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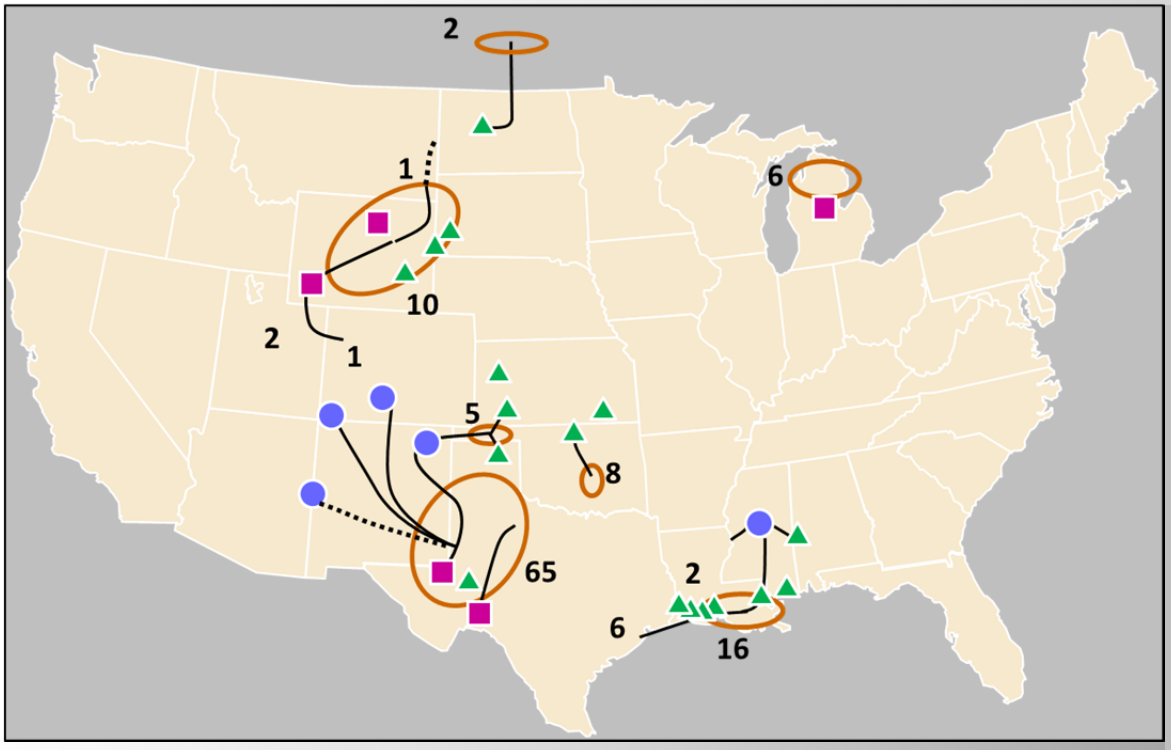

Near-Term Projections of CO_2 Utilization for Enhanced Oil Recovery

April 7, 2014

DOE/NETL-2014/1648

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This report was prepared by Energy Sector Planning and Analysis (ESPA) for the United States Department of Energy (DOE), National Energy Technology Laboratory (NETL). This work was completed under DOE NETL Contract Number DE-FE0004001. This work was performed under ESPA Task 150.07.04.

The authors wish to acknowledge the excellent guidance, contributions, and cooperation of the NETL staff, particularly:

Evelyn Dale, NETL Technical Monitor

DOE Contract Number DE-FE0004001

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Exhibits

Acronyms and Abbreviations

AEO	Annual Energy Outlook
ARI	Advanced Resources International, Inc.
Bcfd	Billion cubic feet per day
CCS	Carbon capture and storage
CO_2	Carbon dioxide
CTL	Coal-to-liquids
CVR	CVR Energy, Inc.
DKRW	DKRW Advanced Fuels, LLC
DOE	Department of Energy
EIA	Energy Information Administration
EOR	Enhanced oil recovery
ESPA	Energy Sector Planning and Analysis
GTL	Gas-to-liquids
HECA	Hydrogen Energy California
IGCC	Integrated gasification combined cycle
MBbld	Million barrels per day
Mcf	Thousand cubic feet
MMcfd	Million cubic feet per day
MMmt	Million metric tons
NETL	National Energy Technology
NRG	NRG Energy
OGJ	Oil & Gas Journal
PCS	PCS Nitrogen, Inc.
SACROC	Scurry Area Canyon Reef Operators Committee
TCEP	Texas Clean Energy Project
UCG	Underground coal gasification
U.S.	United States

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Executive Summary

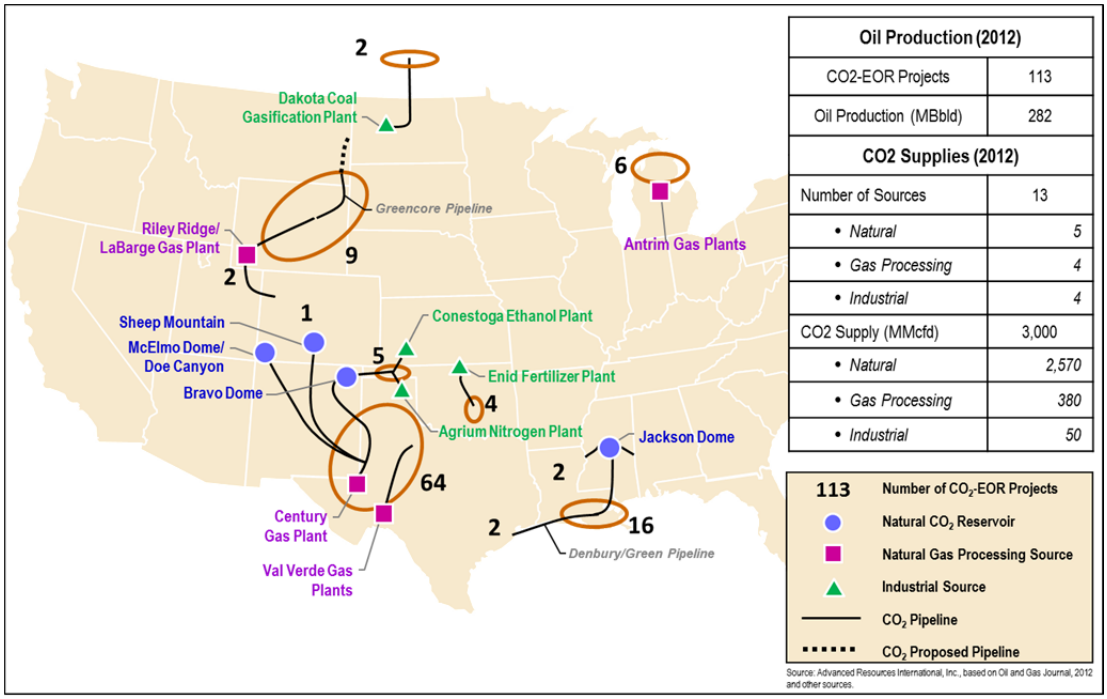
Utilization of natural and industrial CO_2 by the enhanced oil recovery industry has grown steadily since the early 1970s. In fact, the landmark CO_2 flood at the Scurry Area Canyon Reef Operators Committee (SACROC) unit was launched in 1972 utilizing CO_2 captured from a series of natural gas processing plants in the Val Verde Basin of West Texas. Prior to its capture and utilization, this by-product CO_2 had been released into the atmosphere.

The discovery of large natural sources of CO_2 in Colorado (McElmo Dome, Doe Canyon, and Sheep Mountain) plus New Mexico (Bravo Dome) and its transportation to the Permian Basin enabled oil production from CO_2-EOR to steadily grow in West Texas. Subsequent discovery of natural CO_2 supplies at Jackson Dome, Mississippi, and the capture of vented CO_2 at the massive LaBarge natural gas processing facility in western Wyoming provided the foundation for new CO_2-EOR projects along the Gulf Coast and in the Rockies.

Today, a total of 113 CO_2-EOR projects inject 3.1 billion cubic feet per day (Bcfd) (60 million metric tons (MMmt) per year) of natural and industrial CO_2 for enhanced oil recovery, in numerous areas of the United States (U.S.) (Exhibit ES-1). The associated crude oil production in 2012 was 282,000 barrels per day. Growth of oil production from CO_2-EOR has been constrained in the past few years due to limitations in accessible, affordable supplies of CO_2.

In our view, the combination of: 1) significant new volumes of CO_2 captured from industrial sources; 2) the recent completion of new CO_2 pipelines; and 3) the availability of additional natural sources of CO_2 will enable CO_2-EOR based oil production to grow significantly during the rest of this decade.

