

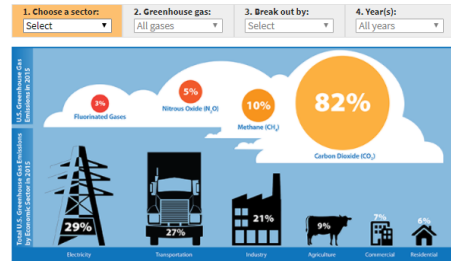


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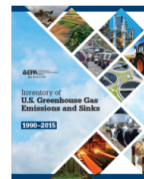
Greenhouse Gas Inventory Data Explorer

The Data Explorer is an interactive tool that provides access to data from EPA's annual inventory of U.S. Greenhouse Gas Emissions and Sinks. You can follow the instructions on the right and use the options below to create customized graphs, examine trends over time, and download the data. You can visit other EPA pages to learn more about [EPA's national inventory](#) and [how it relates to EPA's Greenhouse Gas Reporting Program](#).



- Index of Charts
- Data Explorer Home
- Inventory Report Home
- How to Use this Tool

Create a graph by choosing options from the four dropdown menus above. Within each graph, you can click the legend to turn layers on or off, and you can hover your mouse over the display to reveal data. See "How to Use this Tool" above to learn more.



For more information on sources, data, and methods, visit EPA's greenhouse gas inventory page.

[↑ Top of Page](#)



US EPA Greenhouse Gas Data on Petroleum and Natural Gas Systems

Presented by:

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US EPA – Office of Atmospheric Programs



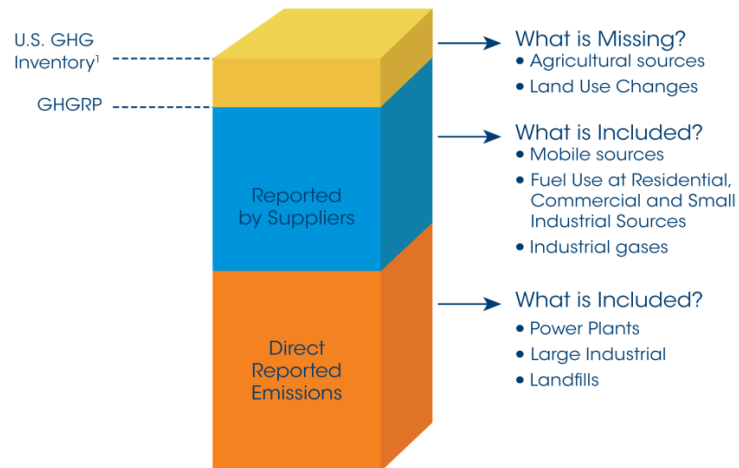
Agenda

- Background on Greenhouse Gas Inventory (GHG Inventory)
- Background on Greenhouse Gas Reporting Program (GHGRP)
- GHGRP Petroleum and Natural Gas Systems (Subpart W): Reporting Year 2017 Data Summary

GHG Reporting Program vs. US GHG Inventory

- Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHGI), the U.S. official GHG Inventory submission to UNFCCC, tracks total annual U.S. emissions across all sectors of the economy, using mostly national-level data
- GHGRP collects detailed emissions data from large greenhouse gas emitting facilities in the United States, as directed by the Clean Air Act
 - GHGRP covers most, but not all, U.S. GHG sources and sinks (i.e., GHGRP does not include agriculture, land use, and small sources)

GHGRP Covers the Majority of U.S. GHG Emissions



Task	Inventory of U.S. GHG Emission and Sinks	Greenhouse Gas Reporting Program
Find total U.S. emissions and sinks	✓	
Review trend data for the past 20+ years	✓	
Browse a map to find the largest emitters in your area		✓
Compare facility emissions across an industrial sector		✓
Find state-level data	Total ✓	Reported ✓



Background on Greenhouse Gas Inventory



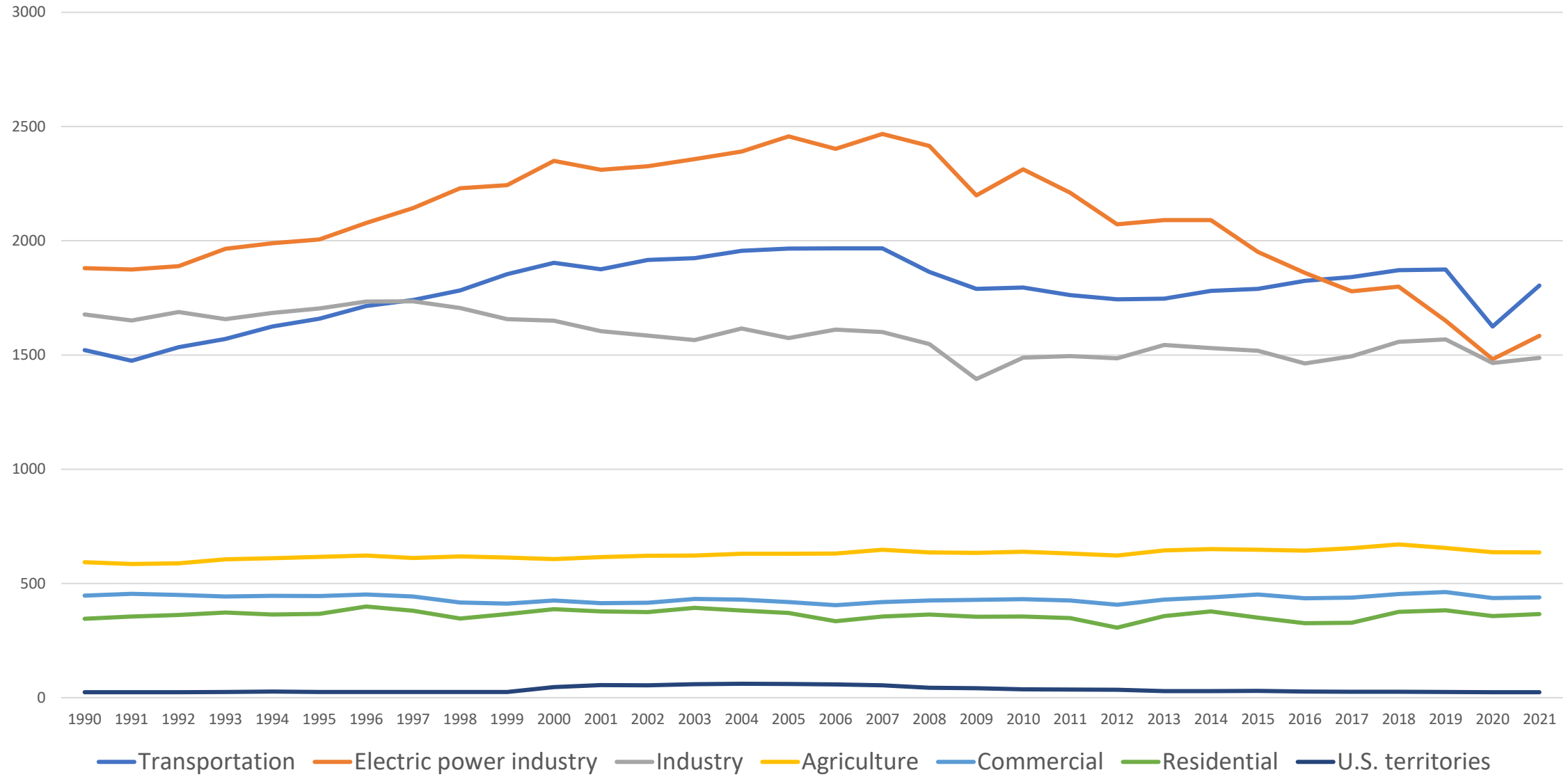
Inventory of U.S. Emissions and Sinks (GHGI)

- Official U.S. estimate of greenhouse gas emissions for reporting to United Nations Framework Convention on Climate Change (UNFCCC)
 - Annual national-level inventory submissions to the UNFCCC since 1994
 - Emission estimates begin in 1990; most current inventory covers 1990-2017
- EPA leads Inventory development, working with several other agencies (e.g., agriculture, energy) to prepare estimates and provide activity data
- Sectors Covered
 - Energy, Industrial Processes, Agriculture, Land-Use Change and Forestry, and Waste
- Gases Covered
 - Carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbon (PFCs), nitrogen trifluoride (NF₃), and sulfur hexafluoride (SF₆)
 - Reported in mass of each gas, and as global warming potential (GWP)-weighted CO₂e emissions
- Record of emissions trends over time
- Each year, Inventory undergoes expert review, public review, and UNFCCC review



Most Recent GHG Inventory Results 1990-2021

Million metric tonnes CO₂-equivalent (MMT CO₂e)

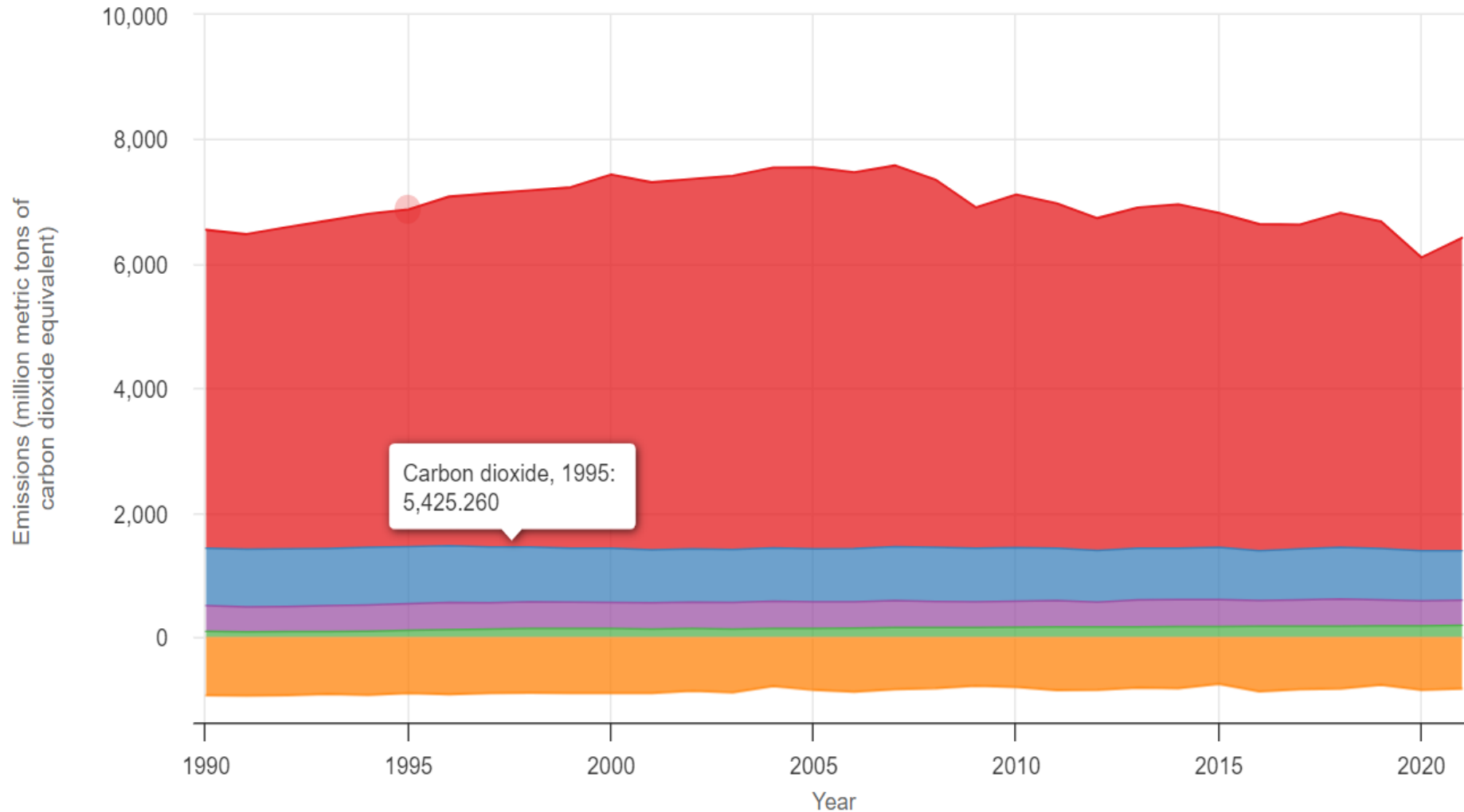




U.S. GHG Emissions by Gas

U.S. Greenhouse Gas Emissions by Gas, 1990–2021

Export



Percent change:

Carbon dioxide:

▼ 1.7%

Methane:

▼ 14.0%

Nitrous oxide:

▼ 1.4%

Fluorinated gases:

▲ 104.8%

Land use and forestry carbon stock change:

Sink ▼ 11.4%

Net total: ▼ 0.4%

Gross total: ▼ 2.3%

● Carbon dioxide ● Methane ● Nitrous oxide ● Fluorinated gases ● Land use and forestry carbon stock change



State-level GHG Data

Link: <https://cfpub.epa.gov/ghgdata/inventoryexplorer/>

- State-level GHG data now covering 1990-2021 for all gases & sectors, fully disaggregating national GHG Inventory across the 50 states (including DC, tribal lands and territories)
- Sums to national data (consistent with national GHGI)
 - Reflects national GHGI improvements
 - Published annually after national GHG inventory (e.g., 3rd publication) in EPA's GHG Inventory Data Explorer
 - Supports states, policymakers, researchers, and the general public
 - May differ from official state data

Greenhouse Gas Inventory Data Explorer

The Data Explorer is an interactive tool that provides access to data from the EPA's annual inventory of U.S. Greenhouse Gas Emissions and Sinks and the Inventory of U.S. Greenhouse Gas Emissions and Sinks by State. You can use the tool to create customized charts or maps, examine trends over time, and download data. Visit other EPA pages to learn more about [the EPA's national inventory](#) and [how it relates to EPA's Greenhouse Gas Reporting Program](#) and the [EPA's state-level greenhouse gas \(GHG\) data](#). The EPA recognizes that there will be differences between the EPA's state-level GHG estimates and some inventory estimates developed independently by individual state governments. Inventory data presented here should not be viewed as official data of any state government. Additional information is available on [official state GHG data](#), where it exists, including information on potential areas of difference between EPA's data and official state data.

Notes on viewing charts and maps

- To view a chart, you can either pick from the full list in the [Index of Charts](#) or create a chart by choosing options sequentially from the six dropdown menus in the "Chart View." You can view data via maps in the "Map View."
- Some drop-down menu options are unavailable at this time and may be added in the future as more data capabilities are added to the tool.
- Within each chart, you can click the legend to turn layers on or off, and you can hover your mouse over the display to reveal data. Chart data can be downloaded from the table below each chart.
- Within each map, you can hover your mouse over a state to see that state's GHG data. Map data can be downloaded from the table below each map.
- National data is rounded to the nearest hundredth and state data is rounded to the nearest thousandth. Values of 0.000 may represent positive values less than 0.0005 MMT CO2 Equivalent.
- Data tables are automatically ordered from highest to lowest values of the most recent year. You can click on the column headings to reorder the table.
- The Data Explorer includes emissions estimates by economic sector, defined by the country's [major economic activities](#), and by inventory Sector, consistent with international reporting standards. You can choose either in the first dropdown menu in the "Chart View" or "Map View."

