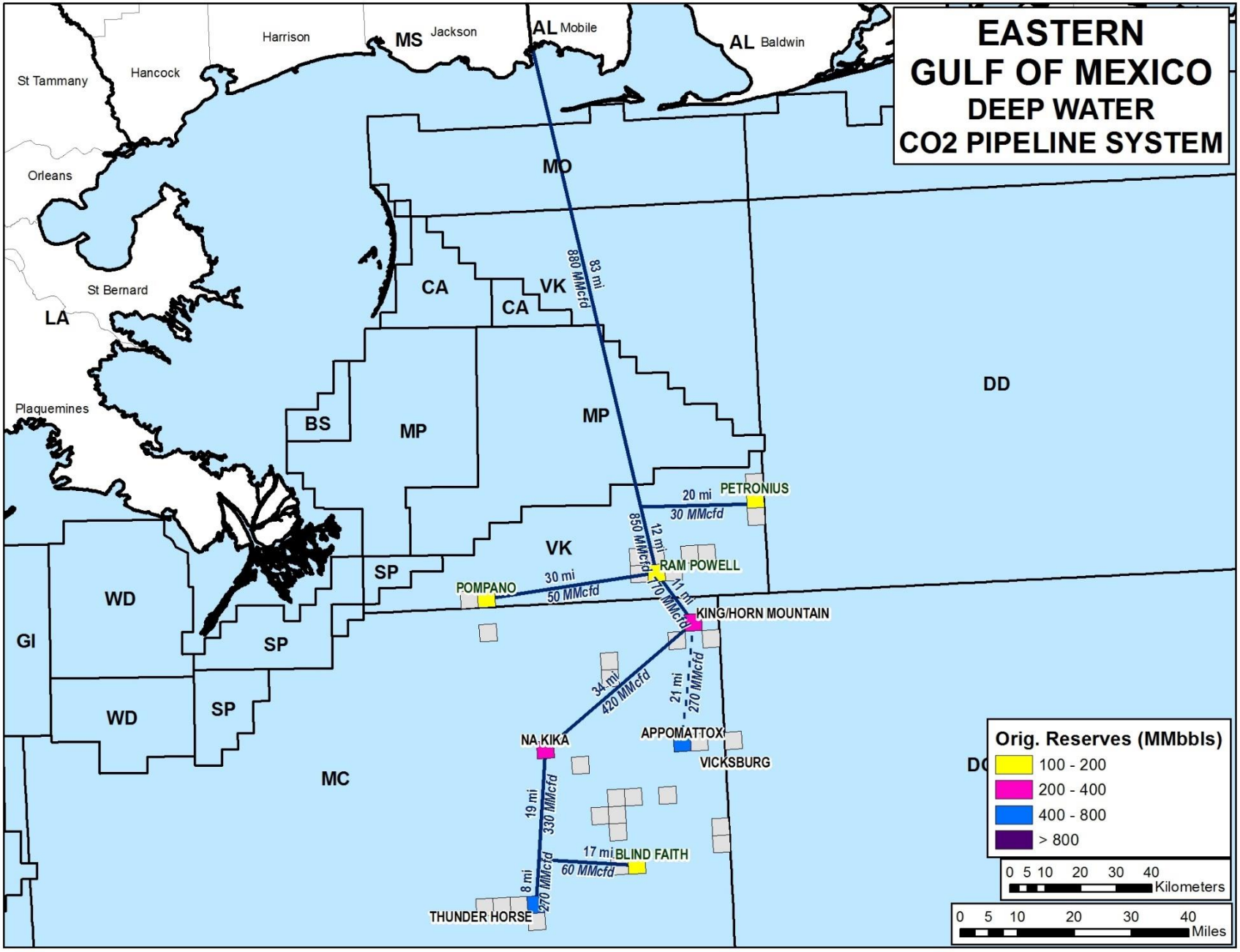
The schematic for the Eastern Deepwater GOM CO_2 Pipeline System follows.