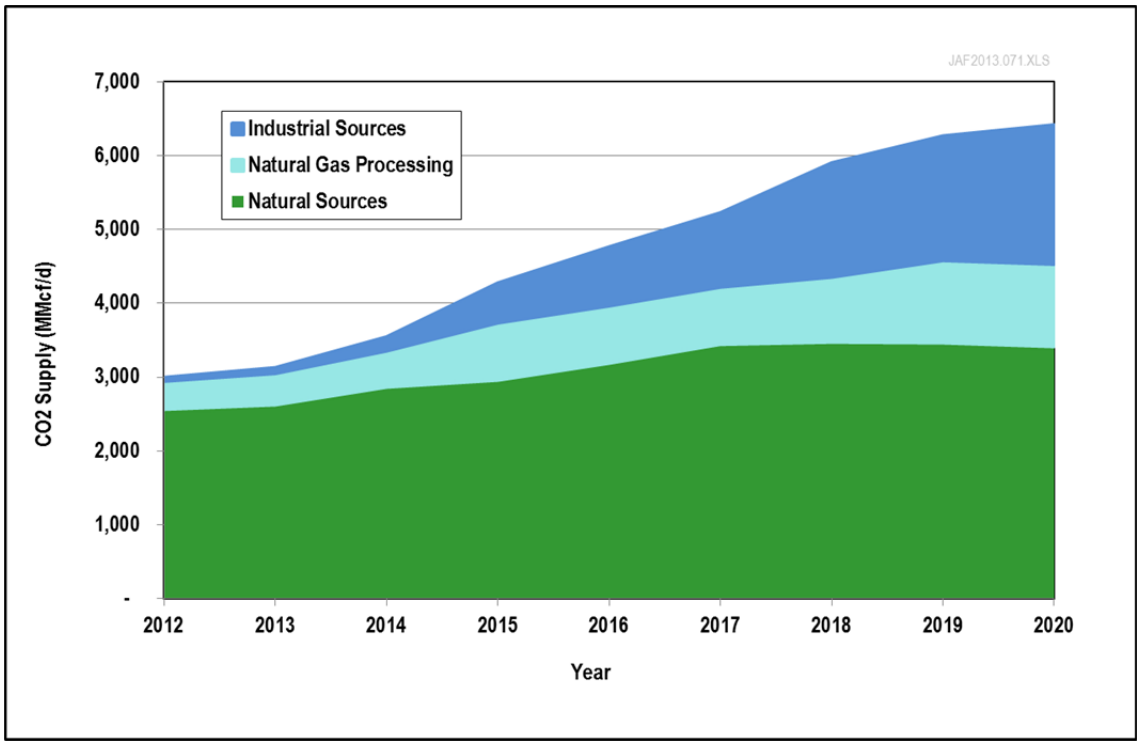
Exhibit ES-1 Current CO_2-EOR operations and CO_2 sources (2012)



- ***Captured CO_2 supply from gas processing and other industrial sources grows from 16% of total supply in 2012 to 47% in 2020.*** Current (year 2012) utilization of gas processing and other industrial CO_2 by EOR is 0.4 Bcfd (8 MMmt per year). This volume is expected to reach 3.0 Bcfd (58 MMmt) by 2020 (Exhibit ES-2). Much of the increased capture and utilization of CO_2 between today and year 2020 will be from industrial plants along the Gulf Coast.

  Overall CO_2 utilization by CO_2-EOR (including natural gas processing and other industrial CO_2 sources) is projected to more than double by year 2020, from 3.0 Bcfd (58 MMmt) today to 6.4 Bcfd (124 MMmt) (Exhibit ES-2). The forecast for CO_2 supply does not include an estimate of future announcements that are not yet in the public domain. Also, the CO_2 supply estimates for announced industrial sources are reduced from the stated capacity to account for the risk of schedule slip or cancellation.

Exhibit ES-2 Utilization and storage of natural and anthropogenic CO_2 with EOR

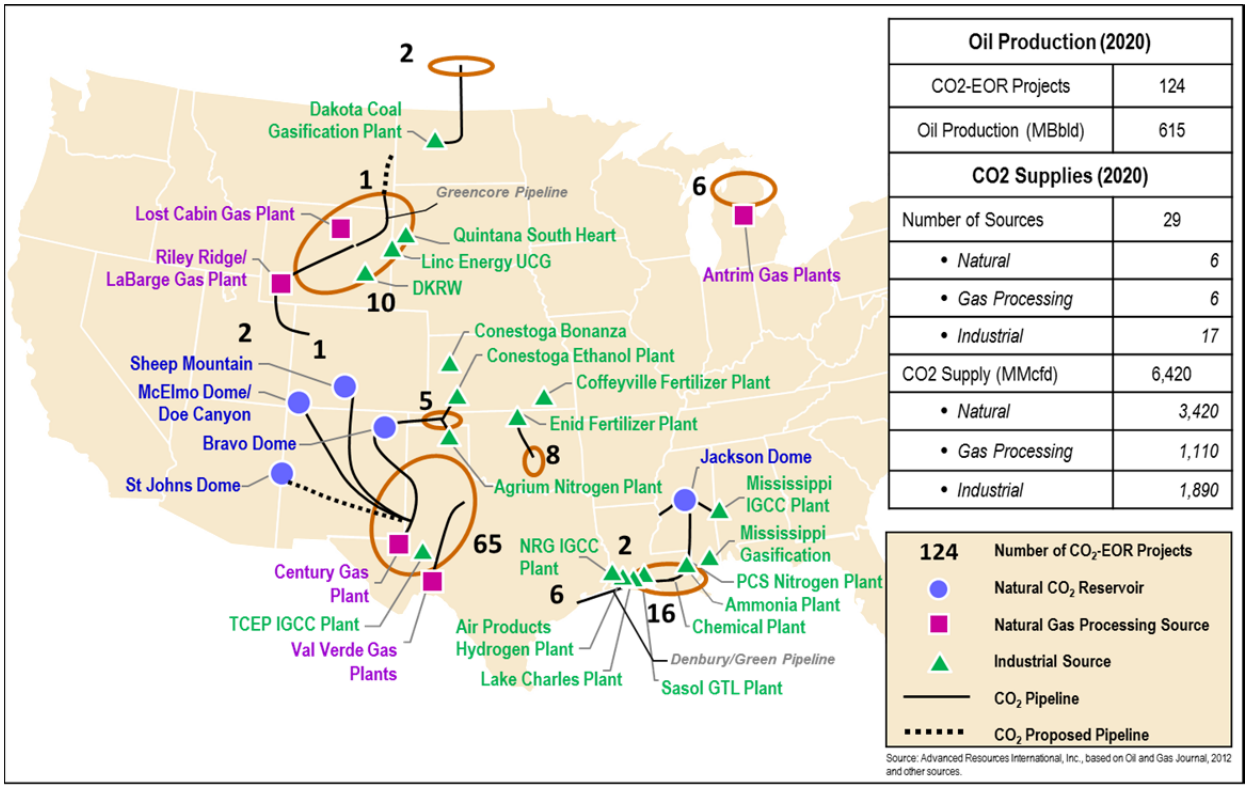


- ***Major new CO_2 pipelines are in place, capable of delivering expanded volumes of CO_2 for utilization by EOR.*** In the past several years, industry has installed and placed into operation several new CO_2 pipelines. These include the Green CO_2 Pipeline along the Gulf Coast, the Greencore CO_2 Pipeline in the Rockies, the Coffeyville to Burbank CO_2 Pipeline in the Mid-Continent, and the Eastern Shelf CO_2 Pipeline in West Texas. Recently, Kinder Morgan announced a new, 213-mile, 16-inch diameter pipeline to transport carbon dioxide (CO_2) from the company's St. Johns source field in Apache County, Arizona, to the Kinder Morgan-operated Cortez Pipeline in Torrance County, New Mexico (1). Moderate distance laterals from these large-scale pipelines will enable more oil fields favorable for CO_2-EOR to be linked with supplies of CO_2 in future years.

- ***With access to additional volumes of CO_2, industry has announced the start of numerous new CO_2 enhanced oil recovery projects.*** Industry has announced the start of a series of new, large-scale CO_2-EOR projects in mature domestic oil fields. Along with expansion of existing CO_2 floods, new CO_2-EOR projects expected online by 2020 include: Conroe, Thompson, Webster and West Ranch along the Gulf Coast; Bell Creek, Grieve, and Poplar Dome in the Rockies; and Burbank and Northeast Hardesty in the Mid-Continent. Numerous other CO_2 floods are scheduled to start after 2020, including Hartzog Draw in the Rockies and the numerous oil fields on the Cedar Creek Anticline in North Dakota.