Navigation

- Data Explorer Home
- Index of Charts

Related Information

- National GHG Inventory
- GHG Inventory by State
- GHG Reporting Program Home

Chart View | **Map View**

Choose:

1. Sector: All sectors

2. Category: All sectors

3. Greenhouse gas: All gases

4. Break out by: Economic sector

5. Year(s): All years

6. Geography: Indiana

Date range: 1990-2021

Indiana Greenhouse Gas Emissions by Economic Sector, 1990-2021

Percent change:

- 20.1%
- 21.8%
- 4.3%
- 8.9%
- 11.0%
- 8.8%

Gross total: 18.6%

Year	Electric power industry	Industry	Transportation	Agriculture	Commercial	Residential
1990	110.0	40.0	10.0	5.0	10.0	5.0
1991	115.0	42.0	11.0	5.0	10.0	5.0
1992	120.0	44.0	12.0	5.0	10.0	5.0
1993	125.0	46.0	13.0	5.0	10.0	5.0
1994	130.0	48.0	14.0	5.0	10.0	5.0
1995	135.0	50.0	15.0	5.0	10.0	5.0
1996	140.0	52.0	16.0	5.0	10.0	5.0
1997	145.0	54.0	17.0	5.0	10.0	5.0
1998	150.0	56.0	18.0	5.0	10.0	5.0
1999	155.0	58.0	19.0	5.0	10.0	5.0
2000	160.0	60.0	20.0	5.0	10.0	5.0
2001	165.0	62.0	21.0	5.0	10.0	5.0
2002	170.0	64.0	22.0	5.0	10.0	5.0
2003	175.0	66.0	23.0	5.0	10.0	5.0
2004	180.0	68.0	24.0	5.0	10.0	5.0
2005	185.0	70.0	25.0	5.0	10.0	5.0
2006	190.0	72.0	26.0	5.0	10.0	5.0
2007	195.0	74.0	27.0	5.0	10.0	5.0
2008	200.0	76.0	28.0	5.0	10.0	5.0
2009	205.0	78.0	29.0	5.0	10.0	5.0
2010	210.0	80.0	30.0	5.0	10.0	5.0
2011	215.0	82.0	31.0	5.0	10.0	5.0
2012	220.0	84.0	32.0	5.0	10.0	5.0
2013	225.0	86.0	33.0	5.0	10.0	5.0
2014	230.0	88.0	34.0	5.0	10.0	5.0
2015	235.0	90.0	35.0	5.0	10.0	5.0
2016	240.0	92.0	36.0	5.0	10.0	5.0
2017	245.0	94.0	37.0	5.0	10.0	5.0
2018	250.0	96.0	38.0	5.0	10.0	5.0
2019	255.0	98.0	39.0	5.0	10.0	5.0
2020	260.0	100.0	40.0	5.0	10.0	5.0
2021	265.0	102.0	41.0	5.0	10.0	5.0

U.S. Greenhouse Gas Emissions by State (Net Total), 2021

Greenhouse Gas Emissions by State (Net Total), 2021

State	2021 Emissions (MMT CO2e)
Alabama	10.0
Alaska	0.5
Arizona	15.0
Arkansas	10.0
California	250.0
Colorado	20.0
Connecticut	10.0
Delaware	5.0
District of Columbia	0.5
Florida	100.0
Georgia	15.0
Hawaii	0.5
Idaho	5.0
Illinois	100.0
Indiana	265.0
Iowa	10.0
Kansas	10.0
Kentucky	10.0
Louisiana	10.0
Maine	5.0
Maryland	10.0
Massachusetts	10.0
Michigan	10.0
Minnesota	10.0
Mississippi	10.0
Missouri	10.0
Montana	5.0
Nebraska	10.0
Nevada	5.0
New Hampshire	5.0
New Jersey	10.0
New Mexico	5.0
New York	10.0
North Carolina	10.0
North Dakota	5.0
Ohio	10.0
Oklahoma	5.0
Oregon	10.0
Pennsylvania	10.0
Rhode Island	5.0
South Carolina	10.0
South Dakota	5.0
Tennessee	10.0
Texas	200.0
Utah	5.0
Vermont	5.0
Virginia	10.0
Washington	10.0
West Virginia	5.0
Wisconsin	10.0
Wyoming	5.0

Related National Charts

More Detailed Views: Agriculture Sector, Commercial Sector, Electric Power Industry, Industrial Sector, Residential Sector, Transportation

Higher-Level Overview(s)



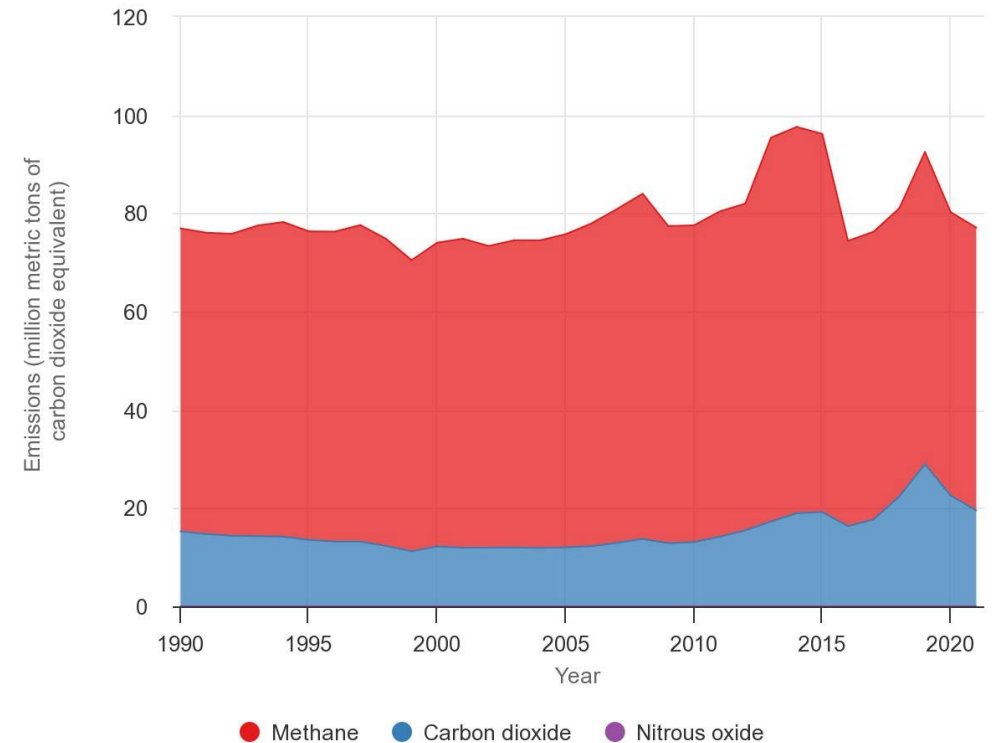
GHG State-Level Estimates for Oil and Gas

Approach to allocate emissions to state-level

- National GHGI emissions are allocated to each state using datasets with state-specific data that are used to represent the relative contributions of state emissions to the national total
 - e.g., state-specific well counts, pipeline miles, production
- Approach reflects state-variations for some sources
 - e.g., pipeline materials, number and types of wells
- Approach does not reflect certain other variation
 - e.g., differences in technologies and practices, impacts of state regulations

Example: Texas

Texas Greenhouse Gas Emissions from Natural Gas and Petroleum Systems, by Gas, 1990–2021

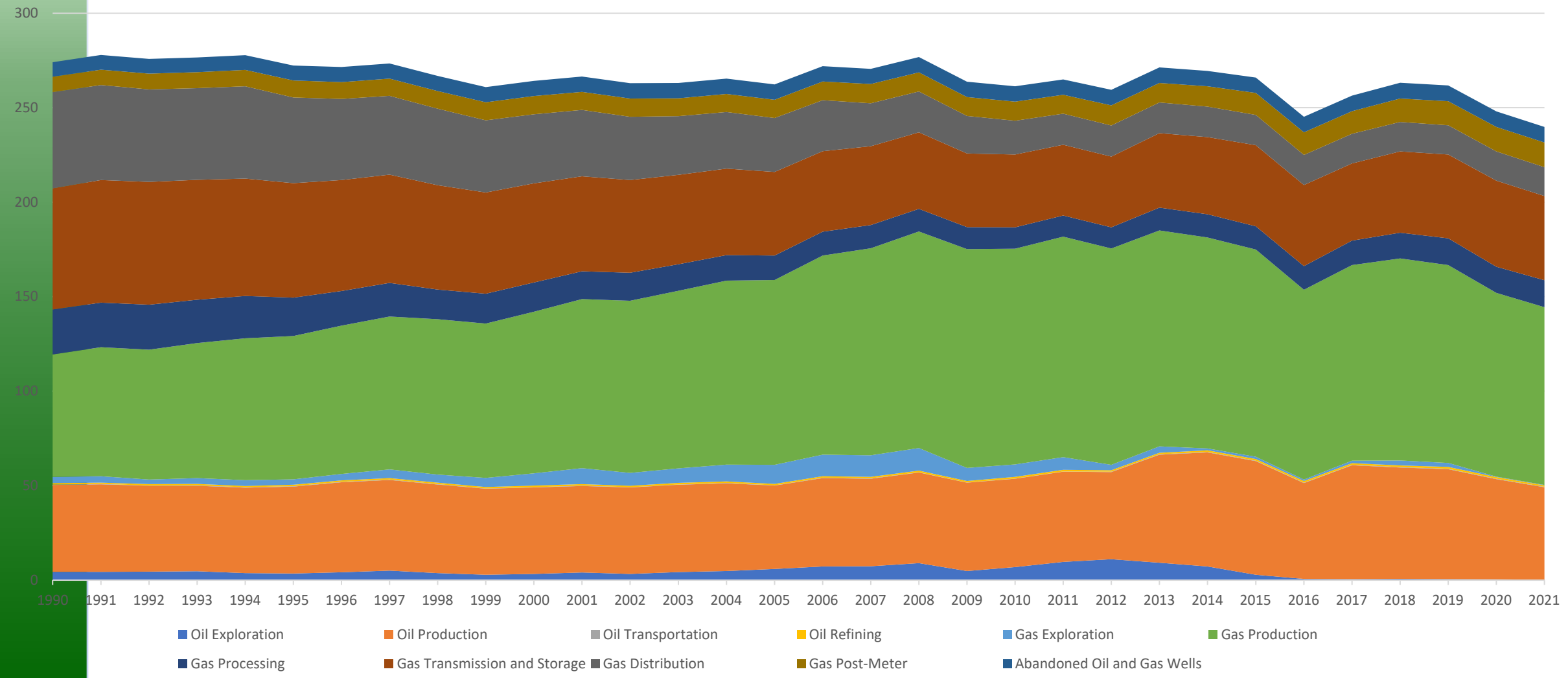


Source: U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2021.
<https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals>



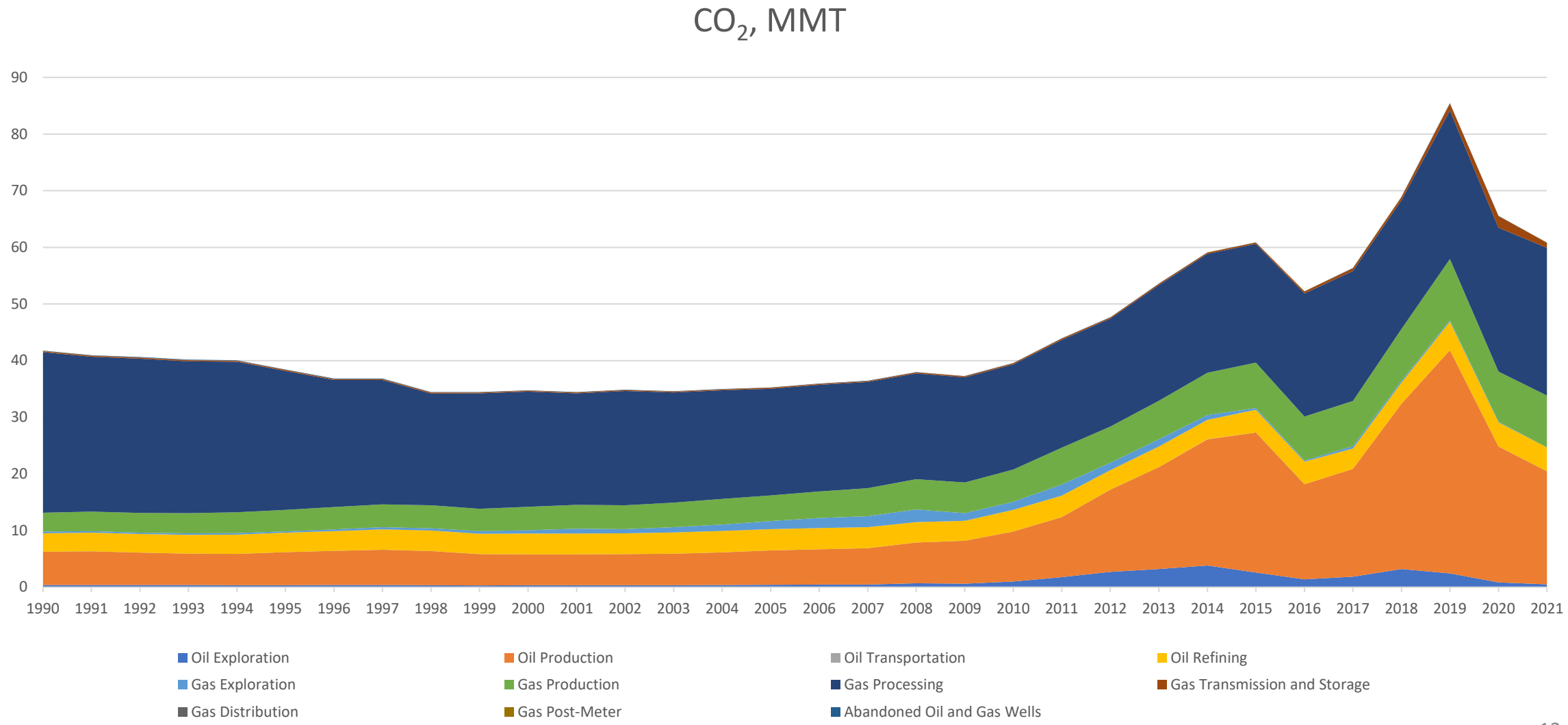
Oil and Gas CH₄ Trends

Methane, MMT CO₂e





Oil and Gas CO₂ Trends





Calculating Oil and Gas Emissions in the GHGI

- Calculated with IPCC higher tier approaches
- Inventory covers leaks, vents, and flares, and is stratified into natural gas and petroleum pathways of the industry
 - Natural gas - offshore production, onshore production, gas processing, gas transmission, underground gas storage, LNG storage, LNG import and export terminals, and gas distribution
 - Petroleum – offshore production, onshore production, oil transportation, and refineries
- Oil and gas in inventory covers hundreds of types of sources
- General approach is to multiply national activity data by emission factors, e.g.:
 - Miles cast iron pipeline x CH₄ per mile cast iron pipeline
 - # residential meters x CH₄ per residential meter



GHGI Key Data Sources

- GHGRP—Key source of emission factors and activity data for recent years
 - Examples: hydraulically fractured completions, pneumatic controllers, liquids unloading
- EDF study series
 - Zimmerle et al. 2015 (with GHGRP)—Emission factors for transmission and storage
 - Lamb et al. 2015 (with GRI 1996)—Emission factors for distribution pipeline emissions
- DOE-funded work
 - Zimmerle et al. 2019—Emission factors for gathering and boosting
 - Moore et al. 2019—Emission factors for commercial and industrial meters
- Other research studies
 - Fischer et al. 2018—Emission factors for residential post-meter
 - Pandey et al. 2019, Cusworth et al. 2021, and Maasackers et al. 2022—Emissions for large well blowout events
- GRI 1996—Primarily used to estimate emissions from early years of time series.
 - For some sources, it is still the best source for emission factors or certain activity data inputs (e.g., component counts for production segment)



Improving Estimates

- Tracking new studies and communicating with researchers—EPA tracks new studies and where possible, communicates with researchers in the study development process to improve relevance of results to EPA’s GHG data.
 - Bottom-up to improve equipment-specific information
 - Top-down to inform where emissions may be over or underestimated and guide improvements
- Stakeholder process—EPA conducts early engagement and communication with stakeholders on new data available.
- Annual data updates—EPA updates the GHG Inventory when new information is available to improve our emissions calculations.
- Gridded Inventory—Improves the ability to compare the national-level Inventory with measurement results that may be at other scales
- Proposed GHGRP regulatory revisions including collecting additional data to help understand potential causes of discrepancy



Updates to U.S. GHGI Oil and Gas Estimates

Year	Update
2023	Implemented basin-level calculation methodologies using GHGRP data for select production sources
2022	Inclusion of post-meter estimates and large well blowouts, improved estimates for abandoned wells and voluntary reductions
2021	Updated data on customer meters and produced water
2020	Use of research study EFs for G&B equipment, use of BOEM and GHGRP data on offshore
2019	Use of GHGRP data for G&B and transmission pipelines, LNG, HF oil wells, N ₂ O emissions
2018	Inclusion of abandoned wells estimate, use of GHGRP for CO ₂ and year-specific EFs
2017	Inclusion of Aliso Canyon estimate, GHGRP for processing, associated gas venting and flaring,
2016	Update to production (GHGRP), G&B emission estimate, transmission (GHGRP and research study), distribution (GHGRP and research study)
2015	Use of GHGRP for refineries, use of latest BOEM for offshore, update to well data source
2014	Use of GHGRP data for HF gas wells
2013	Use of API/ANGA data on liquids unloading, use of NSPS OOOO analysis for gas wells



Stakeholder Process for the 2024 GHGI

- Final 2024 GHGI will be released in April 2024
 - Will cover emissions from 1990-2022
- Public review of the 2024 GHGI will occur in early 2024
- Annual oil and gas stakeholder process for the 2024 GHGI to begin fall of 2023
 - Webinar—October 3, 2023
 - Memos on updates under consideration
 - Additional Information will be available on the stakeholder website