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East Central #1 Deepwater GOM CO_2 Pipeline System

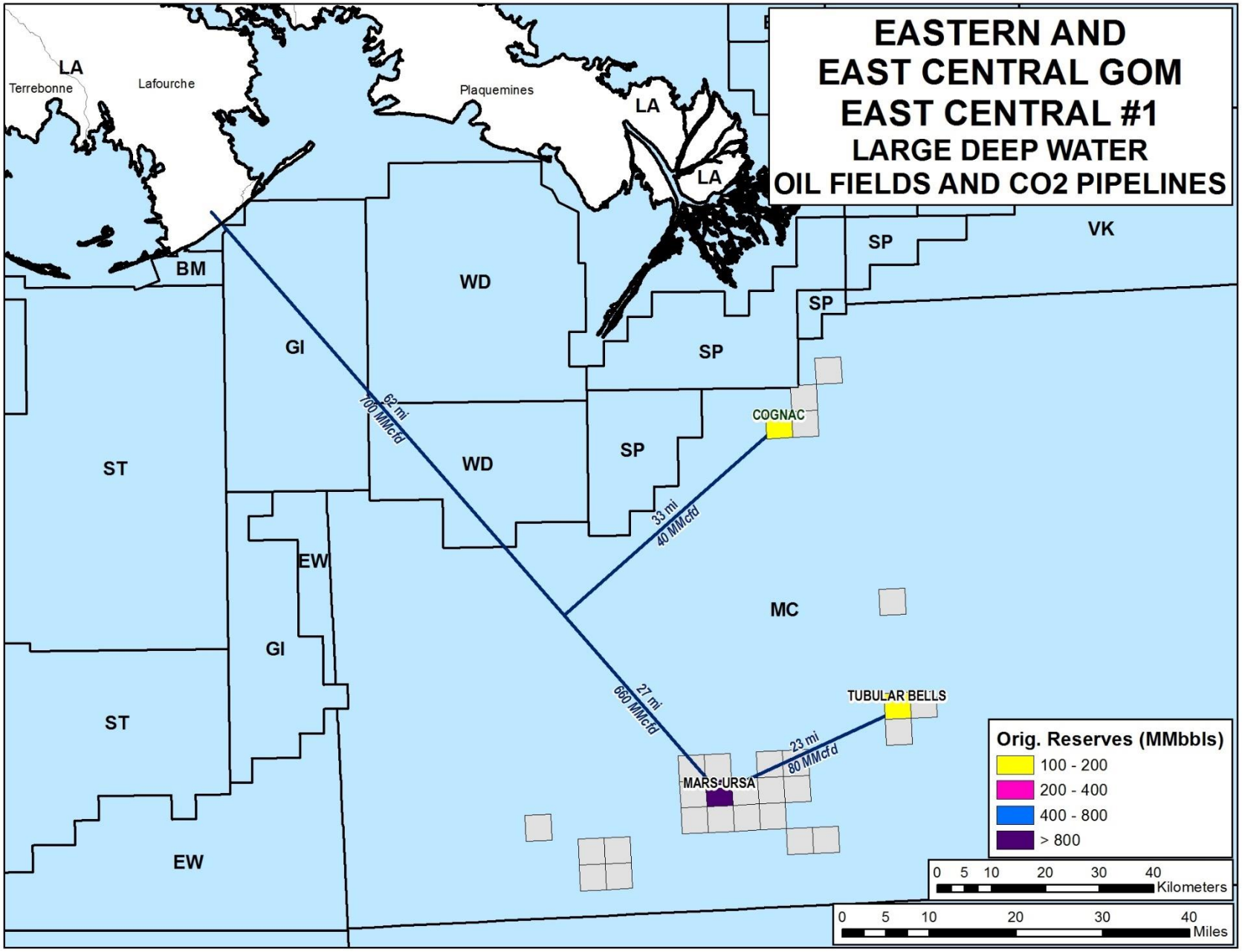
The East Central #1 Deepwater Gulf of Mexico CO_2 Pipeline System is linked to the Mars-Ursa CO_2 Hub and to three major Production Complexes: Cognac, Tubular Bells, and Mars-Ursa.

The 10 oil fields linked to the Mars-Ursa CO_2 Hub offer the technical potential for: (1) 1,030 million barrels of CO_2-EOR based oil recovery; (2) 10,270 Bcf (543 MMmt) of CO_2 use and storage; and (3) CO_2 requirements of 700 MMcfd (13.5 MMmt/yr) for 40 years.

East Central #1 Deepwater CO_2 Pipeline System

Deepwater CO_2 Hub	No. of Fields	CO_2-EOR Oil Recovery	Total CO_2 Requirements		Periodic CO_2 Requirements	
	(#)	(MMB)	(Bcf)	(MMmt)	(MMcfd)	(MMmt/yr)
Mars-Ursa	10	1,030	10,270	543	700	13.5

The schematic for the East Central #1 Deepwater GOM CO_2 Pipeline System follows.