Based on the increased volumes of CO_2 supplies, the completion of major CO_2 pipelines, and the announced new, large-scale CO_2-EOR floods, we anticipate that CO_2-EOR production will grow significantly, reaching 615,000 barrels per day from at least 124 active CO_2 floods by year 2020 (Exhibit ES-3). While the Permian Basin remains the largest CO_2-EOR oil producer, much of the growth occurs in the Gulf Coast, the Rockies, and the Mid-Continent. The CO_2-EOR industry is on pace to store a billion metric tons of CO_2 from gas processing and industrial sources during the next 20 years.

Exhibit ES-3 Projected CO_2-EOR operations and CO_2 sources (2020)



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1 Purpose of the Report

The Oil & Gas Journal's (OGJ) biannual enhanced oil recovery (EOR) survey is the "gold standard" for information on enhanced oil recovery operations in the United States (U.S.) (1) The information in the survey is collected at an EOR project level, providing very detailed, highly valuable data on the nature, location, reservoir settings and oil production from EOR for each of the major EOR technologies—CO_2-EOR, chemical EOR, and thermal EOR. The survey contains data for years 1986 through 2014.

The OGJ survey, while providing a most valuable snapshot of the status of EOR does not provide a "look forward." This report, "Near-Term Projections of CO_2 Utilization by Enhanced Oil Recovery," builds on the Oil & Gas Journal's biannual EOR survey to provide such a "look forward" of the future potential for one of these EOR technologies—CO_2 enhanced oil recovery. The report tabulates industry and other information on the various existing and future sources of CO_2 supplies to be utilized for EOR as well as the industry announced CO_2-EOR projects in mature domestic oil fields.

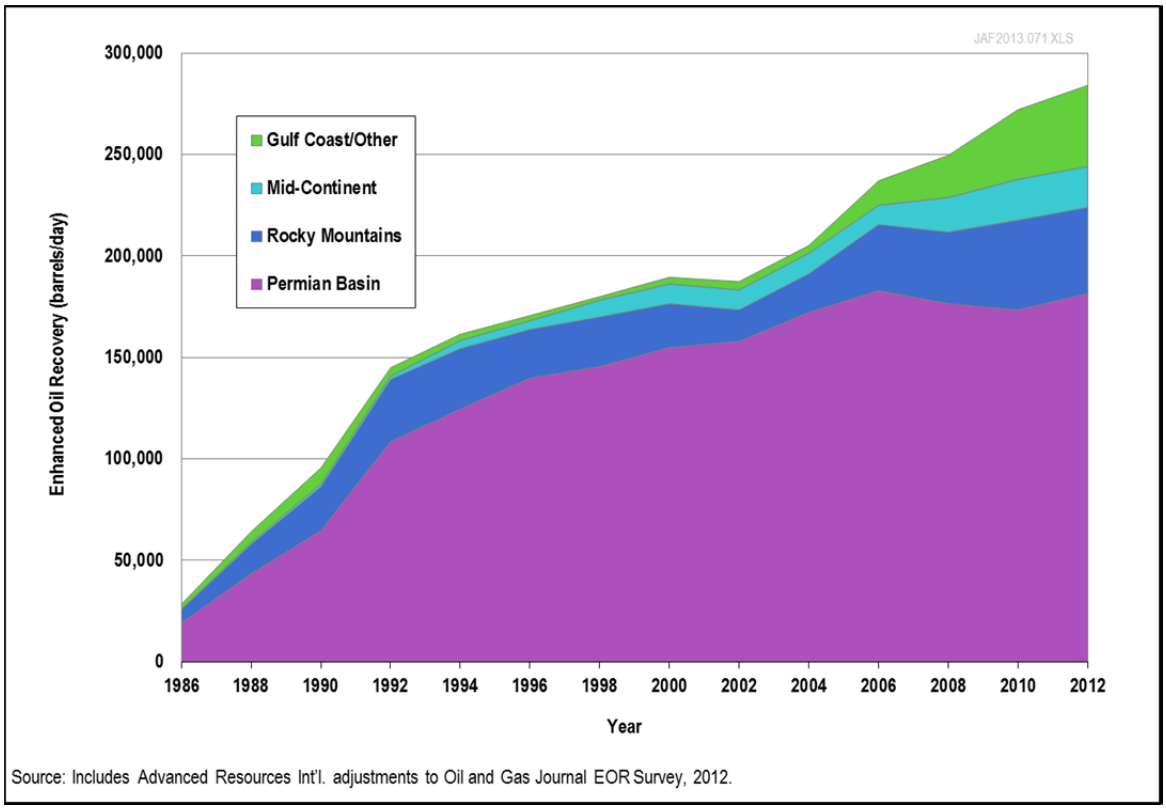
The great bulk of the information in this report is based on a project-by-project matching of defined CO_2 supplies, CO_2 utilization, and CO_2-EOR based oil production. In cases where the announced volumes of available CO_2 supplies exceed the demand for CO_2 by announced CO_2-EOR projects, we provide estimates for additional near-term oil production that could become available from expansion of existing CO_2 floods or the initiation of yet to be announced CO_2 floods.

Two publications, "A Note on Sources of CO_2 Supply for Enhanced-Oil-Recovery Operations" (2) and "Wyoming CO_2 Status and Developments," (3) contributed significantly to the research for this study.

2 Status of CO_2 Enhanced Oil Recovery

Oil production from CO_2-EOR in onshore, lower-48 oil reservoirs will provide 282,000 barrels per day of incremental oil production in 2012. The volume of oil production from CO_2-EOR has grown steadily for the past thirty years (Exhibit 2-1).

Exhibit 2-1 Annual CO_2-EOR production

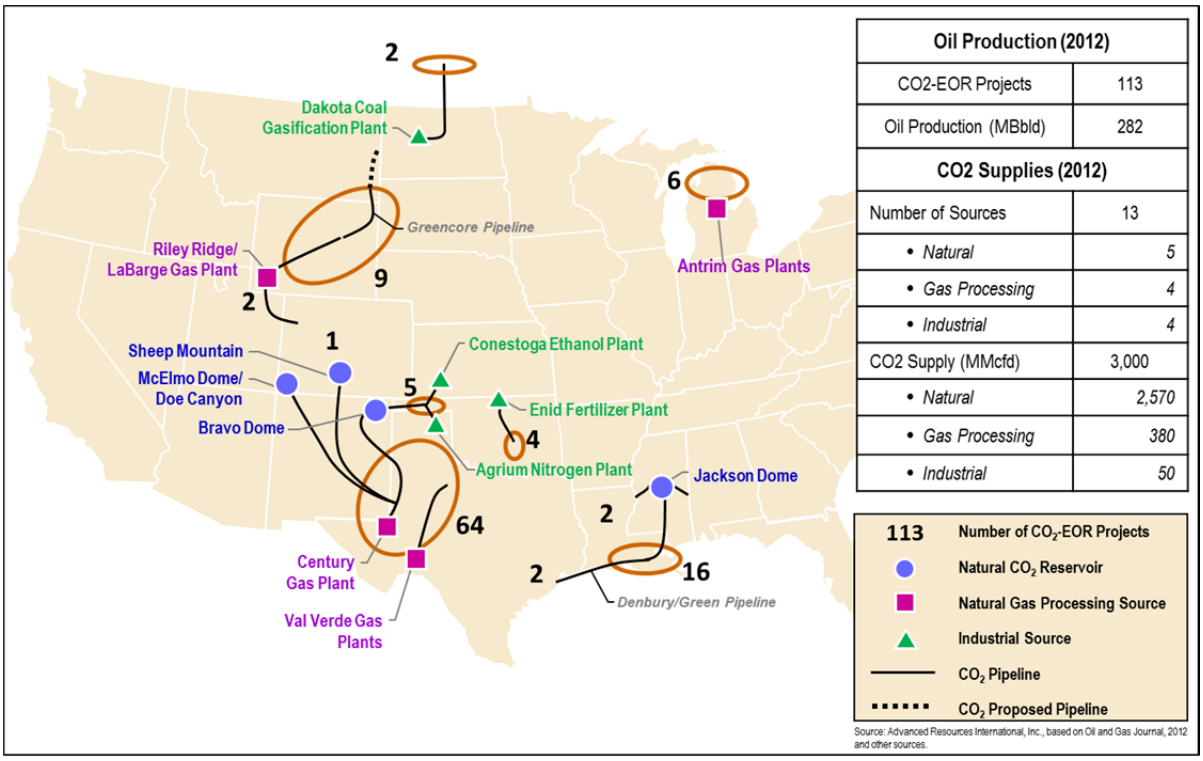


Our study of the status of CO_2-EOR started with information provided in the latest OGJ biennial survey of enhanced oil recovery, published in April, 2012. Our study then independently reviewed the CO_2-EOR oil production on a field-by-field basis for years 2012 and 2013 to develop independent tabulations of CO_2-EOR oil production for 113 active CO_2-EOR projects. Our review, while showing modestly different values for certain oil fields, resulted in aggregate CO_2-EOR oil production values consistent with those reported in the OGJ survey.