<https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems>



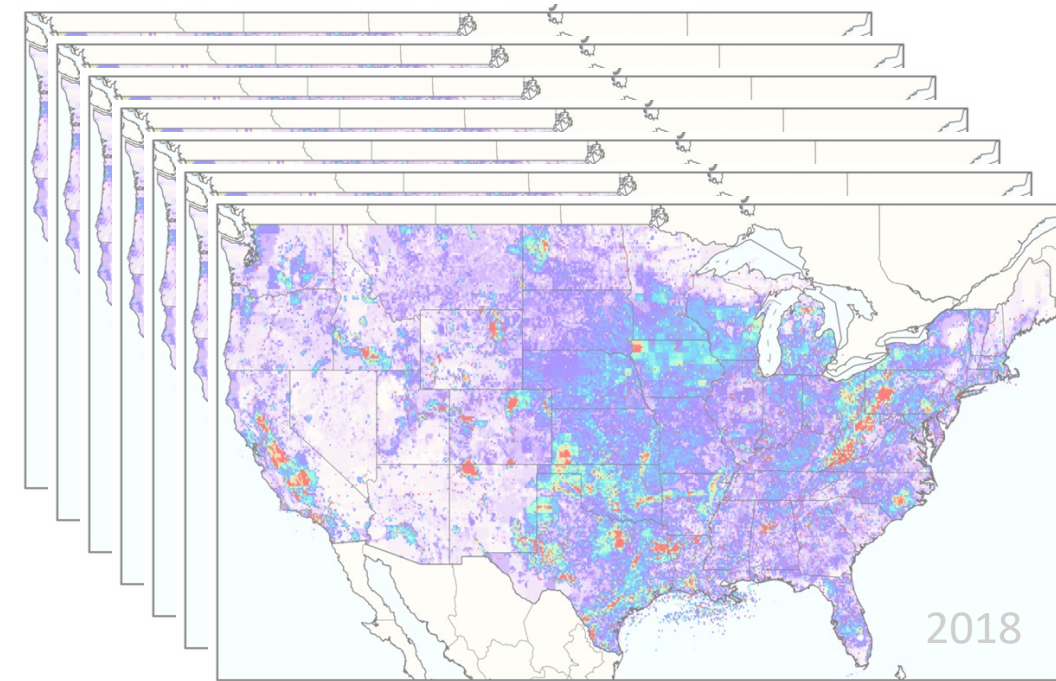
IPCC 2019 Refinement and Atmospheric Observations

- Atmospheric measurement covered under “Quality Assurance, Quality Control, and Verification”
- Describes components needed to compare inventories with atmospheric measurements
 - Measurements of atmospheric gas concentrations, inverse modeling tools, gridded inventory, collaboration
- Describes national experience with use of atmospheric measurements
 - Switzerland (CH₄), UK (CH₄), Australia (SF₆, HFCs)
- Guidance is consistent with EPA use of gridded inventory for comparisons with atmospheric data
 - Identification of areas with potential over- or underestimates



Gridded EPA Methane Emissions Inventory

- Spatially and temporally disaggregated version (~10 x 10 km, monthly resolution) of all methane emission sources in the GHGI
- Allows for more direct comparison between the GHGI and the time and location of atmospheric methane observations/emission rates
- Is used as a prior estimate for inversions of atmospheric methane



Version 1—Published 2016

- Emissions for 2012
- Based on 2016 GHGI
- Research study effort

Version 2—Published 2023

- Timeseries (2012 – 2018, and “express” data set to 2020)
- Based on 2020 GHGI
- Development of a system to streamline future updates



Memos

Greenhouse Gas Emissions

[GHG Emissions Home](#)

[Overview of Greenhouse Gases](#)

[Sources of GHG Emissions](#)

[Global Emissions](#)

[National Emissions](#)

[Facility-Level Emissions](#)

[Carbon Footprint Calculator](#)

[GHG Equivalencies Calculator](#)

Natural Gas and Petroleum Systems

It is EPA's standard process to update the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (GHG Inventory) when relevant new and improved data are available. In recent years, as improved data have become available, EPA has updated methods and data sources for calculating greenhouse gas emissions for several sources in the natural gas and petroleum sectors.



See below for information regarding EPA estimates of greenhouse gas emissions from natural gas and petroleum systems in the annual GHG Inventory.

- [1990-2017 Inventory](#) (published April 2019)

Archives: Previously Posted Memos and Other Information on Stakeholder Engagement

- [1990-2016 Inventory](#) (published April 2018)
- [1990-2015 Inventory](#) (published April 2017)
- [1990-2014 Inventory](#) (published April 2016)
- [1990-2013 Inventory](#) (published April 2015)
- [1990-2012 Inventory](#) (published April 2014)
- [1990-2011 Inventory](#) (published April 2013)

Resources:

- [GRI/EPA 1996: Methane Emissions from the Natural Gas Industry](#)
- [Radian 1999: Methane Emissions from the U.S. Petroleum Industry](#)

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October 2018

Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2017: Updates Under Consideration for Natural Gas Gathering & Boosting Emissions

In supporting documentation associated with the development of EPA's 2018 *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (GHGI), EPA stated plans to consider newly reported data from EPA's Greenhouse Gas Reporting Program (GHGRP) for the 2019 GHGI. In the June 2018 memo *Inventory of U.S. GHG Emissions and Sinks 1990-2017: Updates Under Consideration for Incorporating GHGRP Data* (June 2018 Preliminary Updates memo),¹ EPA described plans to consider newly reported data from EPA's Greenhouse Gas Reporting Program (GHGRP) and other relevant data for updating current emission estimation methodologies in the 2019 GHGI, including stations and pipelines in the natural gas gathering and boosting (G&B) segment.

In the June 2018 Preliminary Updates memo, EPA presented the G&B data that are available from GHGRP subpart W and recent studies, compared these data to the current GHGI basis, and discussed preliminary options for updating estimates of national total emissions. This memo summarizes the previous analyses and explores additional considerations for incorporating GHGRP data for G&B stations and pipelines. The latest considerations are detailed in the following sections:

- Section 2.3.2: Comparing Facility-Level and Unit/Component-Level Emissions Estimates for G&B Stations
- Section 6: Requests for Stakeholder Feedback
- Appendix C: G&B Time Series Emissions Data

EPA received stakeholder feedback on the options discussed in the June 2018 Preliminary Updates memo and summarized the feedback in Section 6. EPA continues to seek stakeholder feedback on whether and how to incorporate data from the GHGRP or other data sources into the 2019 or future GHGI methodologies for G&B emission sources; refer to Section 6 for specific questions.

1 Available GHGRP Data

This section summarizes data sources that EPA has reviewed to develop preliminary approaches and considerations toward update

April 2019

Subpart W of the EPA's GHG natural gas and petroleum systems (CO₂e) emissions. Facilities that (RY) 2011; however, certain W activity and emissions data production, processing, and Subpart W specifies facility subpart W are each defined does not delineate data for

Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2017: Updates to Liquefied Natural Gas Segment

This memorandum documents the updates implemented in EPA's 2019 *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (GHGI) for liquefied natural gas (LNG) storage facilities and LNG import and export terminals. Additional considerations for the LNG segment were previously discussed in memoranda released in June (*Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2017: Updates Under Consideration for Incorporating GHGRP Data*) and October 2018 (*Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2017: Updates Under Consideration for Liquefied Natural Gas Segment Emissions*).¹ During the stakeholder process for developing the 2019 GHGI, stakeholders supported making updates to estimate LNG segment emissions using Greenhouse Gas Reporting Program (GHGRP) subpart W data.

1 2018 (Previous) GHGI Methodology

In the 2018 (previous) GHGI, each LNG facility type estimate included estimates for station fugitives, reciprocating and centrifugal compressor vented and leak emissions, compressor exhaust, and station venting (i.e., blowdowns). The GHGI used the same source-specific CH₄ EFs for both LNG storage stations and LNG import terminals. The CH₄ EFs were based on the 1996 GRI/EPA study, which developed EFs using underground natural gas storage and transmission compressor station data. Specific emissions data for LNG storage stations and LNG import terminals were not available in the GRI/EPA study. For CO₂ emissions estimates from sources other than compressor engine exhaust, the previous GHGI used an assumed ratio of CO₂-to-CH₄ gas content to calculate CO₂ EFs from the CH₄ EFs. For compressor exhaust CH₄, the previous GHGI used EFs from the 1996 GRI/EPA study that were developed for engines and turbines in the natural gas industry (mt CH₄/MMhp-hr) (CO₂ estimates are not included within the natural gas systems estimates, but within separate fuel combustion estimates).

For LNG storage station activity data, the previous GHGI considered complete storage stations and satellite facilities, the latter of which do not perform liquefaction. The GHGI assumed that satellite facilities have approximately one-third of the equipment found at complete storage stations, and thus only included one-third of the satellite facility count in the emissions calculations. Complete storage station and satellite facility counts are available for 1992 and 2003.² Storage station counts for years before 2003 were calculated by applying linear interpolation between the 1992 and 2003 values. Storage station counts for years after 2003 were set equal to the 2003 counts. The count of reciprocating and centrifugal compressors were estimated by applying a certain ratio of compressors per plant. Compressor exhaust activity data were estimated by applying assumptions regarding the number, type, and size of compressors at various facility types (including subcategory types of storage stations and terminals).

For LNG terminals activity data, the previous GHGI determined import terminal counts using data available from the U.S. Department of Energy (DOE) Federal Energy Regulatory Commission (FERC).³ The terminal counts include onshore and offshore facilities. FERC provides both import and export terminal data, but only import terminals



Data Annexes - Emission Factors

Table 3.5-3: Average CH4 Emission Factors (kg/unit activity) for Petroleum Systems Sources, for All Years	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Segment/Source	Emission Factor Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Production															
Large Tanks w/VRU	kg/MMbbl	NA	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	8,997.9	
Large Tanks w/o Control	kg/MMbbl	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	158,050.1	
Small Tanks w/o Flares	kg/MMbbl	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	42,319.7	
Malfunctioning Separator Dump Valves	kg/MMbbl	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	2,972.8	
Pneumatic Devices, High Bleed	kg/device	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	4,370.7	
Pneumatic Devices, Low Bleed	kg/device	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	
Pneumatic Devices, Int Bleed	kg/device	NA	NA	NA	NA	1,534.7	1,534.7	1,534.7	1,534.7	1,534.7	1,534.7	1,534.7	1,534.7	1,534.7	
Chemical Injection Pumps	kg/pump	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	1,515.3	
Vessel Blowdowns	kg/vessel	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
Compressor Blowdowns	kg/compressor	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	72.7	
Compressor Starts	kg/compressor	162.6	162.6	162.6	162.6	162.6	162.6	162.6	162.6	162.6	162.6	162.6	162.6	162.6	
Associated Gas Venting	kg/bbl	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	
220 - Gulf Coast Basin (LA, TX)	kg/bbl	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
360 - Anadarko Basin	kg/bbl	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
395 - Williston Basin	kg/bbl	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	
430 - Permian Basin	kg/bbl	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
"Other" Basins	kg/bbl	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
Well Workovers	kg/event	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	
OCS Offshore Platforms, Shallow water oil, fugitive vented, and combusted	kg/platform	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	116,358.9	
OCS Offshore Platforms, Deep water oil, fugitive, vented, and combusted	kg/platform	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	659,657.7	
Oil Wellheads (heavy crude)	kg/well	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
Oil Wellheads (light crude)	kg/well	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9	116.9	
Separators (heavy crude)	kg/sep	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
Separators (light crude)	kg/sep	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	
Heater/Treaters (light crude)	kg/HT	134.9	134.9	134.9	134.9	134.9	134.9	134.9	134.9	134.9	134.9	134.9	134.9	134.9	
Headers (heavy crude)	kg/hdr	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Headers (light crude)	kg/hdr	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	76.3	
Floating Roof Tanks	kg/tank	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	6,515.8	
Compressors	kg/compressor	703.0	703.0	703.0	703.0	703.0	703.0	703.0	703.0	703.0	703.0	703.0	703.0	703.0	
Large Compressors	kg/compressor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Sales Areas	kg/loading	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Battery Pumps	kg/pump	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	
Gas Engines	kg/MMHP-hr	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	4,622.4	

Table 3.5-4: CH4 Emission Factors for Petroleum Systems, Data Sources/Methodology	A	B	C
Segment/Source	Units	Data Source/Method	
Production			
Large Tanks w/VRU	kg/tank		
Large Tanks w/o Control	kg/tank	2015-2017: Calculated using year-specific GHGRP subpart W data for each tank category (EPA 2018d). 1990-2014: Year 2015 emission factors. Refer to EPA 2017a for additional detail.	
Small Tanks w/o Flares	kg/tank		
Malfunctioning Separator Dump Valves	kg/large tank		
Pneumatic Devices, High Bleed	kg/device		
Pneumatic Devices, Low Bleed	kg/device	Calculated using RY2014 GHGRP subpart W data for each bleed type category. Refer to EPA 2016a for additional detail.	
Pneumatic Devices, Int Bleed	kg/device		
Chemical Injection Pumps	kg/pump	Calculated using RY2014 GHGRP subpart W data. Refer to EPA 2016a for additional detail.	
Vessel Blowdowns	kg/vessel	GRI/EPA 1996	
Compressor Blowdowns	kg/compressor	GRI/EPA 1996	
Compressor Starts	kg/compressor	GRI/EPA 1996	
Associated Gas Venting	kg/bbl		
220 - Gulf Coast Basin (LA, TX)	kg/bbl		
360 - Anadarko Basin	kg/bbl	2015-2017: Developed from year-specific GHGRP subpart W data for each basin or basin group (EPA 2018d). 1990-2014: Use year 2015 EFs. Refer to EPA 2018c for additional detail.	
395 - Williston Basin	kg/bbl		
430 - Permian Basin	kg/bbl		
"Other" Basins	kg/bbl		
HF Workovers: Non-REC with Venting	kg/event	2016-2017: Calculated using year-specific GHGRP subpart W data for each control category (EPA 2018d). 1990-2015: Year 2016 emission factors applied. Refer to EPA 2019 for additional detail.	
HF Workovers: REC with Venting	kg/event		
Non-HF Well Workovers	kg/event	Radian/EPA 1999	
Pipeline Piggings	kg/station	CAPP 1992	
OCS Offshore Platforms, Shallow water oil, fugitive vented, and combusted	kg/platform	Calculated using data from BOEM 2014. Refer to EPA 2015d for additional detail.	
OCS Offshore Platforms, Deep water oil, fugitive, vented, and combusted	kg/platform		
Oil Wellheads (heavy crude)	kg/well	Consensus of Industry Review Panel; EFs from API Workbook 4638 (API 1996); Assume 5 valves, 10 flanges, 1 polished rod & 4 connectors/well	
Oil Wellheads (light crude)	kg/well		
Separators (heavy crude)	kg/sep	Consensus of Industry Review Panel; EFs from API Workbook 4638 (API 1996); Assume 6 valves, 12 flanges and 10 connector/separators.	
Separators (light crude)	kg/sep		
Heater/Treaters (light crude)	kg/HT	Consensus of Industry Review Panel; EFs from API Workbook 4638 (API 1996); Assume 8 valves, 12 flanges and 20 connectors/heater treaters.	
Headers (heavy crude)	kg/hdr	Consensus of Industry Review Panel; EFs from API Workbook 4638 (API 1996); Assume 5 valves, 10 flanges and 4 connectors/header.	
Headers (light crude)	kg/hdr		
Compressors	kg/compressor	Consensus of Industry Review Panel	
Large Compressors	kg/compressor	Consensus of Industry Review Panel	
Sales Areas	kg/loading	Consensus of Industry Review Panel	
Pipelines	kg/mile	Assumed to be zero due to lack of data	
Battery Pumps	kg/pump	API 1995	
Gas Engines	kg/MMHP-hr	GRI/EPA 1996	
Heaters	kg/MMbbl	EPA 1997	
Associated Gas Flaring	kg/bbl		