EASTERN AND
EAST CENTRAL GOM
EAST CENTRAL #1
LARGE DEEP WATER
OIL FIELDS AND CO2 PIPELINES
LA
Terrebonne
Lafourche
Plaquemines
LA
LA
BM
WD
GI
SP
SP
VK
SP
ST
WD
SP
COGNAC
92 mi
700 MMcfd
33 mi
40 MMcfd
EW
GI
MC
ST
27 mi
660 MMcfd
TUBULAR BELLS
23 mi
80 MMcfd
MARS-URSA
EW
Orig. Reserves (MMbbls)
100 - 200
200 - 400
400 - 800
> 800
0 5 10 20 30 40
Kilometers
0 5 10 20 30 40
Miles

East Central #2 Deepwater GOM CO_2 Pipeline System

The East Central #2 Deepwater Gulf of Mexico CO_2 Pipeline System encompasses three major CO_2 Hubs: (1) Bullwinkle CO_2 Hub (Bullwinkle, Brutus, Boxer and Genesis Production Complexes), (2) Atlantis CO_2 Hub (Atlantis, Shenzi, K2, Stampede and Mad Dog Production Complexes), and (3) Jack/St. Malo CO_2 Hub (Jack St. Malo, Heidelberg, Holstein, Tahiti, Shenandoah and Stones Production Complexes).

The 30 oil fields linked to the Bullwinkle, Atlantis, and Jack/St. Malo CO_2 Hubs offer the technical potential for : (1) 1,990 million barrels of CO_2-EOR based oil recovery; (2) 19,910 Bcf (1,053 MMmt) of CO_2 use and storage, and (3) CO_2 requirements of 1,360 MMcfd (26.3 MMmt/yr) of CO_2 for 40 years.

CO_2 Hub	No. of Fields	CO_2-EOR Oil Recovery	Total CO_2 Requirements		Periodic CO_2 Requirements	
	(#)	(MMB)	(Bcf)	(MMmt)	(MMcfd)	(MMmt/yr)
Bullwinkle	10	270	2,730	144	190	3.7
Atlantis	12	770	7,660	405	520	10
Jack / St. Malo	8	950	9,520	504	650	12.6
Total	30	1,990	19,910	1,053	1,360	26.3

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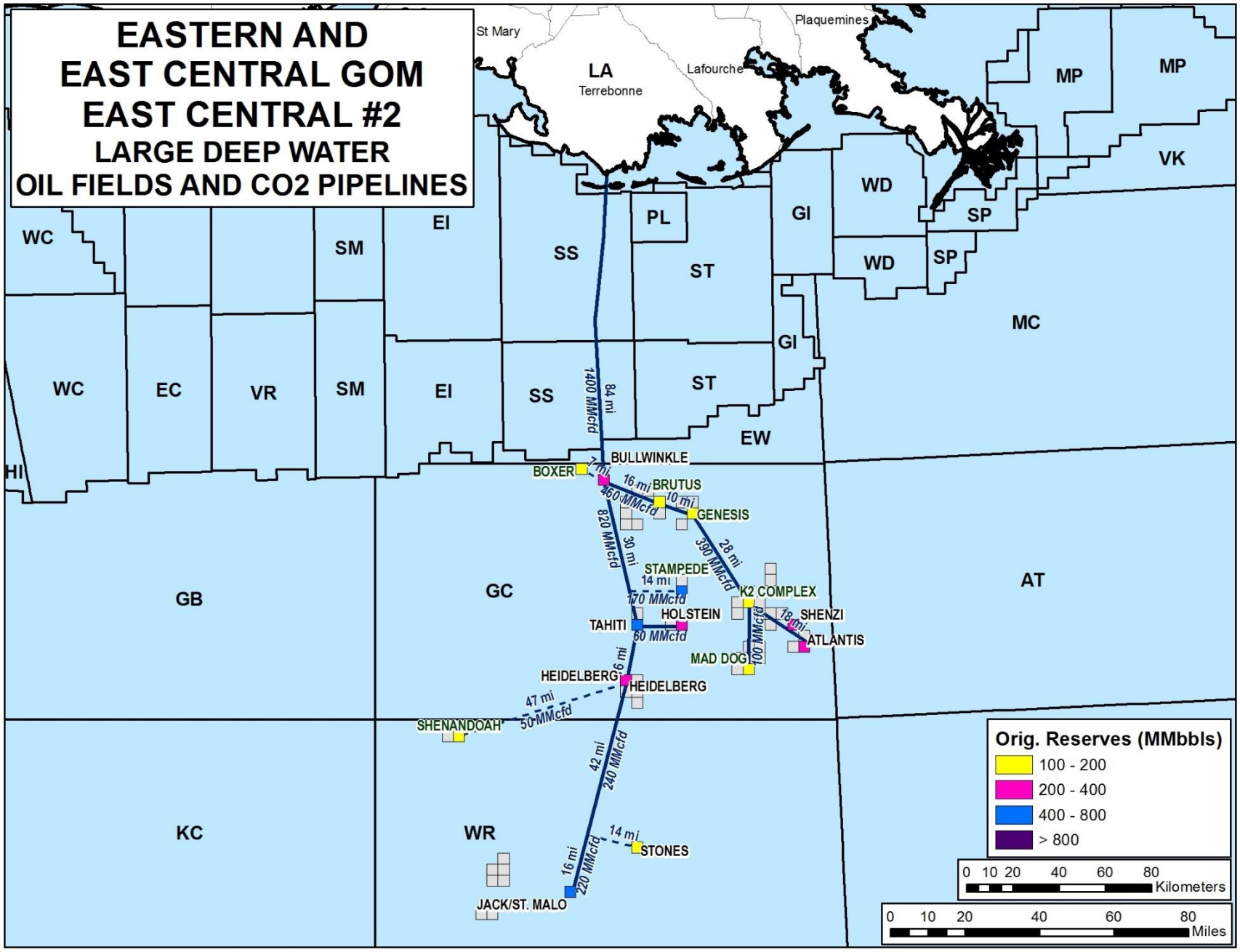
The schematic for the East Central #2 Deepwater GOM CO_2 Pipeline System follows.