Exhibit 2-2 provides a composite overview of the current status of CO_2 supplies and CO_2-EOR activity in the U.S., as of year 2012:

- State-by-state locations for the currently active 113 CO_2-EOR projects. Much of the CO_2-EOR activity is in West Texas (64 projects), followed by Mississippi (16 projects) and Wyoming (9 projects).
- Location of the existing CO_2 supplies sources (natural, gas processing, and industrial). Much of the CO_2 is from naturally occurring CO_2 fields in Colorado, New Mexico, and Mississippi.
- Robust infrastructure of existing and projected CO_2 pipelines, totaling more than 3,000 miles, linking CO_2 supply sources with oil fields.

Exhibit 2-2 Current CO_2-EOR operations and CO_2 sources (2012)



3 Outlook for CO_2 Enhanced Oil Recovery

The Energy Information Administration's (EIA) early release of Annual Energy Outlook (AEO) 2014 projects that oil production from CO_2-EOR remains flat at 280,000 barrels per day through 2014, rising slowly to 360,000 barrels per day by year 2020. After year 2020, CO_2-EOR based oil production is projected to climb to 580,000 barrels per day by 2030 and further to 740,000 barrels per day by year 2040.(4)

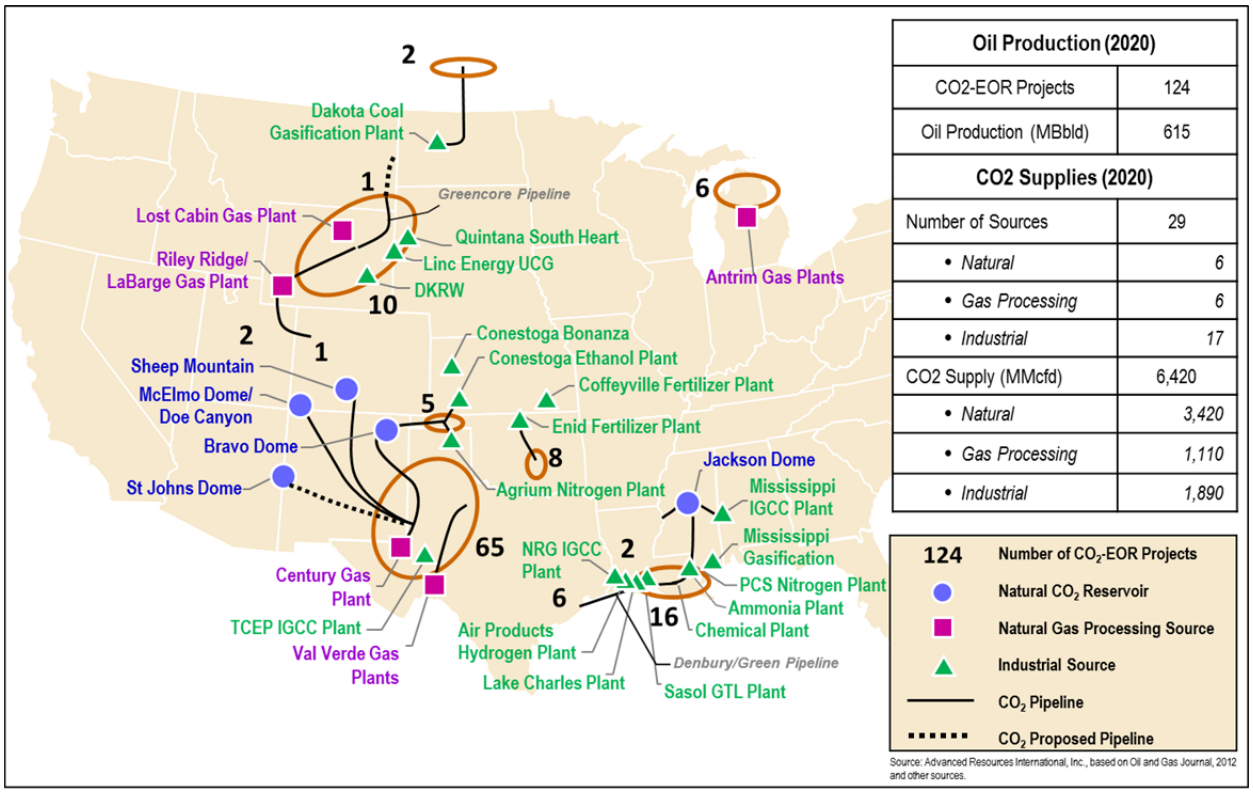
Given the significant additional volumes of available CO_2 supplies and the numerous new announced CO_2-EOR projects, our study indicates the potential for significantly higher volumes of oil production and CO_2 utilization from CO_2-EOR, as summarized below and further discussed in Section 5.

Our analysis shows that incremental oil production from CO_2-EOR operations is expected to increase significantly from 282,000 barrels per day in 2012 to 615,000 barrels per day in 2020, as shown in Exhibit 3-1 and illustrated in Exhibit 3-2.

Exhibit 3-1 Near-term projection of CO_2-EOR oil production by region

Region	CO_2-EOR Oil Production (MBbld)		
	2012	2015	2020
Permian Basin	186	241	301
Gulf Coast	43	73	153
Rockies	36	55	103
Mid-Continent	17	37	58
Total Production	282	405	615

Exhibit 3-2 Projected CO_2-EOR operations and CO_2 sources (2020)



4 Study Methodology

4.1 CO_2 Supplies for EOR

The first step of our study was to review the current status and outlook for both natural as well as industrial sources of CO_2. Currently, the majority of CO_2 supplied for EOR is from natural sources, notably from the McElmo Dome and Bravo Dome natural CO_2 fields, that supply the Permian Basin and portions of the Mid-Continent and Rockies, and from Jackson Dome, that supplies CO_2 for EOR operations along the Gulf Coast.

Natural sources of CO_2 for EOR are expected to increase between now and 2020:

- Total CO_2 supply from McElmo Dome, Bravo Dome, Doe Canyon, Sheep Mountain and Jackson Dome is expected to increase from 2.6 billion cubic feet per day (Bcfd) in 2012 to 3.0 Bcfd in 2020.
- A new natural source of CO_2, St. Johns Dome in New Mexico, is expected to come online by 2016. It will supply 0.5 Bcfd of CO_2 for EOR in the Permian Basin in 2020.

However, future development of CO_2-EOR will need to rely heavily on CO_2 captured from industrial sources. Importantly, sale and utilization of CO_2 provides a benefit to industrial gas processing and power generation that would otherwise likely vent their CO_2 emissions to the atmosphere.

- Significant expansions in CO_2 captured from gas processing plants, such as at Lost Cabin, La Barge, and Riley Ridge in the Rockies (345 MMcfd) and the Century Phase II plant (170 MMcfd) in West Texas.
- Increased capture of CO_2 from nitrogen, hydrogen, fertilizer, and other industrial plants in the Mid-Continent and the Gulf Coast.
- Projected industrial CO_2 sources from Sasol's gas-to-liquids (GTL) plant in Louisiana, Leucadia's coal gasification plant in Mississippi, and DKRW Advanced Fuels, LLC's (DKRW) Phase I coal-to-liquids (CTL) plant in the Rockies.

Based on the above sources plus other future sources of captured CO_2, we estimate that utilization of CO_2 for EOR from natural gas processing and other industrial sources will reach 3.0 Bcfd (58 million metric tons (MMmt)/yr) by 2020.

Probability-Adjusted CO_2 Supplies. The near-term forecast conservatively estimates the volumes of CO_2 sourced from natural gas processing and other industrial facilities scheduled to come online between 2012 and 2020. Each new potential source of CO_2 was assigned a project status and a probability of delivery of CO_2 to the market by the year 2020.

- Planning/Feasibility (75%) – Permitted projects in the final stages of financing and CO_2 off-take negotiations, including projects identified in published business plans.
- Design/Pre-feasibility (50%) – Projects currently undergoing design and feasibility studies that have not received full project permitting.
- Identify (25%) – Conceptual projects identified as possible sources of CO_2 should design, permitting, and feasibility studies prove to be favorable.

Exhibit 4-1 outlines the CO_2 sources included in our study that are currently in the Planning/Feasibility, Design/Pre-feasibility, and Identify stages.