Data Annexes - Activity Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Table 3.5-5: Activity Data for Petroleum Systems Sources, for All Years														
2	Segment/Source	Activity Units	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	Production														
4	Total Oil Wells	oil wells	564,090	565,321	549,420	540,394	523,209	512,035	508,838	509,386	492,949	473,252	475,807	475,791	471,377
5	Total HF Oil Wells	HF oil wells	85,437	89,571	86,707	88,189	87,161	84,653	86,791	87,981	85,753	83,286	85,898	87,545	87,683
6	Large Tanks w/VRU	MMbbl/yr	0	15	30	42	53	64	75	86	93	94	102	109	117
7	Large Tanks w/o Control	MMbbl/yr	1,401	1,346	1,237	1,116	1,024	938	871	811	727	619	568	517	473
8	Small Tanks w/o Flares	MMbbl/yr	95	94	88	82	78	74	71	69	64	57	55	53	51
9	Malfunctioning Separator Dump Valves	MMbbl/yr	1,401	1,400	1,340	1,261									
10	Pneumatic Devices, High Bleed	controllers	165,701	166,010	161,040	157,581									
11	Pneumatic Devices, Low Bleed	controllers	307,730	308,303	299,075	292,650									
12	Pneumatic Devices, Int Bleed	controllers	0	0	0	0									
13	Chemical Injection Pumps	pumps	32,643	32,714	31,794	31,272									
14	Vessel Blowdowns	vessels	216,576	216,975	210,455	205,865									
15	Compressor Blowdowns	compressors	2,949	2,955	2,865	2,799									
16	Compressor Starts	compressors	2,949	2,955	2,865	2,799									
17	Associated Gas Venting	bbl/yr	12,950,306	12,908,265	12,331,402	11,693,594									
18	220 - Gulf Coast Basin (LA, TX)	bbl/yr	825,755	849,488	815,368	776,749									
19	360 - Anadarko Basin	bbl/yr	1,322,261	1,268,446	1,209,814	1,200,267									
20	395 - Williston Basin	bbl/yr	26,918	26,412	24,412	23,108									
21	430 - Permian Basin	bbl/yr	4,612,003	4,618,511	4,380,962	4,186,311									
22	"Other" Basins	bbl/yr	6,163,369	6,145,408	5,900,847	5,507,159									
23	HF Workovers: Non-REC with Venting	events/yr	769	806	780	794									
24	HF Workovers: REC with Venting	events/yr	0	0	0	0									
25	Non-HF Well Workovers	events/yr	35,899	35,681	34,703	33,915									
26	Pipeline Piggings	pig stations	0	0	0	0									
27	OCS Offshore Platforms, Shallow water oil, fugitive vented, and combusted	Shallow water oil platforms	1,769	1,765	1,736	1,693									
28	OCS Offshore Platforms, Deep water oil, fugitive, vented, and combusted	Deep water oil platforms	8	8	8	8									
29	Oil Wellheads (heavy crude)	hvy. crude wells	39,768	39,855	38,734	38,098									
30	Oil Wellheads (light crude)	lt. crude wells	524,322	525,466	510,686	502,296									
31	Separators (heavy crude)	hvy. crude seps	12,714	12,738	12,358	12,096									
32	Separators (light crude)	lt. crude seps	115,713	115,931	112,472	110,087									
33	Heater/Treaters (light crude)	heater treaters	88,149	88,306	85,625	83,682									
34	Headers (heavy crude)	hvy. crude hds	14,714	14,746	14,332	14,096									
35	Headers (light crude)	lt. crude hds	45,616	45,716	44,430	43,700									
36	Compressors	compressors	2,949	2,955	2,865	2,799									
37	Large Compressors	large comprs	0	0	0	0									
38	Sales Areas	loadings/yr	1,987,052	1,986,156	1,900,671	1,789,120									
39	Pipelines	miles gathering line	32,349	31,185	28,782	28,882									
40	Battery Pumps	battery pumps	169,227	169,596	164,826	162,118									
41	Gas Engines	MMHP-h/yr	18,581	18,614	18,047	17,634									
42	Heaters	MMbbl/yr	2,385	2,384	2,281	2,147									
43	Associated Gas Flaring	bbl/yr	139,173,251	138,650,875	131,634,377	124,102,378									
44	220 - Gulf Coast Basin (LA, TX)	bbl/yr	7,272,496	7,481,514	7,181,012	6,840,892									
45	360 - Anadarko Basin	bbl/yr	99,627	94,652	90,104	89,472									
	Index	3.5-1	3.5-2	3.5-3	3.5-4	3.5-5	3.5-6	3.5-7	3.5-8	3.5-9					

	A	B	C												
1	Table 3.5-6: Activity Data for Petroleum Systems, Data Sources/Methodology														
2	Segment/Source	Activity Units	Data Source/Method												
12	Large Tanks w/VRU	MMbbl/yr	[Annual domestic oil production (EIA 2017a)] * [62.7% of oil sent to tanks based on analysis of RY2015 GHGRP subpart W data (EPA 2017a)] * [Tank size and control category throughput fraction in year N]. 2015-2016 category throughput fractions: calculated from year-specific GHGRP subpart W data (EPA 2017a). 2011-2014: Set equal to year 2015 fractions. 1990-2010: Interpolation between zero controls assumed in 1990, to the fractions assigned in 2011. Refer to EPA 2017b for additional detail.												
13	Large Tanks w/o Control	MMbbl/yr													
14	Small Tanks w/o Flares	MMbbl/yr													
15	Malfunctioning Separator Dump Valves	MMbbl/yr	Sum of bbl/yr throughput to large tanks in year N. Refer to EPA 2017b for additional detail.												
16	Pneumatic Devices, High Bleed	controllers	1990-1993: [total producing oil wells in year N] * [activity factors based on consensus of Industry Review Panel]. 2015-2016: [total producing oil wells in year N] * [per-well activity factor calculated from year-specific GHGRP subpart W data (EPA 2017a)]. 2011-2014: [total producing oil wells in year N] * [per-well activity factor calculated from RY2015 GHGRP subpart W data]. 1993-2010: linear interpolation. Refer to EPA 2016a for additional detail.												
17	Pneumatic Devices, Low Bleed	controllers													
18	Pneumatic Devices, Int Bleed	controllers													
19	Chemical Injection Pumps	pumps	Base year 1993 estimate of 31,648 pumps (Radian/EPA 1999), scaled by total producing oil well count in year N compared to base year. 2011-2016: [Total producing oil well count in year N] * [per well activity factor developed from RY2015 GHGRP data]. 1994-2010: Linear interpolation. Refer to EPA 2018a for additional detail.												
20	Vessel Blowdowns	vessels	[Heavy crude seps in year N] + [Light crude seps in year N] + [Heater treaters in year N]												
21	Compressor Blowdowns	compressors	[Compressors in year N]												
22	Compressor Starts	compressors	[Compressors in year N]												
23	Associated Gas Venting	wells													
24	220 - Gulf Coast Basin (LA, TX)	wells	2015-2016: [Total oil production in each year N (DrillingInfo 2017)] * [Fraction of oil production with assoc gas calculated from year-specific GHGRP subpart W data (EPA 2017a)] * [Fraction of assoc gas production that flares calculated from year-specific GHGRP subpart W data]. 2011-2014: [Total oil production in each year N (DrillingInfo 2017)] * [Year 2015 fraction of oil production with assoc gas] * [Fraction of assoc gas production that flares calculated from year-specific GHGRP subpart W data]. 1990-2010: [Total oil production in each year N (DrillingInfo 2017)] * [Year 2015 fraction of oil production with assoc gas] * [Year 2011 fraction of assoc gas production that flares]. Each data element is specific to each basin or basin group. Refer to EPA 2018c for additional detail.												
25	360 - Anadarko Basin	wells													
26	395 - Williston Basin	wells													
27	430 - Permian Basin	wells													
28	"Other" Basins	wells													
29	Well Workovers	events/yr	[Total producing oil wells in year N] * [Workover rate of 7.5% (Radian/EPA 1999)]												
30	OCS Offshore Platforms, Shallow water oil, fugitive vented, and combusted	Shallow water gas platforms	1990-2010: [Number of oil & gas platforms in year N] * [Fraction of oil platforms in year N] * [Fraction of shallow water platforms in year N] (BOEMRE 2011). 2011-2015: Year 2010 data used as proxy.												
31	OCS Offshore Platforms, Deep water oil, fugitive, vented, and combusted	Deep water gas platforms	1990-2010: [Number of oil & gas platforms in year N] * [Fraction of oil platforms in year N] * [Fraction of deep water platforms in year N] (BOEMRE 2011). 2011-2015: Year 2010 data used as proxy.												
32	Total Oil Wells	oil wells	Total producing oil wells calculated in each year N through analysis of DrillingInfo raw data feed (DrillingInfo 2017). Refer to EPA 2015a and EPA 2017b for additional detail.												
33	Oil Wellheads (heavy crude)	hvy. crude wells	[Total producing oil wells in year N] * [7.05% heavy crude fraction (remainder light crude) (Radian/EPA 1999)].												
34	Oil Wellheads (light crude)	lt. crude wells													
35	Separators (heavy crude)	hvy. crude seps	1990-1993: Mean of two approaches based on year 1993 estimates: [total producing oil wells in year N * 217,804 separators for year 1993] / [total producing oil wells in year 1993] and [Production in year N (EIA 2017a)] * [26,562 separators for year 1993] / [Production for year 1993]; expert judgment assigns 90.1% light crude, 9.9%												
	Index	3.5-1	3.5-2	3.5-3	3.5-4	3.5-5	3.5-6	3.5-7	3.5-8	3.5-9	3.5-10				



Background on Greenhouse Gas Reporting Program



Overview of GHG Reporting Program

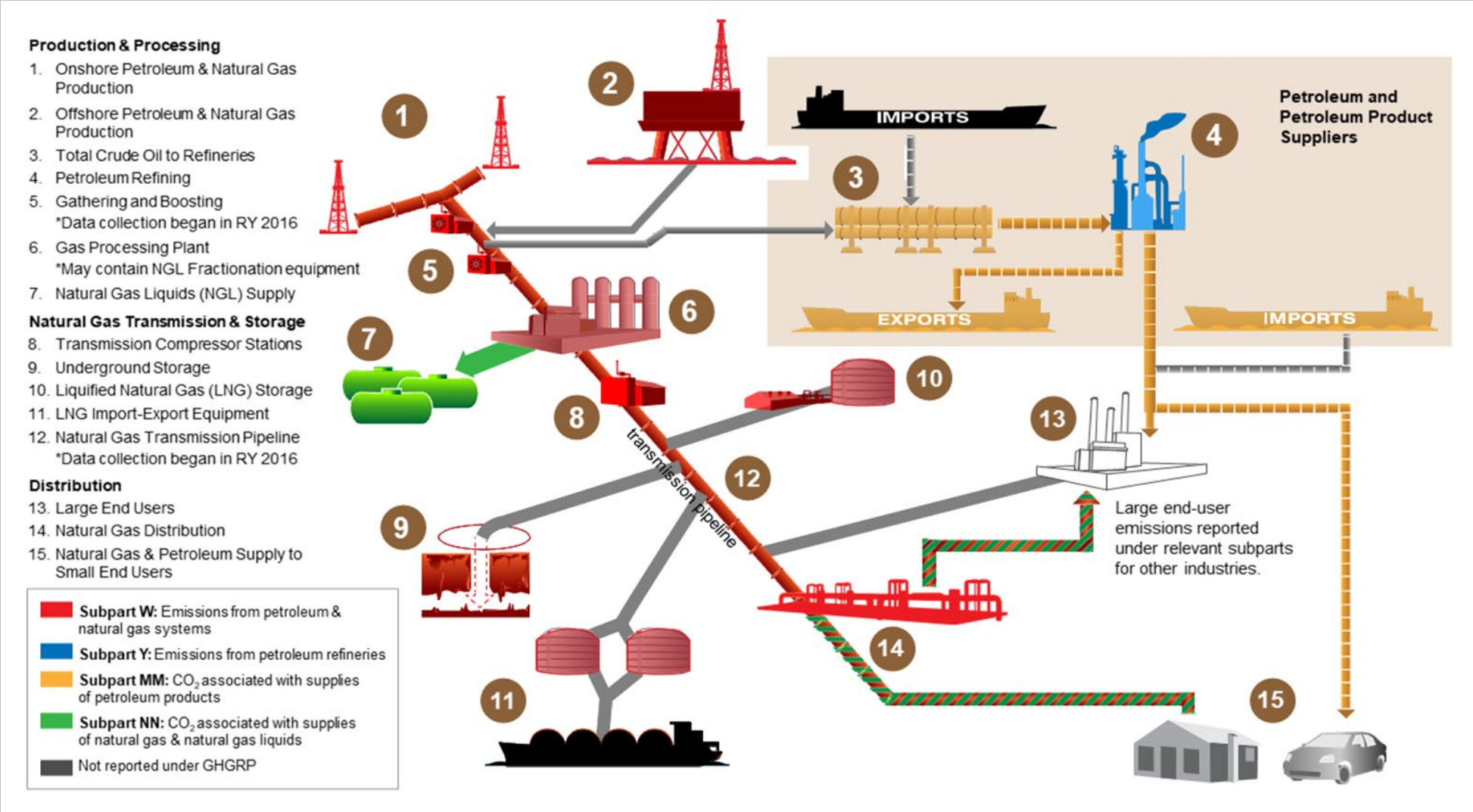
- Launched in response to FY 2008 Consolidated Appropriations Act
- Annual reporting of GHG emissions by 41 source categories
 - 33 types of direct emitters
 - 6 types of suppliers of fuel and industrial GHGs
 - Facilities that inject CO₂ underground for geologic sequestration, enhanced oil recovery, or any other purpose
- Most facilities compare emissions for the facility to a 25,000 metric tons CO₂ equivalent (CO₂e) threshold to determine applicability
 - Covers a subset of oil and gas facilities; for example, about half of onshore oil and gas producing wells are subject to GHGRP
- Most source categories began collecting data in 2010
 - An additional 12 source categories began collecting data in 2011
 - We now have 12 years of data for 29 source categories and 11 years of data for 12 source categories
- Facilities use uniform methods prescribed by the EPA to calculate GHG emissions, such as direct measurement, engineering calculations, or emission factors derived from direct measurement
 - In some cases, facilities have a choice of calculation methods for an emission source
- Direct reporting to EPA electronically
- EPA verification of GHG data



Source Categories Covered by GHG Reporting Program

Power	Refining & Petrochem	Other Chemicals	Combustion	Waste	Metals	Minerals	Pulp & Paper	High GWP Gases
<ul style="list-style-type: none"> - Electricity Generation - Electrical Equipment Mfg. - Electrical Equipment Use 	<ul style="list-style-type: none"> - Petroleum Refineries - Petrochem. Production 	<ul style="list-style-type: none"> - Adipic Acid - Ammonia - Hydrogen Production - Nitric Acid - Phosphoric Acid - Titanium Dioxide 	<ul style="list-style-type: none"> - Stationary Combustion 	<ul style="list-style-type: none"> - Industrial Waste Landfills - Industrial Wastewater Treatment - MSW Landfills 	<ul style="list-style-type: none"> - Aluminum - Ferroalloy - Iron & Steel - Lead - Magnesium - Silicon Carbide - Zinc 	<ul style="list-style-type: none"> - Cement - Glass - Lime - Misc. Carbonate Use - Soda Ash 	<ul style="list-style-type: none"> - Pulp & Paper 	<ul style="list-style-type: none"> - Electronics Mfg. - Fluorinated GHG Production - HCFC-22 Prod./HFC-23 Destruction - Pre-Charged Equipment Import/Export - Industrial Gas Suppliers
Petroleum & Natural Gas Systems			Fuel Suppliers			Carbon Capture & Sequestration		Mining
<ul style="list-style-type: none"> - Onshore Production - Offshore Production - Gathering and Boosting (as of 2016) - Natural Gas Processing - Natural Gas Transmission Compression - Natural Gas Transmission Pipeline (as of 2016) - Natural Gas Distribution - Underground Natural Gas Storage - Liquefied Natural Gas Storage - Liquefied Natural Gas Import/Export 			<ul style="list-style-type: none"> - Coal-Based Liquid Fuels Suppliers - Natural Gas and Natural Gas Liquids Suppliers - Petroleum Product Suppliers 			<ul style="list-style-type: none"> - Geologic Sequestration of CO₂ - Injection of CO₂ - CO₂ Suppliers 		<ul style="list-style-type: none"> - Underground Coal Mines
							<p>Direct Emitters Suppliers CO₂ Injection</p>	