EASTERN AND
EAST CENTRAL GOM
EAST CENTRAL #2
LARGE DEEP WATER
OIL FIELDS AND CO2 PIPELINES
St Mary
Plaquemines
LA
Terrebonne
Lafourche
MP
MP
VK
WD
SP
WD
SP
GI
PL
EI
SS
ST
WC
SM
MC
GI
WC
EC
VR
SM
EI
SS
ST
EW
HI
GB
GC
AT
KC
WR
1400 MMcfd
84 mi
BULLWINKLE
BOXER
7 mi
16 mi
BRUTUS
460 MMcfd
10 mi
GENESIS
820 MMcfd
30 mi
28 mi
390 MMcfd
STAMPEDE
14 mi
170 MMcfd
K2 COMPLEX
TAHITI
HOLSTEIN
60 MMcfd
100 MMcfd
18 mi
SHENZI
ATLANTIS
MAD DOG
HEIDELBERG
6 mi
HEIDELBERG
47 mi
50 MMcfd
SHENANDOAH
42 mi
240 MMcfd
14 mi
STONES
16 mi
220 MMcfd
JACK/ST. MALO
Orig. Reserves (MMbbls)
100 - 200
200 - 400
400 - 800
> 800
0 10 20 40 60 80
Kilometers
0 10 20 40 60 80
Miles

Eastern and East Central GOM Deepwater CO_2 Pipeline Systems

We estimate technically feasible oil recovery of 4.3 billion barrels, an ultimate CO_2 demand of 43 Tcf (2,300 million metric tons), and CO_2 flows of 2.9 Bcfd (57 MMmt/yr) for the Deepwater GOM CO_2 Pipeline System.

Pipeline System	CO_2 Hub	CO_2 EOR*	CO_2 Demand**		CO_2 Flow	
		(MMbbls)	(Bcf)	(MMmt)	(MMcfd)	(MMmt/y)
Eastern						
	King/Horn Mt.	280	2,770	147	190	3.7
	Thunder Horse	600	6,040	319	420	8.1
	Appomattox	400	3,980	211	270	5.2
Eastern Sub-Total		**1,280**	**12,790**	**677**	**880**	**17.0**
East Central #1						
	Mars-Ursa	**1,030**	**10,270**	**543**	**700**	**13.5**
East Central #2						
	Bullwinkle	270	2,730	144	190	3.7
	Atlantis	770	7,650	405	520	10.0
	Jack/St. Malo	950	9,520	504	650	12.6
East Central #2 Sub-Total		**1,990**	**19,900**	**1,053**	**1,360**	**26.3**
Total		**4,300**	**42,960**	**2,273**	**2,940**	**56.8**

*Technically viable oil recovery is estimated at 15% of OOIP.

**Technically viable CO_2 requirements are estimated using 10 Mcf of CO_2 per barrel of oil recovery.

5/24/2017

Eastern and East Central GOM Deepwater CO_2 Pipeline Investment Costs

Our overall estimate of installing the three CO_2 pipeline systems in the deep waters of the Gulf of Mexico is about $4.1 billion.

Pipeline System	CO_2 Requirements		Pipeline Requirements	Capital Costs*
	(MMcfd)	(MMmt/yr)	(inch-miles)	($MM)
Eastern	880	17.0	4,862	$1,310
East Central #1	700	13.5	3,048	$820
East Central #2	1,360	26.3	7,166	$1,980
Total	**2,940**	**56.8**	**15,076**	**$4,110**

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Opportunities for lowering these costs would involve further optimizing the CO_2 pipeline system.