Exhibit 4-1 Probability-adjusted industrial CO_2 supplies due online by 2020

Project Status	Probability of Coming Online by 2020	Region	Project
Planning/Feasibility	75%	Permian Basin	Summit TCEP
		Rockies	DKRW Phase I
		Mid-Continent	Burbank Expansion
		Gulf Coast	Mississippi Gasification
			Sasol GTL
Design/ Pre-Feasibility	50%	Rockies	Linc Energy UCG
			Quintana South Heart IGCC
Identify	25%	Gulf Coast	Indiana Gasification
			Kentucky NewGas

4.1.1 Regional CO_2 Supplies

Permian Basin. The current sources of CO_2 supply for the Permian Basin include McElmo Dome, Doe Canyon, and Sheep Mountain in Colorado, Bravo Dome in New Mexico, and the Century and Val Verde gas plants in Texas. Together, these sources provided 1.7 Bcfd in 2012 for EOR to fields in the Permian Basin.

Expansion of natural CO_2 supply from McElmo Dome and Doe Canyon is expected in 2014 and 2015, respectively. A new source of natural CO_2 from St. Johns Dome in New Mexico is expected partially online by 2016 and fully online by 2017. CO_2 from expansion of the Century gas processing plant and from the Texas Clean Energy Project (TCEP) become available for the Permian Basin in 2015 to 2016. Overall CO_2 supply for EOR is expected to increase to 2.7 Bcfd by 2017 and stay at the level through 2020.

Gulf Coast. The current (year 2012) CO_2 supply for EOR of 0.9 Bcfd for the Gulf Coast is natural CO_2 from Jackson Dome in Mississippi. Two new industrial sources of CO_2—the Air Products hydrogen, and the PCS nitrogen plants in Louisiana—came online in 2013 and will reach their full supply potential of 50 and 25 MMcfd, respectively, by 2014.

Aside from a modest increase in supply from Jackson Dome, the bulk of the incremental CO_2 supply for EOR in the Gulf Coast is expected to be from industrial sources. A number of chemical plants in Louisiana are scheduled to capture and supply CO_2 to the region, including the Lake Charles gasification plant, the Mississippi gasification plant, and a planned Sasol GTL plant in Louisiana plus new ammonia and chemical plants yet to be publically named. Two new

power plants, Mississippi Power's and NRG Energy's (NRG) power plants will capture and supply CO_2 for EOR in 2015 and 2017, respectively. Total CO_2 supply for EOR is expected to increase to 2.6 Bcfd by 2020.

Rockies. The majority of CO_2 currently supplied to the Rockies comes from the Shute Creek/LaBarge gas plant. A small volume of natural CO_2 supply from McElmo Dome is supplied to the CO_2 floods at the Greater Aneth oil field. Total supply of CO_2 for EOR in the Rockies was 245 MMcfd in 2012.

In addition to expansion of CO_2 capture at Shute Creek/LaBarge and Lost Cabin gas processing plants, four additional sources of CO_2 are scheduled to come online including: the Riley Ridge gas processing plant; the DKRW Medicine Bow fuel plant; the Linc Energy gasification plant; and the Quintana South Heart integrated gasification combined cycle (IGCC) plant. These expansions and new sources of CO_2 are projected to increase CO_2 supply for Rockies EOR to 750 MMcfd by 2020.

Mid-Continent. The great bulk of the CO_2 supply in the Mid-Continent comes from industrial sources of CO_2, including the Koch nitrogen plant, the Agrium fertilizer plant, the CVR Energy, Inc.'s (CVR) Coffeyville nitrogen plant, and the Conestoga Arkalon and Bonanza nitrogen plants. Additional supplies of natural CO_2, 35 MMcfd, are supplied to the Postle field in Oklahoma from Bravo Dome. Total CO_2 supply for Mid-Continent EOR was 85 MMcfd in 2012.

Several new sources of CO_2 are expected for the Mid-Continent. The Lilly Lateral pipeline will extend Bravo Dome CO_2 supply to the Northeast Hardesty EOR project. Increased supplies of CO_2 from the CVR Coffeyville and Koch Nitrogen plants would support expansion of CO_2-EOR at Burbank and surrounding oil fields. Total CO_2 supply for EOR in the Mid-Continent is expected to increase nearly 300 MMcfd by 2020.

4.2 CO_2 Utilization by EOR

The utilization rate of purchased CO_2 volumes per barrel of incremental oil varies both by region and by operator. Regional CO_2 utilization ratios were used to model purchased CO_2 volumes when published CO_2 volumes were unavailable.

CO_2 utilization ratios were determined from State Oil and Gas Commission data, from data provided by individual CO_2 flood operators, and by CO_2-EOR modeling data (PROPHET2 CO_2-EOR flood simulations). Different ratios were used based on the development phase of each CO_2-EOR operation. Utilization ratios for "Initial," "Developing," and "Mature" project phases are listed by region in Exhibit 4-2.

Exhibit 4-2 CO_2 utilization ratios by phase

CO_2 Utilization (Mcf/Bbl)	Initial	Developing	Mature
Permian Basin	-	12.0	9.1
Gulf Coast	25.0	20.0	15.0
Rockies	19.0	9.0	5.0
Mid-Continent	12.5	7.0	6.0

4.3 CO_2-EOR Oil Production

4.3.1 Baseline CO_2-EOR Oil Production

Baseline CO_2-EOR oil production data for all CO_2-EOR projects were obtained from the most current sources of information available:

- ***Operator Data.*** Companies like Denbury, Devon and Chaparral provide detailed information on their current CO_2-EOR based oil production.
- ***State Data.*** State oil and gas commission data, particularly in the Permian Basin and Rockies, was collected for oil fields for which enhanced oil production data was not available from operators.
- ***Oil & Gas Journal Data.*** When CO_2-EOR oil production data was not available from operators or from state data, the study used the information in OGJ EOR Survey, which provides detailed data on enhanced oil production by oil field and by oil reservoir.
- ***Net-To-Gross Adjustment.*** For the most part, the oil production data supplied by operators is net oil production (gross production less royalties and outside working interests). Gross enhanced oil production totals were determined by using state data on total oil field/reservoir production. For CO_2-EOR projects without available net-to-gross production information, an 80% net-to-gross ratio was used.

4.3.2 Near-Term CO_2-EOR Oil Production

The estimates of future CO_2-EOR oil production, to year 2020, were based on a variety of sources:

- ***Existing CO_2 Floods.*** The starting point for estimating future oil production was the set of 113 currently operating CO_2-EOR projects. The study projected future CO_2-EOR oil production for each of these 113 existing CO_2 floods taking into account the following information:
  - Operator projections for future oil production were available for most of the CO_2-EOR projects in the Gulf Coast, Mid-Continent and the Rockies.
  - For the Permian Basin, the study used a combination of operator projections and project by project historical trend data to estimate future oil production from CO_2-EOR for each existing CO_2 flood.
- ***Planned CO_2-EOR Floods.*** CO_2-EOR operators often provide data on new CO_2-EOR start date, peak production year, and expected ultimate recovery on a project by project basis. This information was used to establish CO_2-EOR based oil production for the eleven new CO_2-EOR projects included in the study.
- ***Potential CO_2-EOR Floods.*** In cases where the available CO_2 supply exceeded the CO_2 demand for existing and planned CO_2-EOR floods, the study estimated the volume of future oil production from CO_2-EOR using regional CO_2 utilization factors (thousand cubic feet (Mcf) of CO_2 per barrel of oil production).

4.4 Regional CO_2-EOR Production

Permian Basin. Gross oil production data for CO_2-EOR operations in the Permian Basin were obtained from the Texas Railroad Commission database, which tracks oil and gas production data. Enhanced oil production due to CO_2-EOR was obtained from company data or from the Oil & Gas Journal EOR Survey to develop an enhanced to gross production ratio. Enhanced oil production was then projected based on recent historical production trends for both total and enhanced oil production.

Gulf Coast. Production estimates for each of the 20 current and 3 planned Denbury CO_2-EOR projects were developed based on project start date, peak oil year, peak oil rate, and total expected recovery provided by operators. CO_2 utilization ratios, consistent with Gulf Coast CO_2, floods were applied to the estimates of oil production to calculate purchased CO_2 utilization. Projection for one non-Denbury flood in the Gulf Coast was generated using internal Advanced Resources International, Inc. (ARI) data sources.

Rockies. CO_2-EOR oil production in the Rockies was based on both operator and state production data. Oil production from mature CO_2 floods was assumed to continue their historical decline. Oil production from newer CO_2 floods was estimated based on expected peak production followed by gradual decline. CO_2 utilization rates were based on current known CO_2 injection rates projected into the future.

Mid-Continent. Estimates of CO_2-EOR oil production for the Mid-Continent were based on operator information, supplemented by information in the Oil & Gas Journal 2012 EOR Survey. Anticipated CO_2 utilization was available for the nine Chaparral Energy CO_2 floods. CO_2 utilization for the remaining four mid-continent CO_2 floods was estimated using regional CO_2 utilization ratios.