Petroleum and Natural Gas Systems in the GHGRP

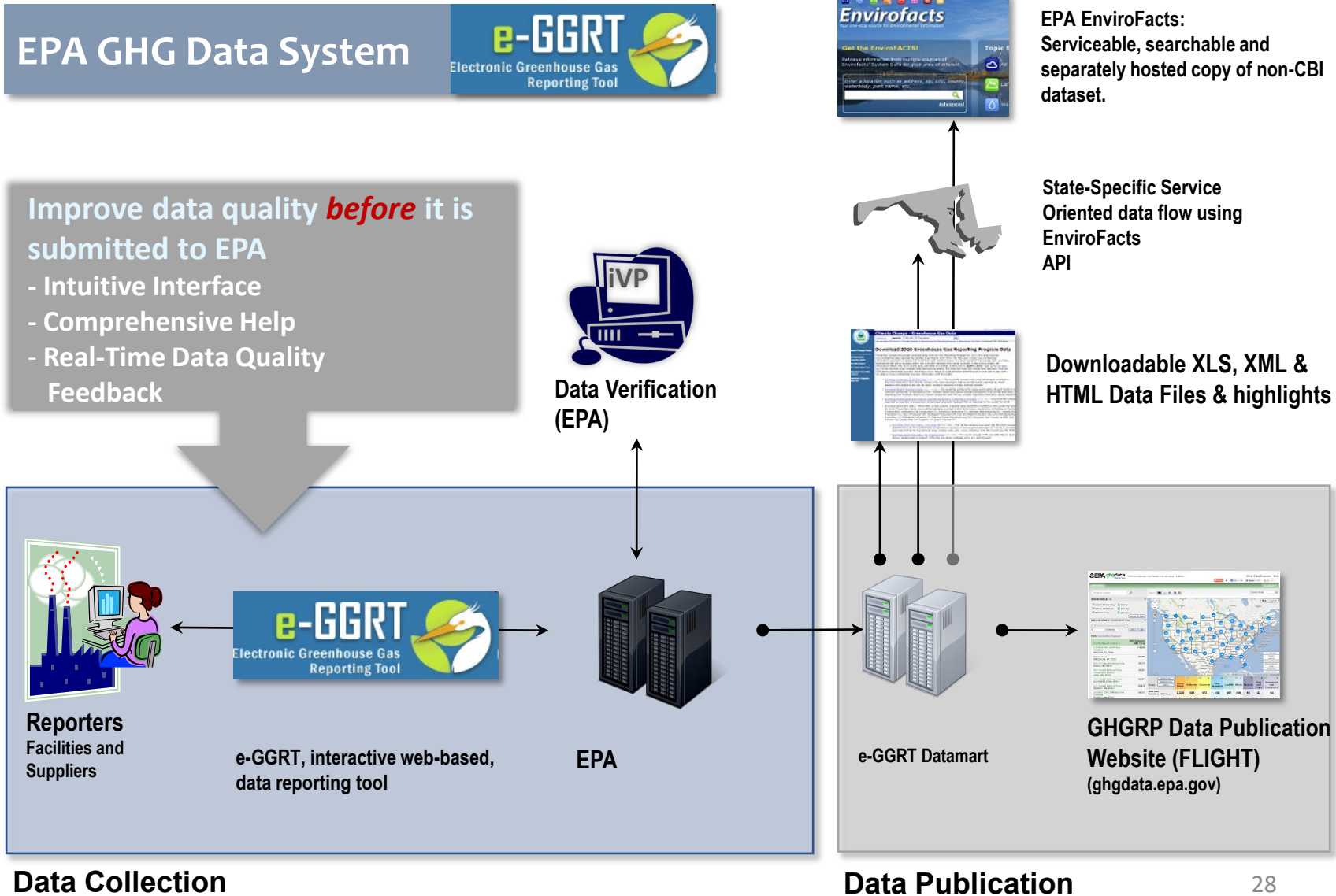




What is a Facility?

- In general, a “facility” for purposes of the GHGRP means all co-located emission sources that are commonly owned or operated
- However, certain industry segments within the Petroleum and Natural Gas Systems source category have unique “facility” definitions
 - Onshore production: the “facility” includes all emissions associated with wells owned or operated by a single company (the permit holder) in a specific hydrocarbon producing basin (as defined by the geologic provinces published by the American Association of Petroleum Geologists)
 - Natural gas distribution: the “facility” is a local distribution company as regulated by a single state public utility commission
 - Gathering and boosting: a “facility” means all gathering pipelines and other equipment located along those pipelines that are under common ownership or common control by a gathering and boosting system owner or operator and that are located in a single hydrocarbon basin
 - Natural gas transmission pipeline, a “facility” means the total U.S. mileage of natural gas transmission pipelines, owned and operated by an onshore natural gas transmission pipeline owner or operator
- The other industry segments in the Petroleum and Natural Gas Systems source category follow the general GHGRP definition of “facility”

Electronic Reporting Workflow





Validation and Verification

EPA's verification process includes thousands of electronic checks.

These checks comprise two groups. **Pre-submittal and Post-submittal checks.**

Pre-submittal (validation) checks generally refer to electronic checks and messaging performed by e-GGRT and presented to the reporter before the annual GHG report is certified and submitted

Post-submittal check refers to electronic checks, manual review, and messaging performed by EPA after the annual report is certified and submitted.



GHGRP Petroleum and Natural Gas Systems: Reporting Year 2021 Data Summary



Analytical Tips Using Subpart W Data

- Facility definition
- Reporting threshold
- GHGRP vs GHGI
- State vs. basin vs. sub-basin
- FLIGHT vs. Envirofacts
- Calculation methods
- Report resubmissions

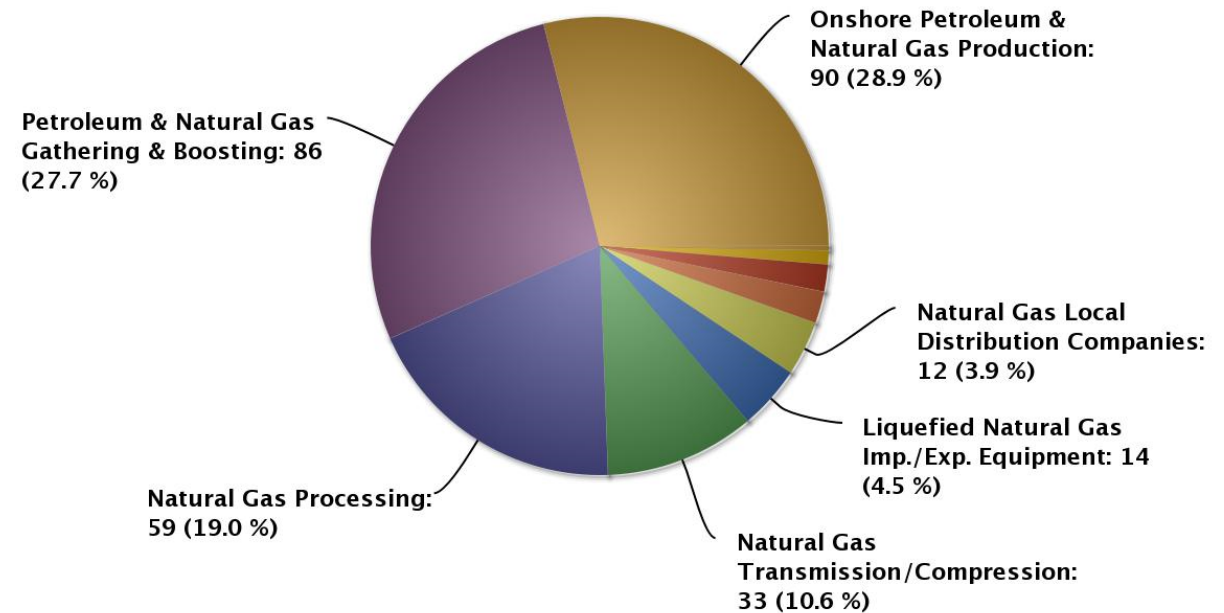


Subpart W – Summary of RY2021 Reported Data

Subparts W & C Reported Emissions

Industry Segment	Facility Count	CO ₂ e Emissions (MMT)
Offshore Production	132	6.4
Onshore Production	470	90
Gathering and Boosting	365	86
NG Processing	452	59
NG Transmission Compression	654	33
NG Transmission Pipeline	50	2.6
Underground NG Storage	49	1
LNG Storage	5	<1
LNG Import/Export	11	14
NG Distribution	165	12
Other Oil and Gas Combustion	56	7
Subpart W Total	2,379	312

U.S. – Petroleum and Natural Gas Systems – Direct GHG Emissions of Selected Gases Reported by Sector in Million Metric Tons of CO₂e

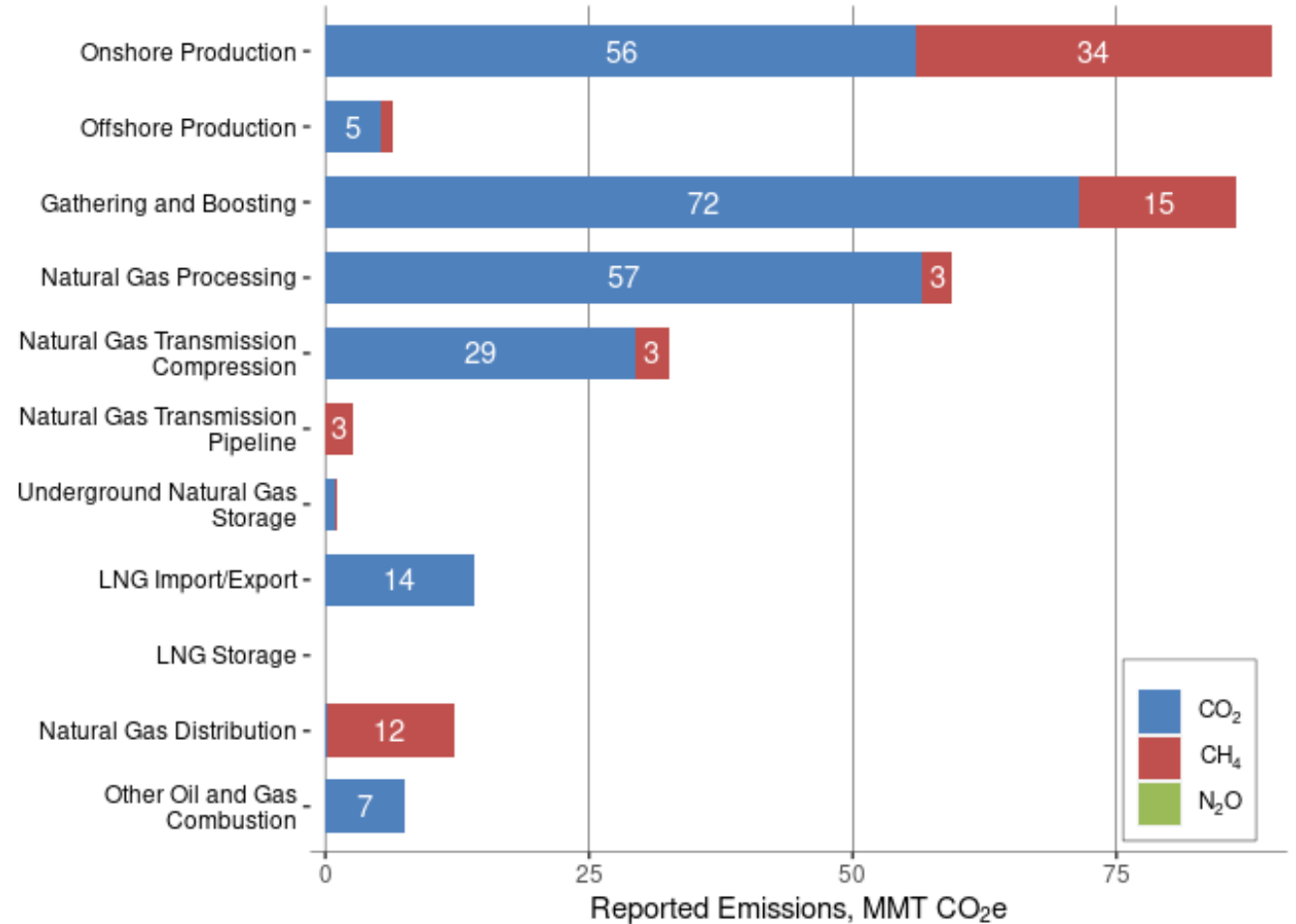


Data reported to EPA as of 08/12/2022



Reported Emissions by Greenhouse Gas

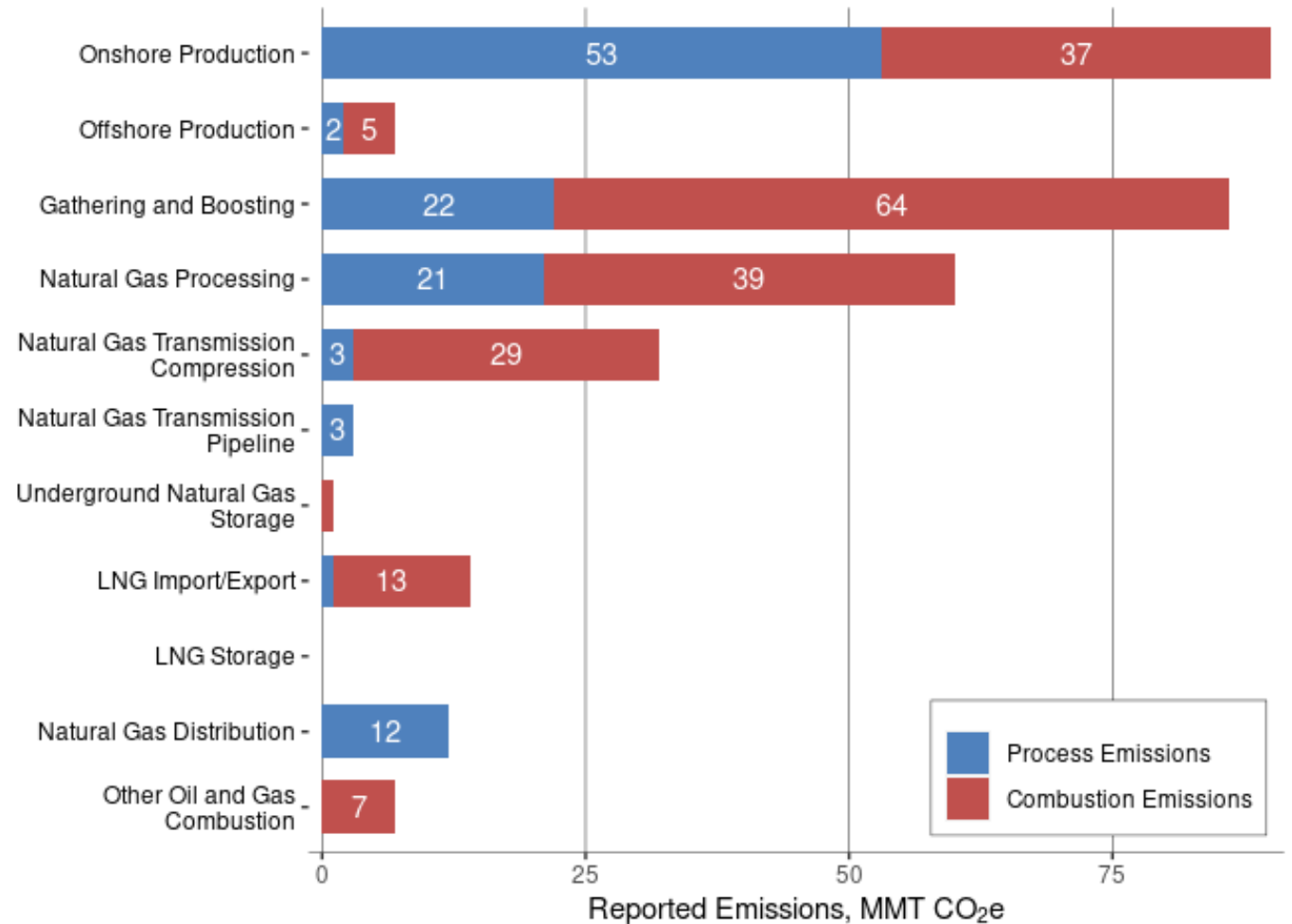
- CO₂ emissions accounted for 241 MMT CO₂e and CH₄ emissions accounted for 71 MMT CO₂e
- Emissions from natural gas distribution were primarily CH₄ while emissions from natural gas transmission compression, natural gas processing, gathering and boosting, and onshore production were mostly CO₂