*We assume capital costs of $240,000 per inch-mile for shallow water and $300,000 per inch-mile for deepwater.

Summary of Findings

Our prefeasibility study of the Eastern and East Central Gulf of Mexico CO_2 Pipeline System provides the following findings:

1. **Time Urgency for the CO_2 Pipeline System**. Eighteen large deepwater oil fields are close to abandonment having produced 93% of their original reserves. Once these fields are abandoned and their platforms removed, the feasibility of conducting CO_2-EOR and storing CO_2 in these oil fields become much more challenging and costly.
2. **The Eastern and East Central GOM Deepwater CO_2 Pipeline System**. The three GOM deepwater CO_2 pipelines would facilitate the implementation of CO_2-EOR and CO_2 storage in 63 large GOM oil fields.
   - Technically feasible oil recovery of 4.3 billion barrels,
   - CO_2 demand and storage of nearly 43 Tcf (2,270 million metric tons),
   - CO_2 delivery (and storage) of 2.9 Bcf per day, equal to 57 million metric tons per year, over a 40 year time period, and
   - Capital costs of $4.1 billion dollars for an all new CO_2 pipeline system.

Eastern and East Central Gulf of Mexico Deepwater Oil Field Areas Nearing Abandonment

Production Complex		Original Reserves			2014 Annual Production			Cumulative Production through 2014			Reserves		
Name	# Fields	Oil (MMbbl)	Gas (Bcf)	BOE (MMbbl)	Oil (MMbbl)	Gas (Bcf)	BOE (MMbbl)	Oil (MMbbl)	Gas (Bcf)	BOE (MMbbl)	Oil (MMbbl)	Gas (Bcf)	BOE (MMbbl)
PETRONIUS	2	160	198	195	3.7	8.9	5.3	150.7	177.6	182.3	9	21	13
BOXER	1	102	172	132	0.6	0.9	0.8	100.4	168.5	130.4	2	3	2
RAM POWELL	1	99	897	259	1.5	5.7	2.6	95.0	881.2	251.8	4	16	7
MAD DOG	2	166	102	184	10.4	3.3	11.1	135.5	40.6	142.8	30	61	41
GENESIS	1	146	213	184	4.1	4.7	4.9	133.4	195.8	168.2	13	17	16
BRUTUS	2	122	193	156	2.7	2.5	3.2	111.5	154.8	139.1	10	39	17
COGNAC	2	182	837	331	0.4	2.2	0.8	180.1	803.1	323.0	2	34	8
BULLWINKLE	7	393	691	515	3.4	5.7	4.3	370.4	633.3	483.0	22	58	32
EASTERN & EAST CENTRAL	**18**	**1,369**	**3,302**	**1,957**	**27**	**34**	**33**	**1,277**	**3,055**	**1,821**	**92**	**248**	**136**

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Summary of Findings (Cont'd)

3. **Pipeline Delivery Costs for CO_2.** Using a capital cost of $4.1 billion, a 14% capital charge, and an O&M charge of 5% of capital, the annual costs (including the capital charge) for the GOM deepwater CO_2 pipeline system would be about $780 million.

   With annual delivery of nearly 57 million metric tons, the CO_2 transportation costs for the GOM Deepwater CO_2 Pipeline System would be about $14 per metric ton. Assuming 0.5 metric tons of CO_2 per barrel of recovered oil, the CO_2 transportation cost would be about $7 per barrel of oil.

4. **GOM Deepwater CO_2 Pipeline Benefits.** With potential oil recovery of 4.3 billion barrels, an oil price of $80 per barrel (EIA AEO 2017 projected oil price (WTI) for Year 2025, in real 2016 dollars), and a deepwater royalty rate of 18.75%, the Federal Government would receive about $64 billion dollars of royalty revenues from the oil produced using the GOM Deepwater CO_2 Pipeline System (assuming all of the technically recoverable oil would be developed).

3. Next Steps

As part of our existing Scope of Work, we plan to address two additional topics.

- CO_2 utilization/storage, oil recovery and CO_2 pipeline systems for eastern Louisiana, Mississippi and Alabama state waters.
- The potential and capacity of storing CO_2 in the depleted gas fields of the Eastern and East Central GOM, including state, shallow Federal, and deep Federal waters.

A critical topic, although not within our Scope of Work, would be addressing the question - - *How much of the CO_2 demand and potential for oil recovery in the GOM offshore would be economically viable to pursue?*

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