5 Results and Discussion

Our recent analysis, as set forth in more detail below, indicates that the combination of: 1) significant new volumes of CO_2 captured from industrial sources; 2) the recent completion of new CO_2 pipelines; and 3) the availability of additional natural sources of CO_2 will enable CO_2-EOR production to grow steadily between now and year 2020.

The main findings of our study, discussed in-depth in this section of the report, are as follows:

1. We anticipate nearly seven-fold growth in capture and utilization of CO_2 from gas processing and other industrial sources, chemical facilities and power plants. Current (year 2012) utilization of industrial CO_2 by EOR is 0.4 Bcfd (8 MMmt per year). This volume is expected to reach 3.0 Bcfd (58 MMmt) by 2020 (Exhibit 5-1). Much of the increased capture and utilization of industrial CO_2 between today and year 2020 will be from the numerous announced industrial and other plants along the Gulf Coast.

Overall CO_2 utilization by CO_2-EOR (including natural CO_2, natural gas processing and other industrial sources) is projected to more than double by year 2020, from 3.1 Bcfd (60 MMmt) today to 6.4 Bcfd (124 MMmt) (Exhibit 5-2 and Exhibit 5-3).

Exhibit 5-1 Utilization of natural and industrial CO_2 with EOR

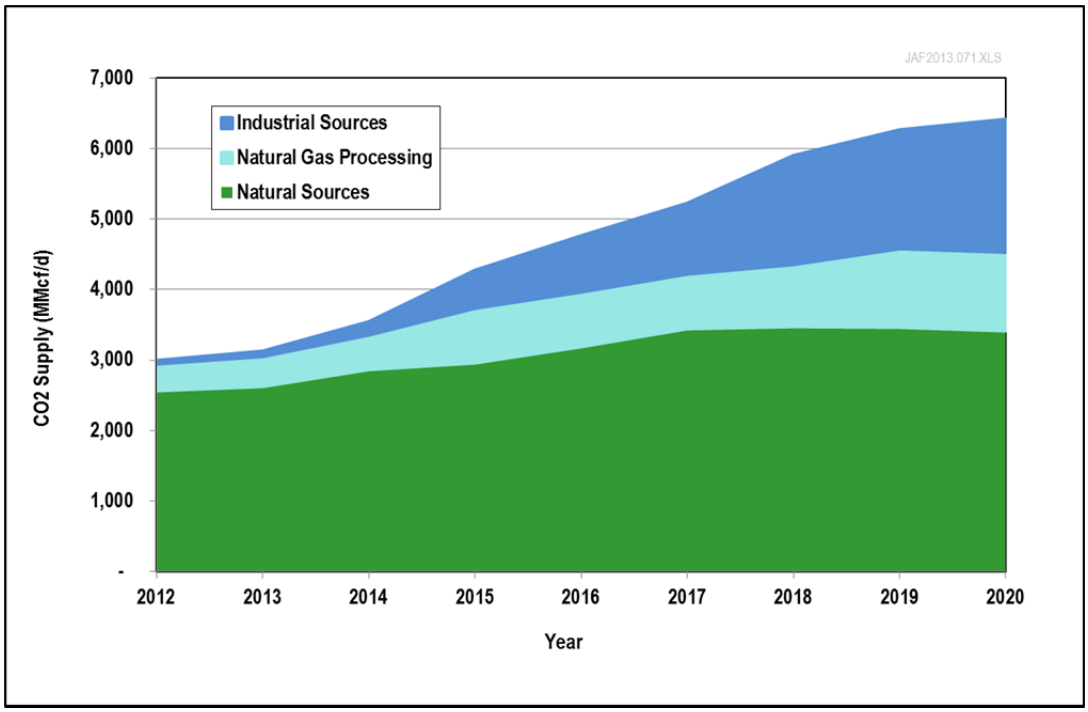


Exhibit 5-2 Utilization of natural and industrial CO_2 for EOR by region

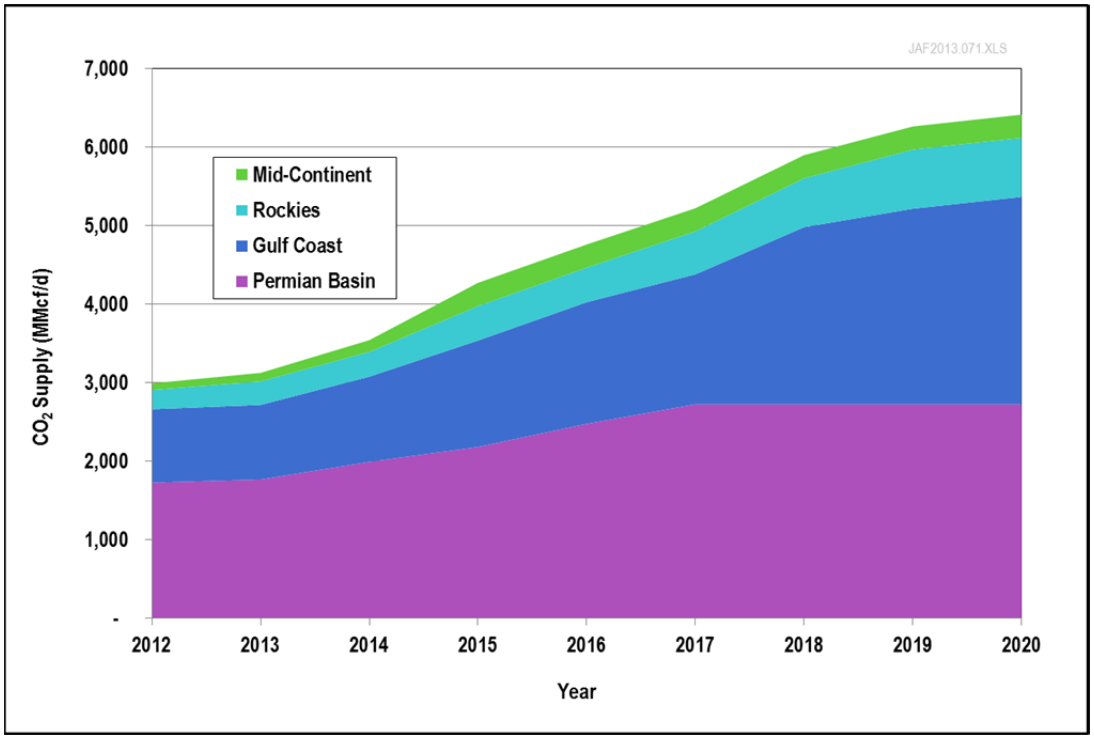


Exhibit 5-3 Projected near-term CO_2 utilization by region and source

Region	Supply Source	Daily CO_2 Supply (MMcfd)								
		2012	2013	2014	2015	2016	2017	2018	2019	2020
Permian Basin	Natural	1,565	1,605	1,820	1,850	2,050	2,300	2,300	2,300	2,300
	Natural Gas Processing	165	165	175	335	335	335	335	335	335
	Industrial Sources	-	-	-	-	94	94	94	94	94
	Total	1,730	1,770	1,995	2,185	2,479	2,729	2,729	2,729	2,729
Gulf Coast	Natural	935	935	960	990	1,020	1,025	1,055	1,045	995
	Natural Gas Processing	-	10	50	50	50	50	155	260	260
	Industrial Sources		5	75	315	480	580	1,046	1,186	1,386
	Total	935	950	1,085	1,355	1,550	1,655	2,256	2,491	2,641
Rockies	Natural	30	50	50	50	50	50	50	50	50
	Natural Gas Processing	215	250	265	390	390	390	390	520	520
	Industrial Sources	-	-	-	-	-	108	183	183	183
	Total	245	300	315	440	440	548	623	753	753
Mid-Continent	Natural	35	35	35	70	70	70	70	70	70
	Natural Gas Processing	-	-	-	-	-	-	-	-	-
	Industrial Sources	50	73	115	225	225	225	225	225	225
	Total	85	108	150	295	295	295	295	295	295
Total Supply	**Natural**	**2,565**	**2,625**	**2,865**	**2,960**	**3,190**	**3,445**	**3,475**	**3,465**	**3,415**
	Natural Gas Processing	**380**	**425**	**490**	**775**	**775**	**775**	**880**	**1,115**	**1,115**
	Industrial Sources	**50**	**78**	**190**	**540**	**799**	**1,006**	**1,548**	**1,688**	**1,888**
	Total	**2,995**	**3,128**	**3,545**	**4,275**	**4,764**	**5,226**	**5,903**	**6,268**	**6,418**

2. We anticipate that CO_2-EOR production will grow significantly, reaching 405,000 barrels per day by 2015 and 615,000 barrels per day by year 2020. While CO_2-EOR oil production in all four regions examined by this study is expected to increase, the Permian Basin and the Gulf Coast are projected to lead the way, each with over 100,000 barrels per day of increased CO_2-EOR oil production (Exhibit 5-4 and Exhibit 5-5).