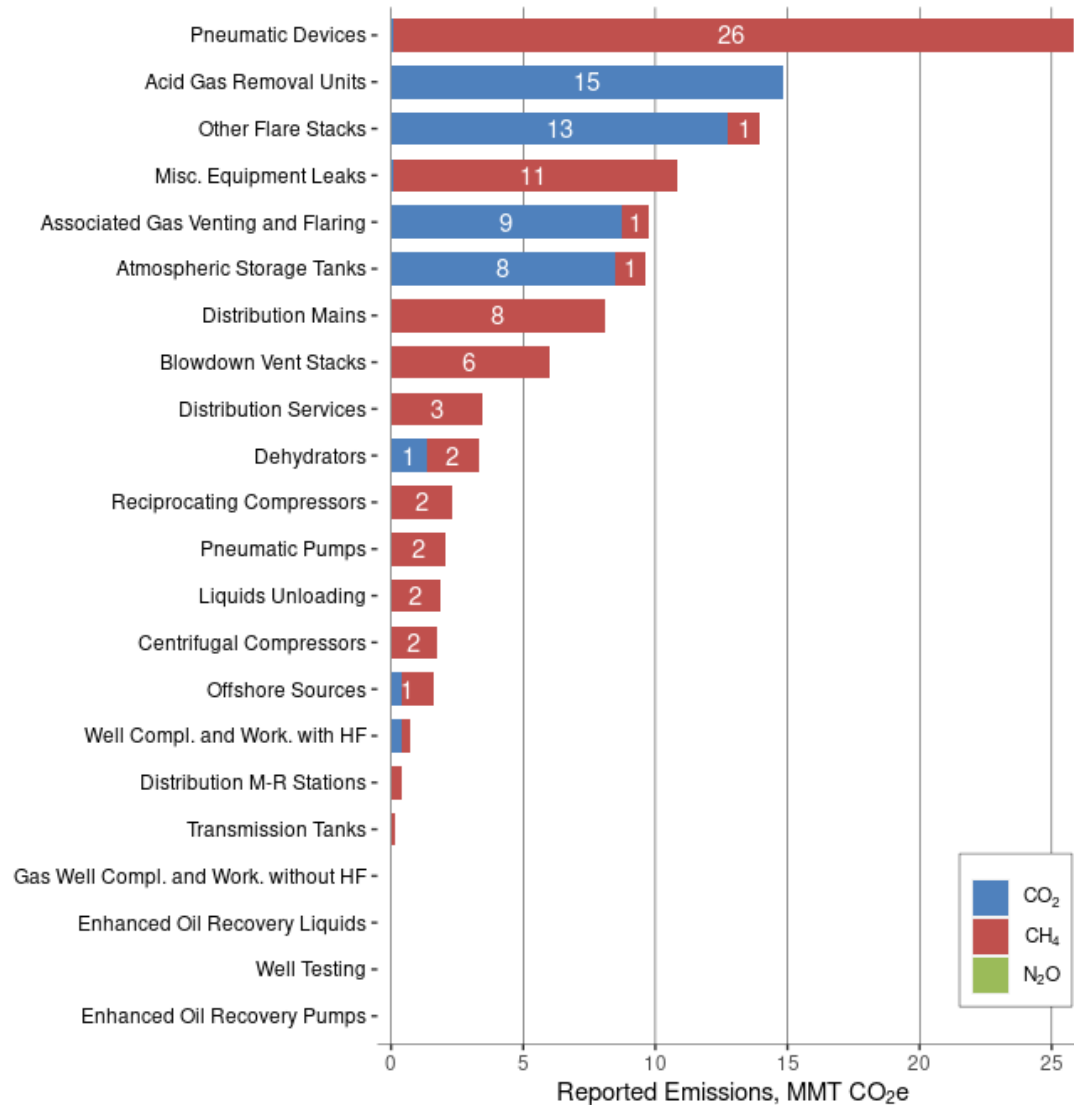


Combustion and Process Emissions

- GHG emissions can result from combustion of fossil fuels, or from process sources that lead to the direct emission of GHGs
- Total combustion emissions were 196 MMT CO₂e and were primarily from gathering and boosting, natural gas processing, onshore production, and natural gas transmission compression
- Total process emissions were 117 MMT CO₂e and were primarily from onshore production, gathering and boosting, natural gas processing, and natural gas distribution



Process Emission Sources



- The figure to the left shows total reported process emissions across all Petroleum and Natural Gas Systems facilities
- The largest reported process emission sources were pneumatic devices, acid gas removal units, other flare stacks, and miscellaneous equipment leaks.



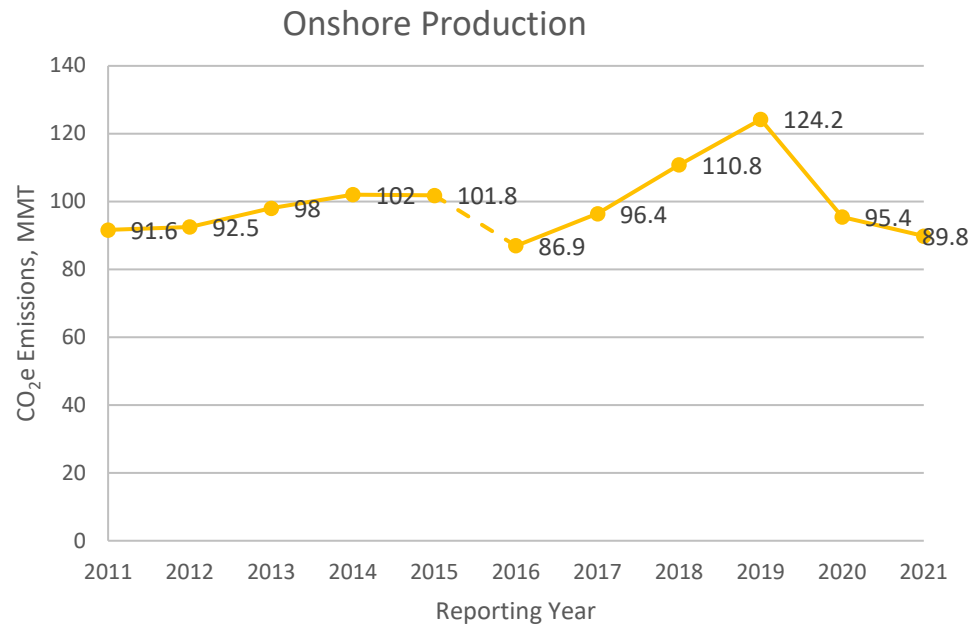
Reported Emissions by Segment: 2016-2021

Industry Segment ³¹²	2016 Reported Emissions (MMT CO ₂ e)	2017 Reported Emissions (MMT CO ₂ e)	2018 Reported Emissions (MMT CO ₂ e)	2019 Reported Emissions (MMT CO ₂ e)	2020 Reported Emissions (MMT CO ₂ e)	2021 Reported Emissions (MMT CO ₂ e)
Onshore Production	87	96	111	124	95	90
Offshore Production	7.4	7.2	7.5	7.3	6.5	6.4
Gathering and Boosting	76	76	81	88	86	86
Natural Gas Processing	56	56	57	61	59	59
Natural Gas Transmission Compression	23	24	28	31	30	33
Natural Gas Transmission Pipeline	3.2	2.7	3.1	2.9	3.5	2.8
Underground Natural Gas Storage	1.5	1.5	1.5	1.5	1.2	1.2
LNG Import/Export	3.3	3.8	6.8	10	11	14
LNG Storage	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Natural Gas Distribution	14	14	13	13	13	12
Other Oil and Gas Combustion	6.2	6.9	8.6	8.1	7.7	7.4
Total	278	288	317	347	314	312

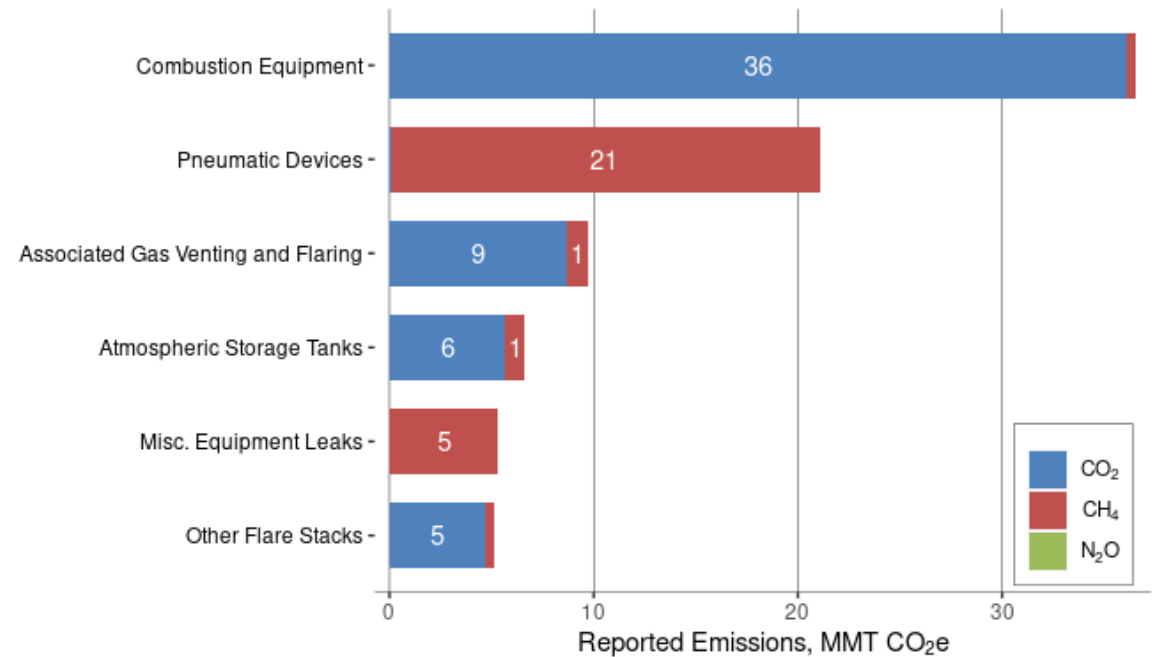


Subpart W – Onshore Production

- RY 2021 reported emissions from onshore production totaled 90 MMT CO₂e
- Methane emissions totaled 34 MMT CO₂e and carbon dioxide emissions totaled 56 MMT CO₂e
- The top reported emission sources were combustion equipment, pneumatic devices and associated gas venting and flaring.