- ***Permian Basin.*** Continued production from current projects and expansion of smaller floods to field-wide CO_2 floods is expected to increase enhanced production from 186,000 barrels per day in 2012 to 301,000 barrels per day by 2020.
- ***Gulf Coast.*** Increasing production from 20 current Gulf Coast CO_2 floods combined with the start-up of new CO_2 floods in East Texas (Webster, Conroe, and Thompson) is

expected to increase production from 43,000 barrels per day in 2012 to 153,000 barrels per day by 2020.

- ***Rockies.*** The addition of the Bell Creek and Grieve CO_2 floods, along with expanded CO_2 supplies, is expected to increase enhanced production in the Rockies from 36,000 barrels per day in 2012 to 103,000 barrels per day in 2020.
- ***Mid-Continent.*** The addition of the Northeast Hardesty CO_2 flood and significant expansion of the Burbank project is expected to increase enhanced production in the Mid-Continent from 17,000 barrels per day in 2012 to 58,000 barrels per day by 2020.

Exhibit 5-4 Projected CO_2-EOR production by region

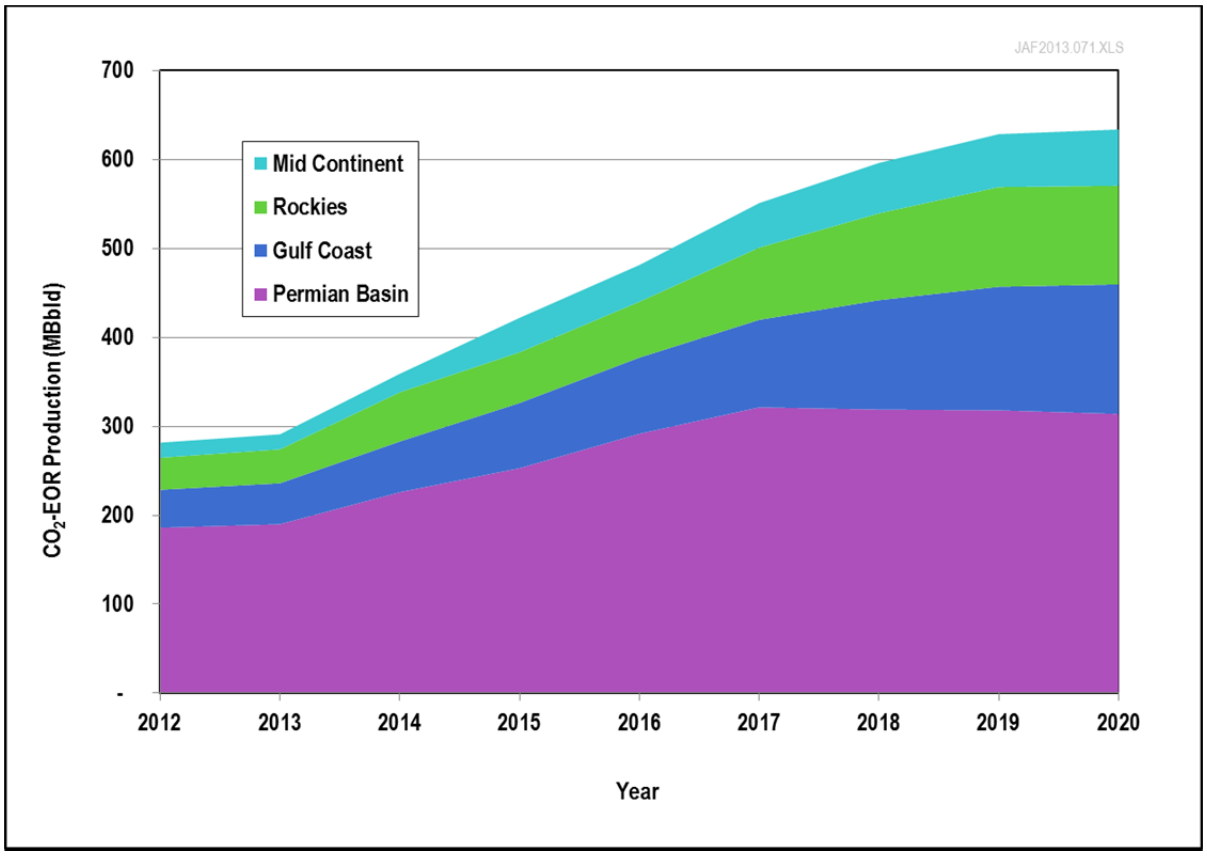


Exhibit 5-5 Projected near-term CO_2-EOR oil production

Region	Project Type	CO_2-EOR Oil Production (MBbld)		
		2012	2015	2020
Permian Basin	Current	186	204	199
	Expansion	-	37	102
	Total	186	241	301
Gulf Coast	Current	43	56	62
	Planned	-	2	48
	Potential	-	15	43
	Total	43	73	153
Rockies	Current	36	42	39
	Planned	-	2	10
	Potential	-	12	55
	Total	36	55	103
Mid-Continent	Current	17	20	25
	Planned	-	12	26
	Potential	-	4	6
	Total	17	37	58
Total Production	**Current**	**282**	**321**	**325**
	Planned	**-**	**15**	**84**
	Potential*	**-**	**68**	**206**
	Total	**282**	**405**	**615**

* Includes Permian Basin "Expansion" Projects

3. Major new CO_2 pipelines are in place, capable of delivering expanded volumes of CO_2 for utilization by EOR. In the past several years, industry has installed and placed into operation several new CO_2 pipelines. These include the Green CO_2 Pipeline along the Gulf Coast, the Greencore CO_2 Pipeline in the Rockies, the Coffeyville to Burbank CO_2 Pipeline in the Mid-Continent, and the Eastern Shelf CO_2 Pipeline in West Texas. Recently, Kinder Morgan announced a new, 213-mile, 16-inch diameter pipeline to transport carbon dioxide (CO_2) from the company's St. Johns source field in Apache County, Arizona, to the Kinder Morgan-operated Cortez Pipeline in Torrance County, New Mexico. (1) While current CO_2 pipeline infrastructure will need to expand to meet anticipated demand, we expect that moderate distance laterals and extensions of large-scale pipelines will enable more oil fields that are favorable for CO_2-EOR to be linked with supplies of CO_2. Exhibit 5-6 lists the major active CO_2 transport pipelines that supply most of the CO_2-EOR projects in the U.S.

Exhibit 5-6 Major U.S. CO_2 pipelines in 2012 (5)

Region	Pipeline	Operator	State	Est. Capacity (MMcfd)	Diameter (in)	Length (mi)
Permian Basin	Bravo	Oxy Permian	NM/TX	362	20	218
	Canyon Reef	Kinder Morgan	TX	223	16	139
	Center Line	Kinder Morgan	TX	223	16	113
	Central Basin	Kinder Morgan	TX	223	16	143
	Cortez	Kinder Morgan	TX	1,220	30	550
	Eastern Shelf	Kinder Morgan	TX	100	10	91
	Este	ExxonMobil	TX	135/176	12/14	84
	Sheep Mountain	Oxy Permian	TX	590	24	407
	W. TX Trinity	Trinity CO_2	TX/NM	83	12	60
	Wellman	PetroSource	TX	67	6	26
Gulf Coast	Choctaw	Denbury	MS/LA	362	20	183
	Delta	Denbury	MS/LA	590	24	108
	Free State	Denbury	MS	362	20	86
	Green	Denbury	LA	932	24	274
	Sonat	Denbury	MS	166	18	50
Rockies	Greencore	Denbury	MT/WY	725	20	232
	Powder River Basin	Anadarko	WY	223	16	125
	Shute Creek	ExxonMobil	WY	1,220	24	28
Mid-Continent	Coffeyville	Chaparral Energy	OK	67	6	23
	Transpetco	Transpetco	TX/OK	83	8	110

4. With access to additional volumes of CO_2, industry has announced the start of numerous new CO_2 enhanced oil recovery projects. Industry has announced the start a series of new, large-scale CO_2-EOR projects in mature domestic oil fields. Along with expansion of existing CO_2 floods, new CO_2-EOR projects expected online by 2020 include: Conroe, Thompson, Webster, and West Ranch along the Gulf Coast; Bell Creek, Grieve, and Poplar Dome in the Rockies; and Burbank and Northeast Hardesty in the Mid-Continent.