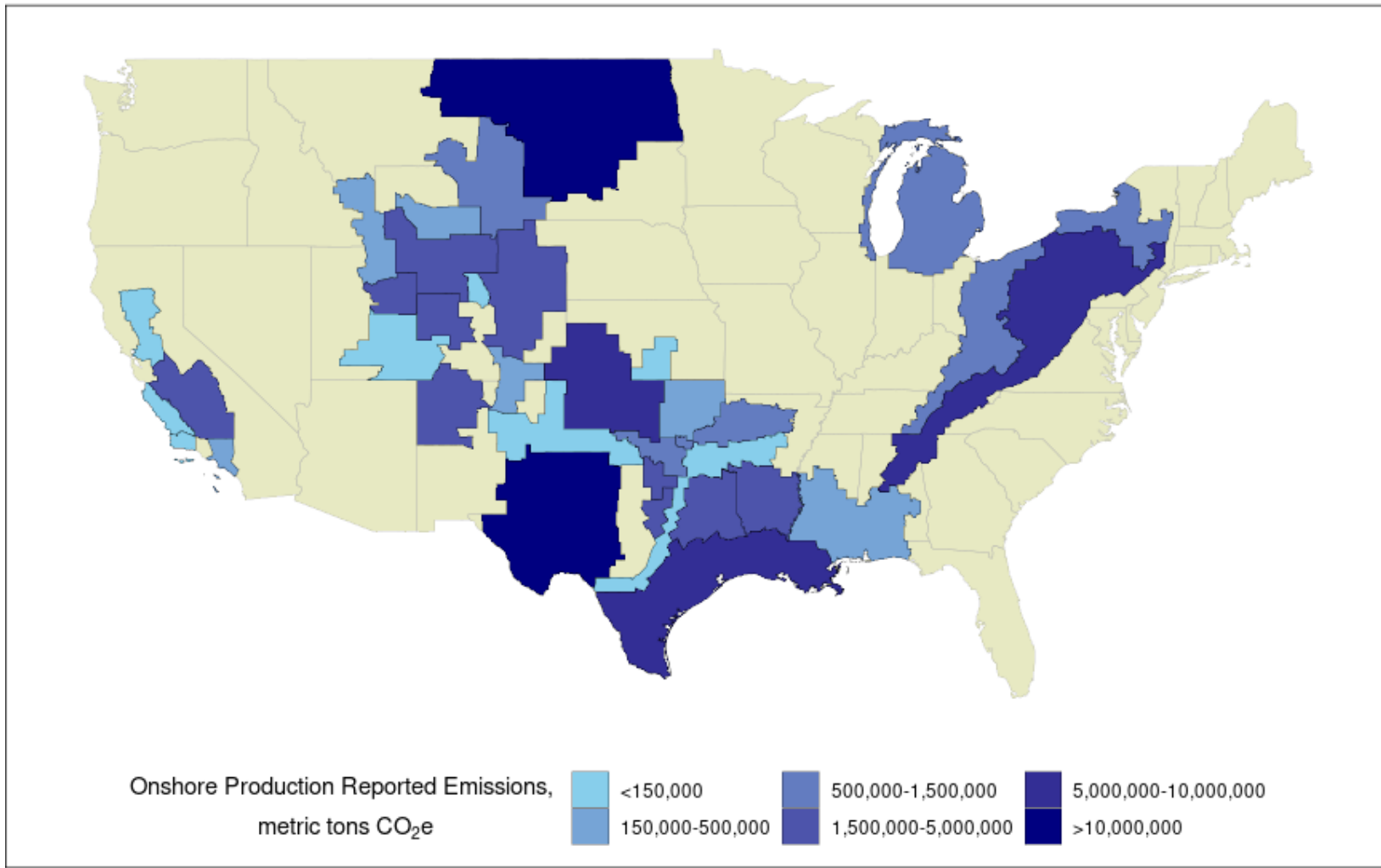


2021 Top Reported Emission Sources



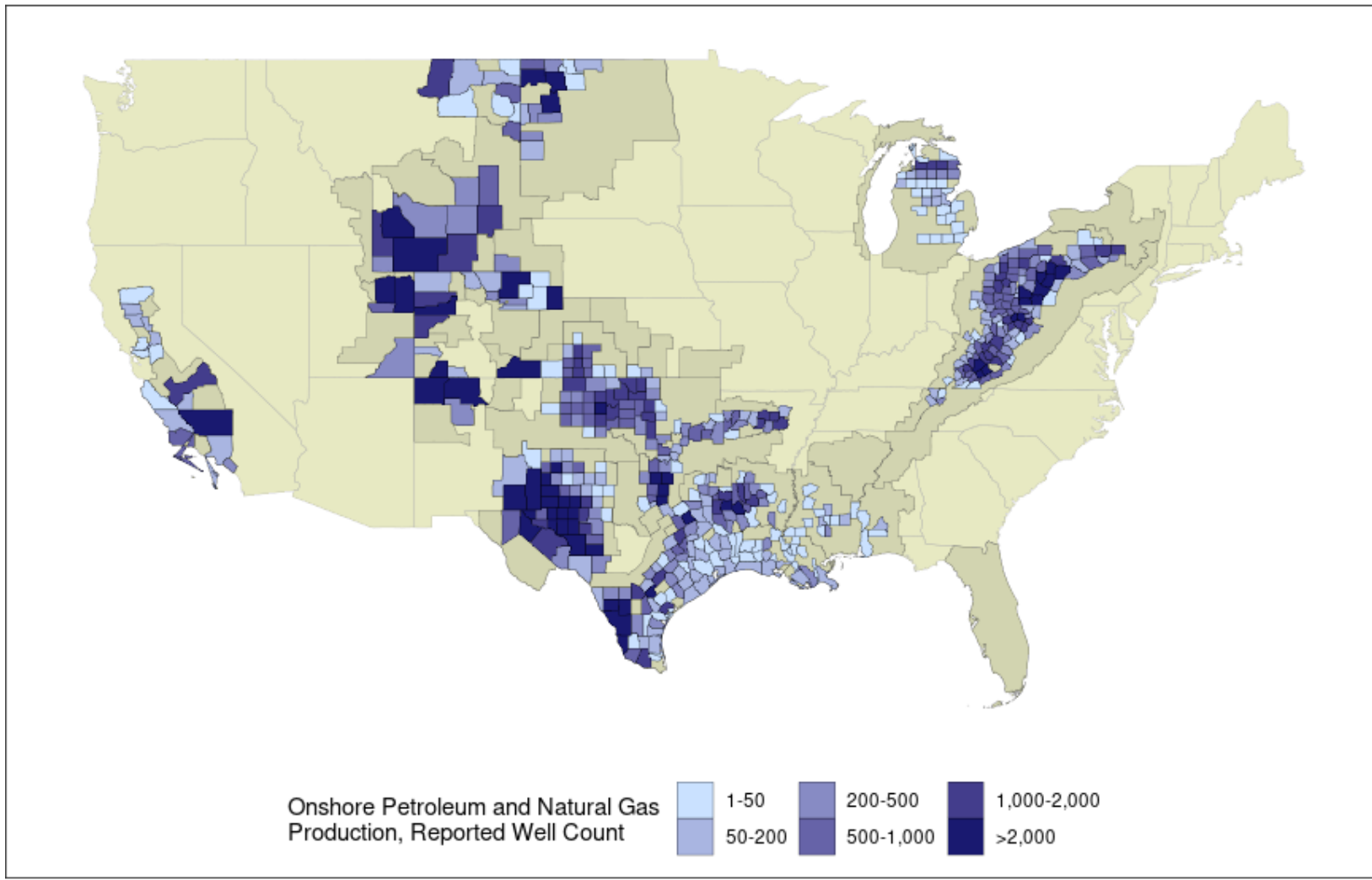


Onshore Production Emissions by Basin





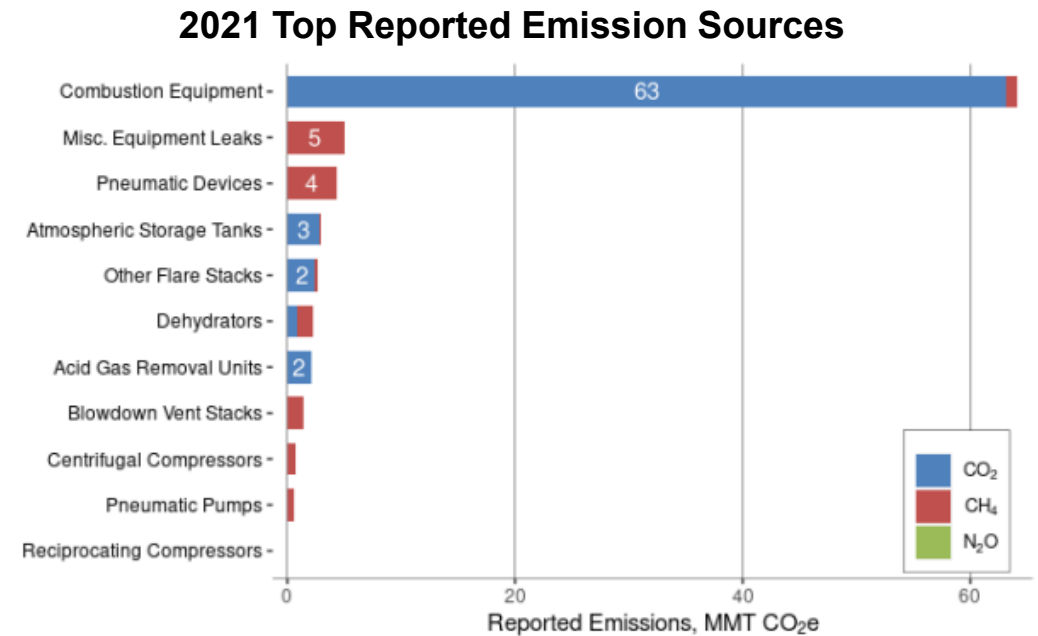
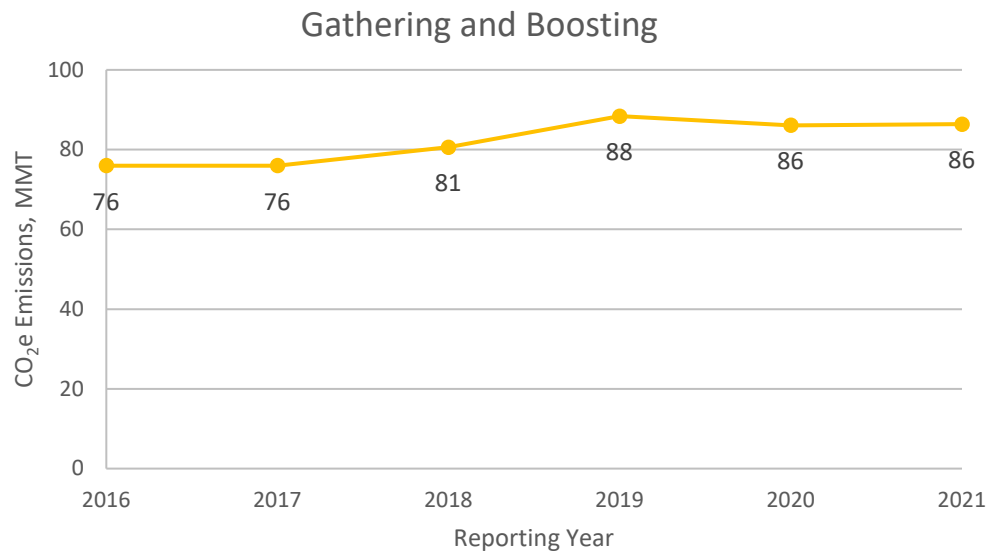
Onshore Production Well Count by County





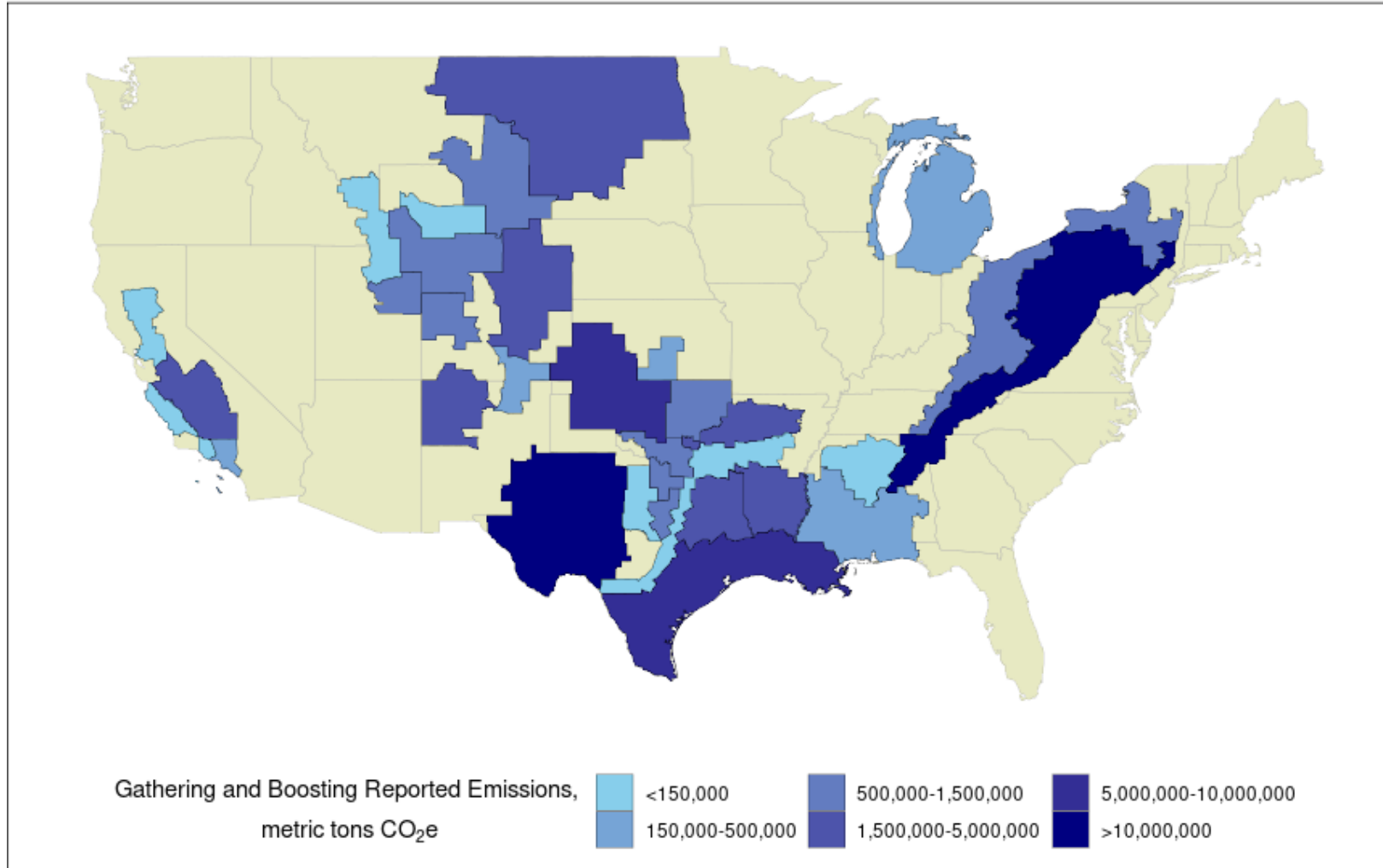
Subpart W - Gathering and Boosting

- The gathering and boosting segment was first reported in 2016
- RY 2021 reported emissions from gathering and boosting totaled 86.4 MMT CO₂e
- Methane emissions totaled 14.9 MMT CO₂e and carbon dioxide emissions totaled 71.5 MMT CO₂e
- The top reported emission sources were combustion equipment, miscellaneous equipment leaks, pneumatic devices and atmospheric storage tanks.





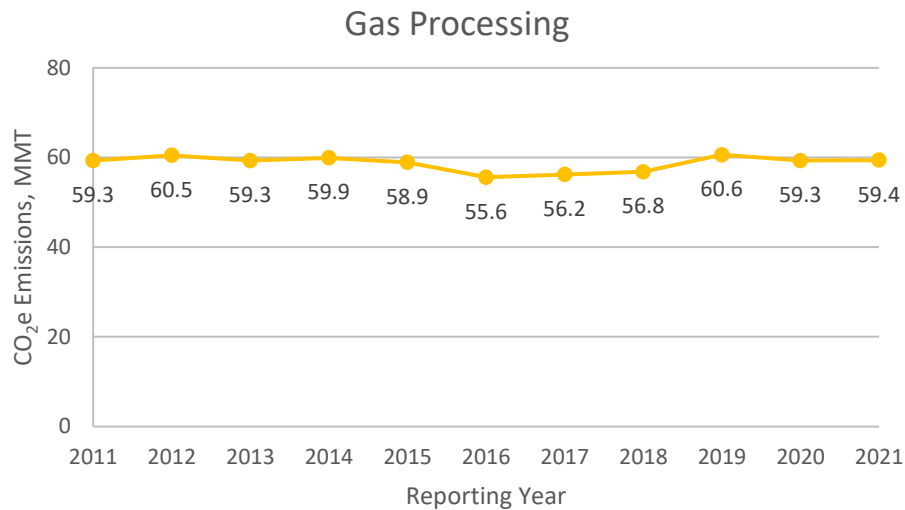
Gathering and Boosting Emissions by Basin



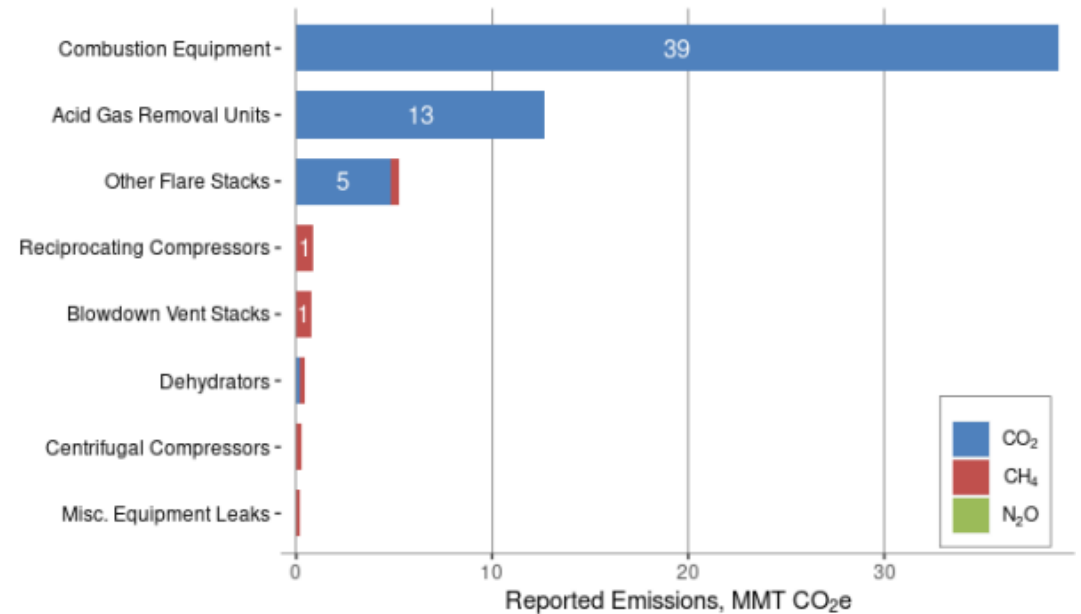


Subpart W – Gas Processing

- RY 2021 reported emissions from gas processing totaled 59.4 MMT CO₂e
- Methane emissions totaled 2.8 MMT CO₂e and carbon dioxide emissions totaled 56.6 MMT CO₂e
- The top reported emission sources were combustion equipment, acid gas removal units and other flare stacks.



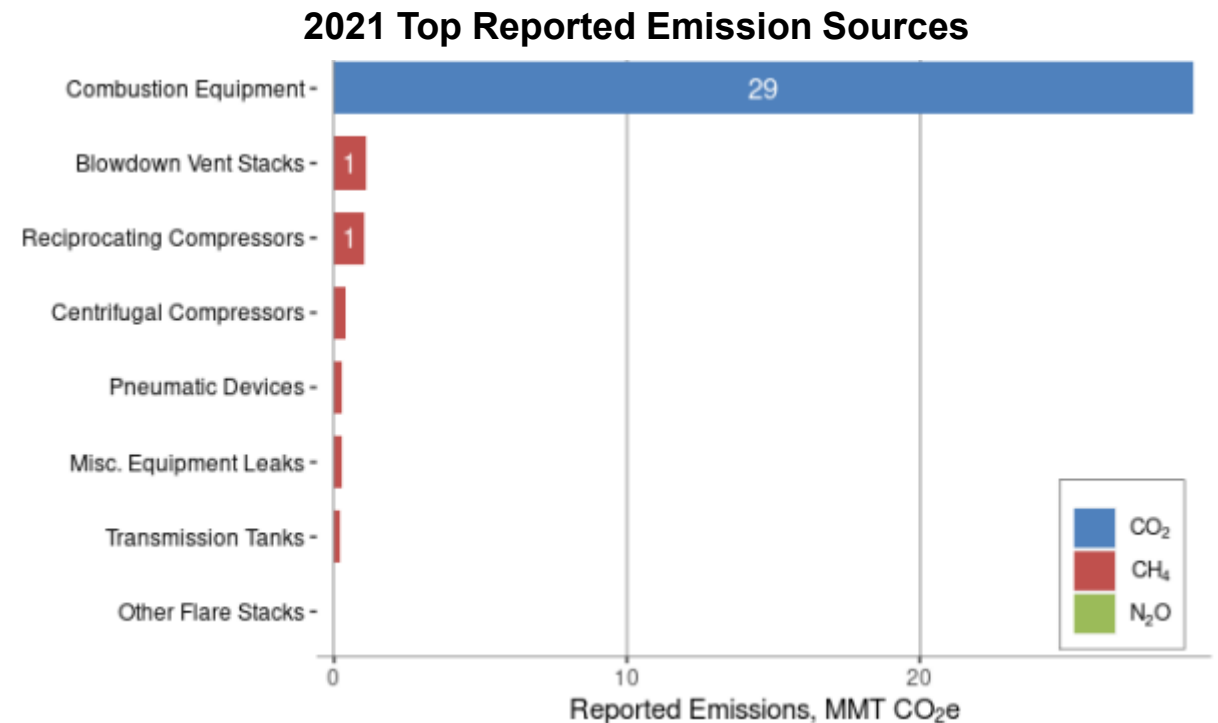
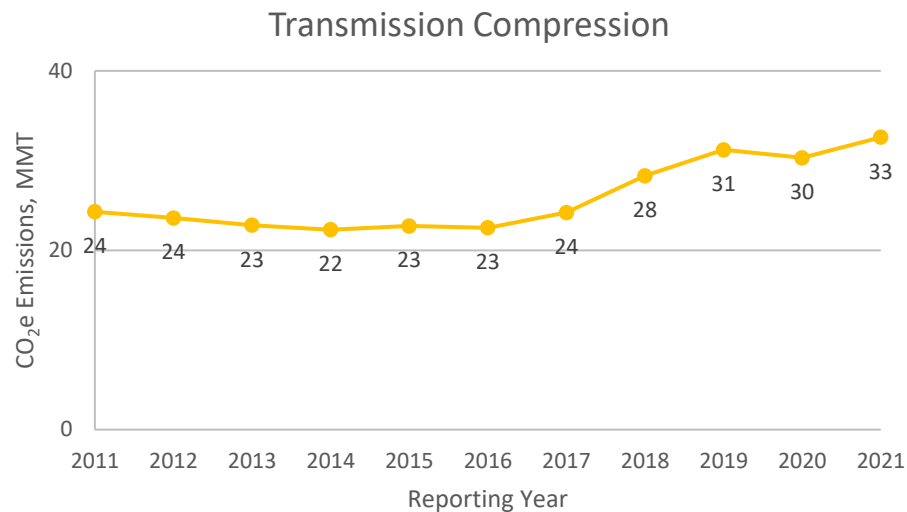
2021 Top Reported Emission Sources





Subpart W – Transmission Compression

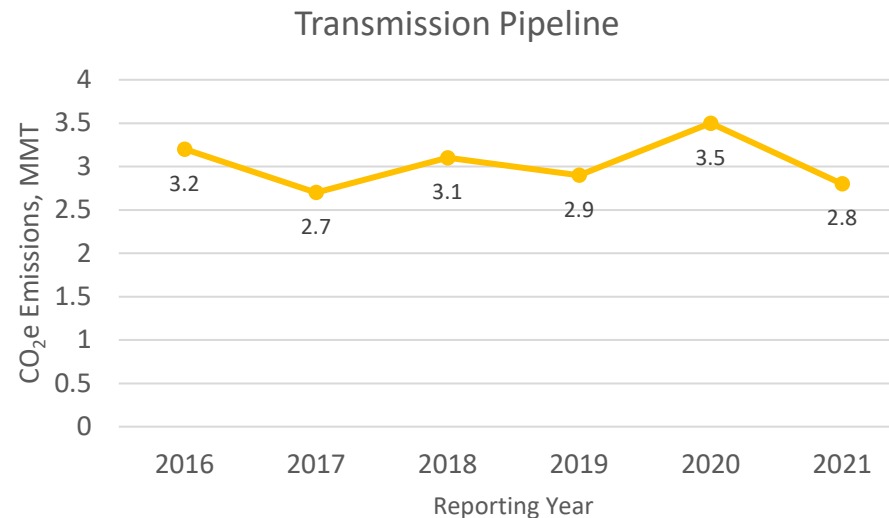
- RY 2021 reported emissions from natural gas transmission compression totaled 32.6 MMT CO₂e
- Methane emissions totaled 3.3 MMT CO₂e and carbon dioxide emissions totaled 29.4 MMT CO₂e
- The top reported emission sources were combustion equipment, blowdown vent stacks and reciprocating compressors.