In addition to the new CO_2-EOR projects coming online by 2020, numerous other CO_2 floods are scheduled to start after 2020:

- Denbury has announced that the Hartzog Draw field will be operational after 2020 and will provide an ultimate incremental recovery of about 25 million barrels of oil.
- Denbury has also announced that several fields within the Cedar Creek Anticline in Montana and South Dakota will be operational after 2020, with an ultimate incremental recovery of about 275 million barrels of oil.

- Operators in the Permian Basin are currently identifying a number of oil fields amenable to EOR, which have yet to be announced.
- Should the Hydrogen Energy California (HECA) IGCC plant come online between 2018 and 2020, upwards of 150 million cubic feet per day of CO_2 would become available for EOR operations. The majority of this CO_2 would be utilized at a new EOR flood in the large Elk Hills oil field in Kern County, CA.

5. This near-term projection provides a conservative estimate of additional CO_2 supplies and CO_2-EOR based oil production. Looking ahead to 2020, we see a much more robust CO_2 enhanced oil recovery industry, with major new sources of industrial CO_2 being captured and utilized for EOR. No doubt some of the currently planned industrial sources of CO_2 will not materialize. However, these will be more than replaced by numerous new fertilizer, chemical, ethanol, and other industrial plants with high purity CO_2 emissions looking to sell their captured CO_2 to the CO_2-EOR industry for oil production and CO_2 storage. New discoveries of subsurface CO_2 reservoirs could also increase CO_2 supply. (7)

Exhibit 5-7 lists 14 new natural gas processing and industrial sources of CO_2 announced since 2010. Of these new projects, five are already supplying CO_2 to EOR operations (PCS Nitrogen, Inc., Conestoga Bonanza, Conestoga Arkalon, LaBarge expansion, and Val Verde expansion) and the remaining nine are due online between 2016 and 2020.

Exhibit 5-7 New natural gas processing and industrial CO_2 sources announced between 2010 and 2013

Region	Project Name	Company	State	Status	Year Online
Gulf Coast	PCS Nitrogen	PCS Nitrogen	LA	Online	2013
	Ammonia Plant	Denbury	LA	Expected	2016
	NRG Power Plant	NRG Energy	TX	Expected	2017
	Sasol GTL	Sasol	LA	Expected	2018
	Kentucky NewGas	ConocoPhillips/Peabody	KY	Expected	2018
	Chemical Plant	Denbury	LA	Expected	2020
Rockies	DKRW Phase 1	Medicine Bow	WY	Expected	2016
	Riley Ridge	Denbury	WY	Expected	2017
	Linc Energy UCG	Linc Energy	WY	Expected	2017
	Quintana South Heart	Great Northern Power	ND	Expected	2017
	LaBarge Expansion	Exxon	WY	Online	2012
Mid-Continent	Conestoga Arkalon	Conestoga	KS	Online	2011
	Conestoga Bonanza	Conestoga	KS	Online	2013
Permian Basin	Val Verde Gas Plant Expansion	Blue Source	TX	Online	2012

Exhibit 5-8 outlines the volumes of CO_2 from these 14 sources by region that are likely to become available by 2020. This 1,180 million cubic feet per day supports nearly 90,000 barrels

per day of new CO_2-EOR oil production based on the average CO_2 utilization ratio for each region.

Exhibit 5-8 CO_2 sources announced between 2010 and 2013 and associated oil production by region

Region	New CO_2 Supplies (MMcfd)	Projected New EOR (MBbld)
Gulf Coast	850	48,570
Rockies	310	38,750
Mid-Continent	10	1,540
Permian Basin	10	1,110
Total	**1,180**	**89,970**

Using history as the guideline, it is likely that additional yet-unknown natural gas processing and chemical plants will be installed in the U.S. over the next six years. This renders the baseline near-term projection of CO_2 supplies available for EOR as a relatively conservative estimate.

Using currently available and announced CO_2 supplies, the Baseline Case is for an estimated 615,000 barrels of oil per day from EOR by 2020 (Exhibit 5-9).

Exhibit 5-9 Baseline vs. upside projection of CO_2-EOR production by 2020

Study Case Comparison	Oil Production by 2020 (Bbld)
Baseline CO_2-EOR Case	615,000

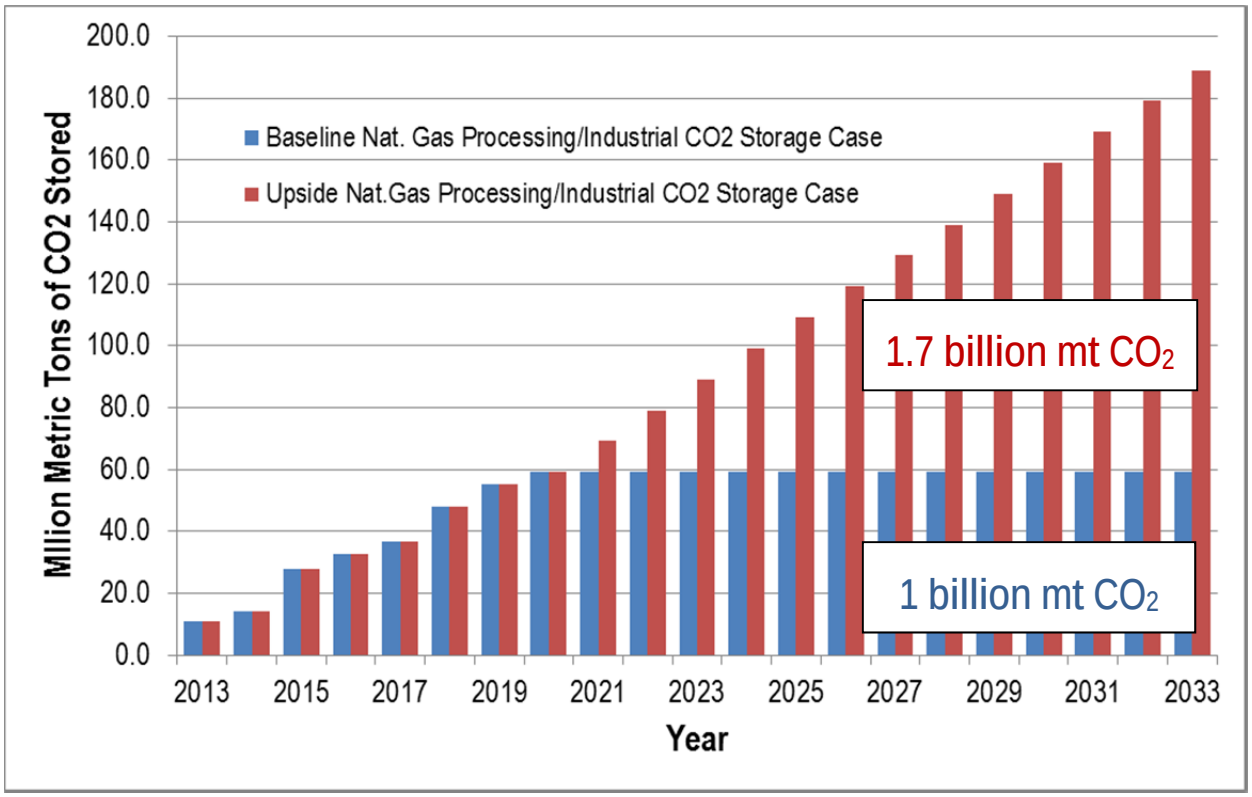
6. Along with the production of increased volumes of domestic oil, the CO_2-EOR industry is on pace to store a billion metric tons of CO_2 from gas processing and industrial sources during the next 20 years. These CO_2 storage volumes are only from the active, announced and projected CO_2-EOR projects in place by year 2020. Including CO_2-EOR projects scheduled or projected to start after year 2020, significantly higher volumes of CO_2 from natural gas processing and industrial sources would be utilized for and stored with CO_2-EOR during this 20-year time period.

We estimate that nearly 10 million metric tons of CO_2 from natural gas processing and industrial sources was stored in underground formations in 2013 using to CO_2-EOR. This total will increase to 25 million metric tons in 2015 and to 58 million metric tons in 2020.

The Baseline CO_2 Storage Case, assuming a constant storage rate of 58 million metric tons per year going forward, indicates that over 1 billion metric tons of CO_2 will be stored using CO_2-EOR in the next 20 years (Exhibit 5-10). If the CO_2 utilization rate were to continue on its current trend of increasing by 7 million metric tons per year, the Upside CO_2 Case storage would

be equal to 1.7 billion metric tons of CO_2 from natural gas processing, and other industrial sources stored with CO_2-EOR over the next 20 years.

Exhibit 5-10 Projection of 1 billion metric tons of CO_2 stored from current natural gas processing and industrial sources



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