Subpart W – Transmission Pipeline

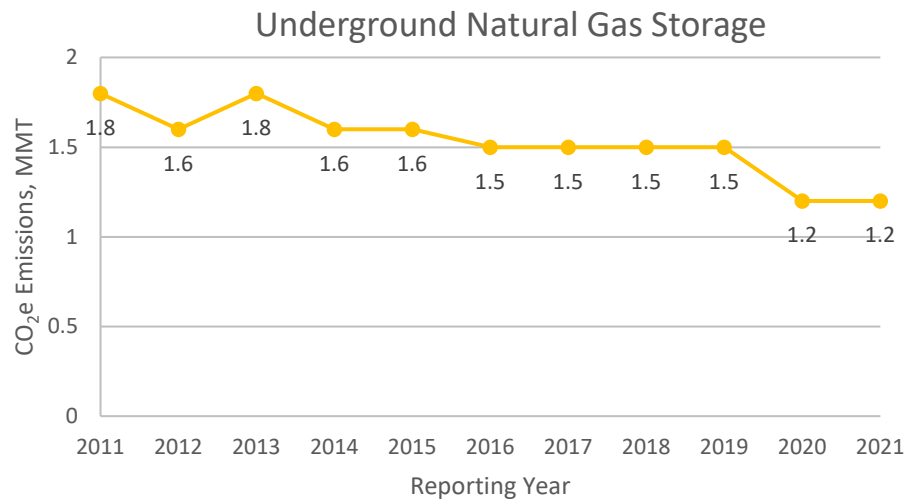
- The transmission pipeline segment was first reported in 2016
- The segment contains one reported emission source, blowdown vent stacks
- RY 2021 reported emissions from transmission pipelines totaled 2.6 MMT CO₂e
- Methane emissions totaled 2.6 MMT CO₂e and carbon dioxide emissions totaled 0.003 MMT CO₂e



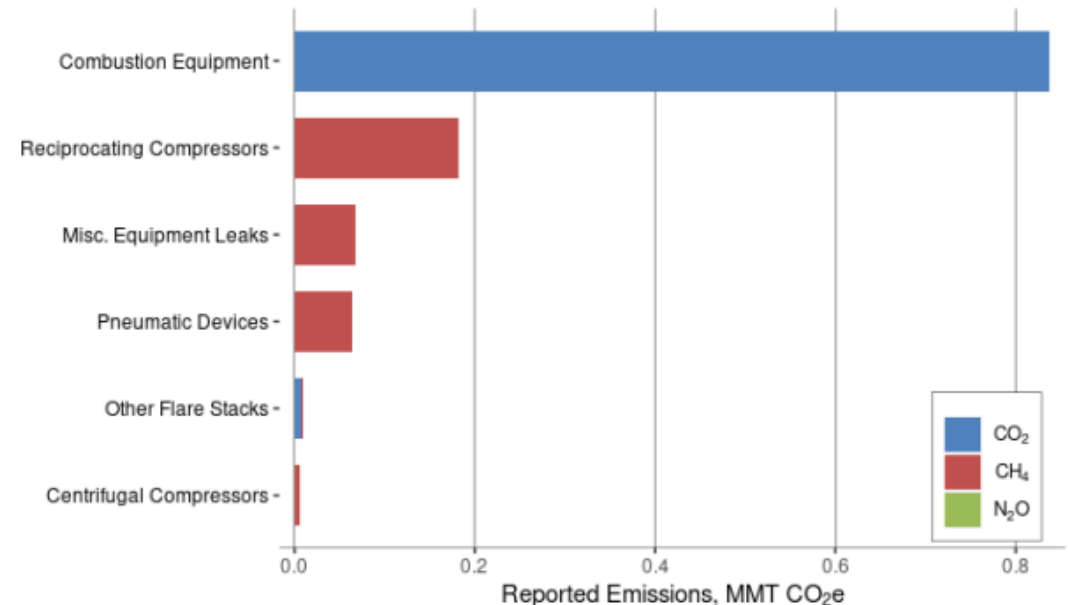


Subpart W – Underground Natural Gas Storage

- RY 2021 reported emissions from underground natural gas storage totaled 1.2 MMT CO₂e
- Methane emissions totaled 0.3 MMT CO₂e and carbon dioxide emissions totaled 0.8 MMT CO₂e
- The top reported emission sources were combustion equipment followed by reciprocating compressors.

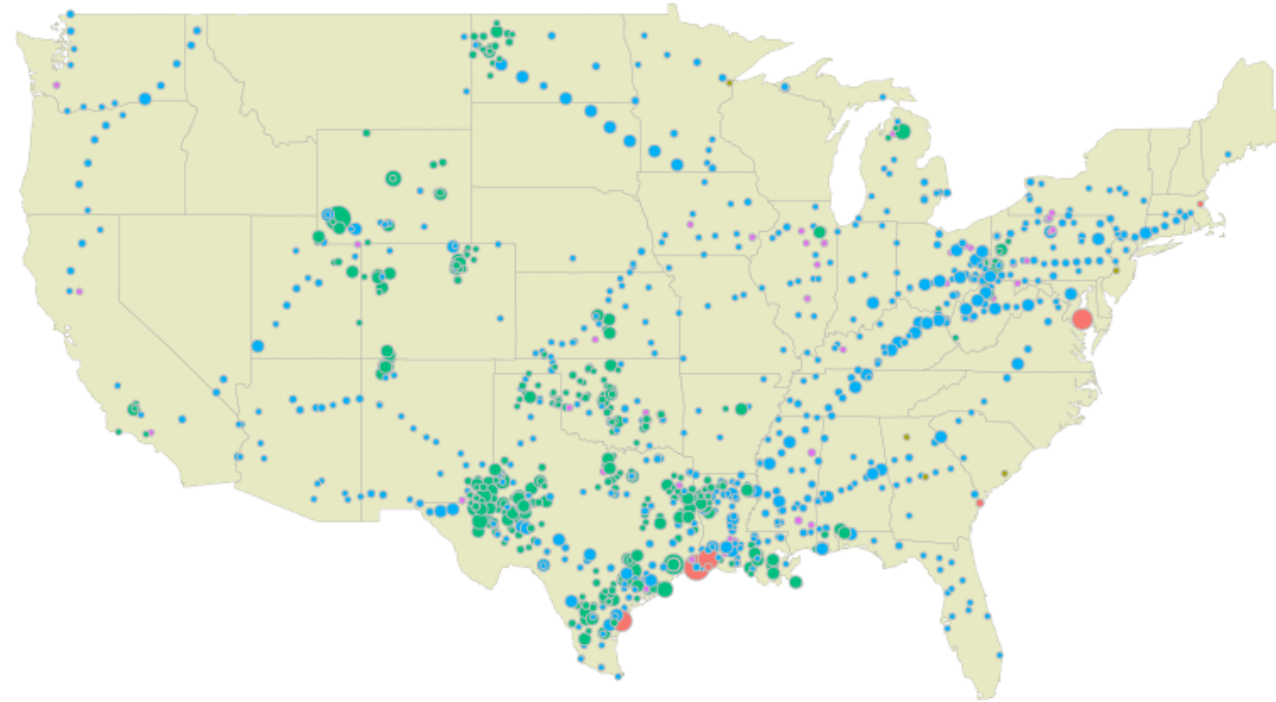


2021 Top Reported Emission Sources





Facility Locations and Reported Emissions by Industry Sector



Industry Segment

- LNG Import/Export
- LNG Storage
- Natural Gas Processing
- Natural Gas Transmission Compression
- Underground Natural Gas Storage

Total Reported Emissions, metric tons CO₂e

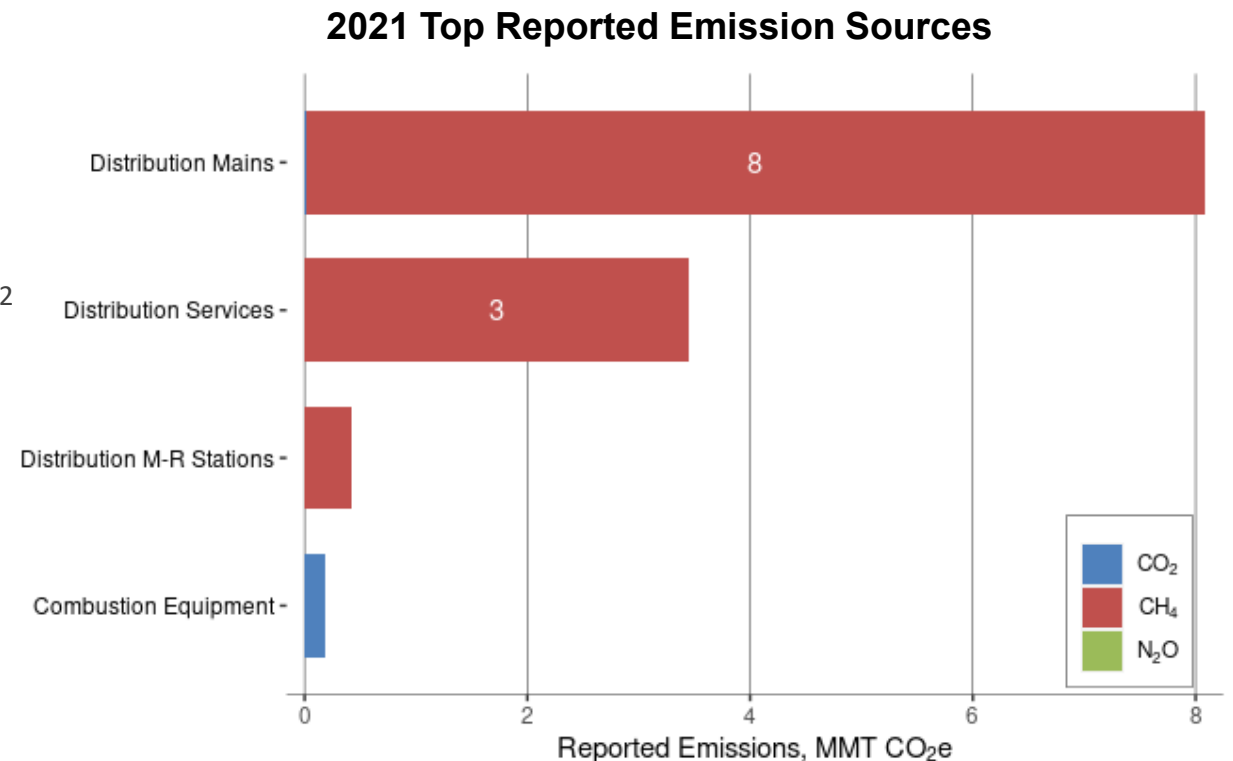
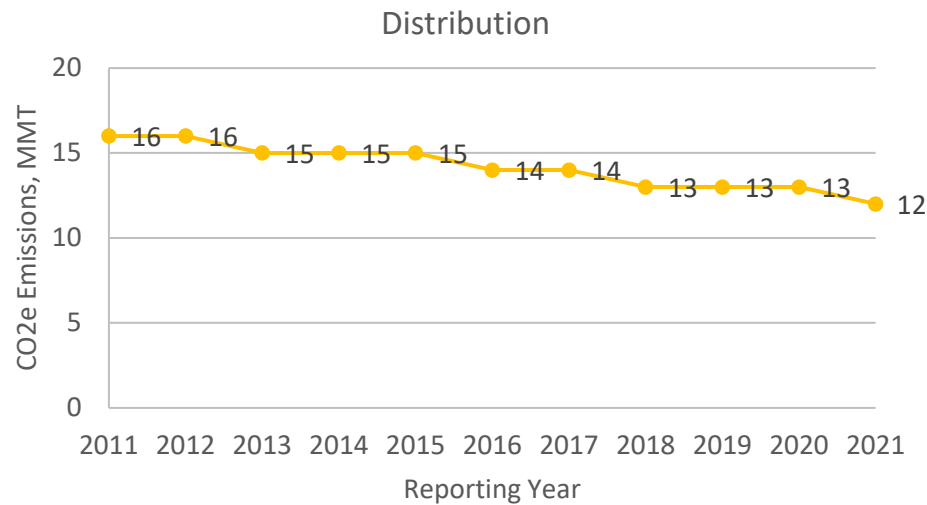
- 0-50,000
- 50,000-100,000
- 100,000-500,000
- 500,000 - 1,000,000
- 1,000,000-3,000,000
- >3,000,000

GHGRP data as of 8/12/22



Subpart W – Natural Gas Distribution

- RY 2021 reported emissions from underground natural gas storage totaled 12.1 MMT CO₂e
- Methane emissions totaled 11.9 MMT CO₂e and carbon dioxide emissions totaled 0.2 MMT CO₂e
- The top reported emission sources were emissions from distribution mains and services





For More Information



Resources – GHG Inventory

- Main report and csv tables for full time series for each table:
<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>
- Natural Gas and Petroleum Systems Stakeholder Information:
<https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems>
- Gridded GHG Inventory:
 - Website: <https://www.epa.gov/ghgemissions/gridded-2012-methane-emissions>
 - Data Download (.nc files with daily, monthly, and annual data):
<https://www.epa.gov/ghgemissions/gridded-2012-methane-emissions#data>



GHGRP Data Access – Subpart W

- EPA has several data portals to access data collected by the GHGRP on Petroleum and Natural Gas Systems
- EPA’s easy-to-use Facility Level Information on GreenHouse gas Tool (FLIGHT) allows users to view GHG data from Petroleum and Natural Gas Systems in a variety of ways
 - View GHG data reported by individual facilities
 - Aggregate reported emissions based on industry segment or geographic level
 - Search for facilities by name, location, corporate parent, or NAICS code
 - Visit FLIGHT: <http://ghgdata.epa.gov/ghgp>
- Detailed non-CBI data is available on Envirofacts
 - Access GHG data on Envirofacts: <https://enviro.epa.gov/query-builder/ghg>



Other GHGRP Resources

- GHGRP Subpart W website:
<http://www.epa.gov/ghgreporting/subpart-w-petroleum-and-natural-gas-systems>
- GHGRP Help Desk: GHGReporting@epa.gov
- GHGRP Support Site:
<https://ccdsupport.com/confluence/display/help/Subpart+W+-+Petroleum+and+Natural+Gas+Systems>
 - Subpart W Reporting form available at this site