Greenhouse Gas Reporting Program: Petroleum and Natural Gas Systems 2011 Data Summary

U.S. Environmental Protection Agency
Office of Atmospheric Programs, Climate Change Division
February 27, 2013

Introduction

- In February 2013, EPA released greenhouse gas (GHG) data for Petroleum and Natural Gas Systems collected under the Greenhouse Gas Reporting Program (GHGRP) from the 2011 reporting year
- These data represent a significant step forward in better understanding greenhouse gas emissions from petroleum and natural gas systems
- EPA is working to improve the quality of data from this sector and expects that the GHGRP will be an important tool for the Agency and the public to analyze emissions, identify opportunities for improving the data, and understand emissions trends
- In this presentation, we will provide a summary of the reported data

Background on Petroleum and Natural Gas Systems in the Greenhouse Gas Reporting Program

Overview of GHGRP

- Program launched in response to FY 2008 Consolidated Appropriations Act
- Annual reporting of GHGs by 41 source categories
  - 33 types of direct emitters
  - 6 types of suppliers of fuel and industrial GHGs
  - Facilities that inject CO_2 underground for geologic sequestration, enhanced oil recovery, or any other purpose
- 25,000 metric tons CO_2 equivalent (MT CO_2e) or more per year reporting threshold for most sources
- Most source categories began collecting data in 2010, with first annual reports submitted to EPA in September 2011
  - An additional 12 source categories began collecting data in 2011, with first annual reports submitted to EPA in September 2012
- Reporting only, no control or use requirements

Source Categories Covered by GHGRP

Power	Refining & Petrochem	Other Chemicals	Combustion	Waste	Metals	Minerals	Pulp & Paper	High GWP Gases
- Electricity Generation - Electrical Equipment Mfg. - Electrical Equipment Use	- Petroleum Refineries - Petrochem. Production	- Adipic Acid - Ammonia - Hydrogen Production - Nitric Acid - Phosphoric Acid - Titanium Dioxide	- Stationary Combustion	- Industrial Waste Landfills - Industrial Wastewater Treatment - MSW Landfills	- Aluminum - Ferroalloy - Iron & Steel - Lead - Magnesium - Silicon Carbide - Zinc	- Cement - Glass - Lime - Misc. Carbonate Use - Soda Ash	- Pulp & Paper	- 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
- Onshore Production - Offshore Production - Natural Gas Processing - Natural Gas Transmission/Compression - Natural Gas Distribution - Underground Natural Gas Storage - Liquefied Natural Gas Storage - Liquefied Natural Gas Import/Export	- Coal-Based Liquid Fuels Suppliers - Natural Gas and Natural Gas Liquids Suppliers - Petroleum Product Suppliers	- Geologic Sequestration of CO_2 - Injection of CO_2 - CO_2 Suppliers	- Underground Coal Mines

Direct Emitters
Suppliers
CO_2 Injection

How Does GHG Reporting Program Relate to US GHG Inventory?

- Inventory of GHG Emissions and Sinks – annual report submitted to UNFCCC
  - "Top Down" approach: aggregated national data by sectors
  - Estimates based on data from variety of sources
  - Covers all man-made US GHG emission sources and sinks

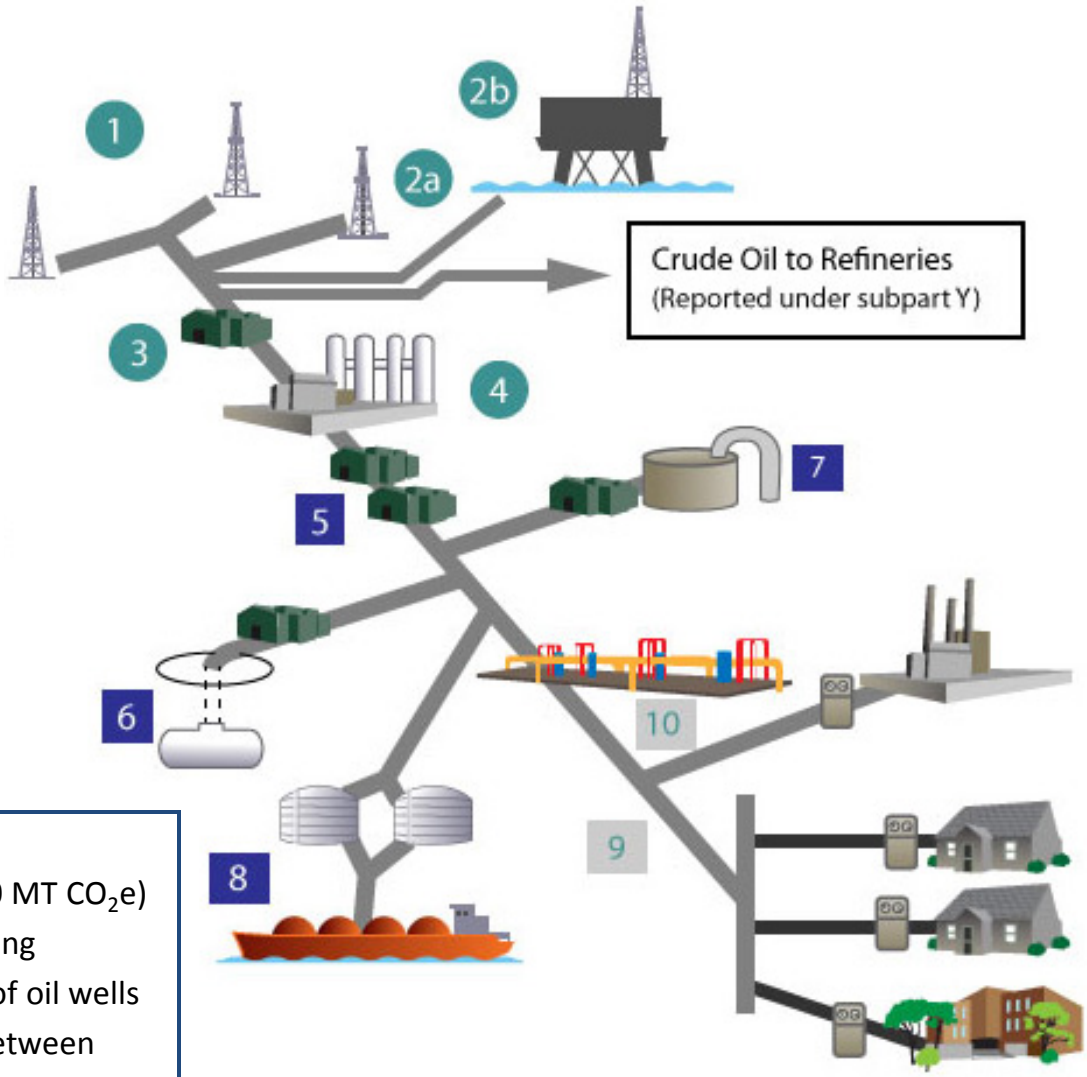
- Greenhouse Gas Reporting Program
  - "Bottom Up" approach: facility-level data above threshold
  - Geographic data collected
  - Additional data collected on facilities
  - Covers a subset of US GHG emissions

Petroleum and Natural Gas Systems in GHGRP (Subpart W)

Production and Processing
1. Onshore Production
2a, 2b. Offshore Production
3. Gathering and Boosting (not covered by Subpart W)
4. Natural Gas Processing

Transmission and Storage
5. Natural Gas Transmission
6. Underground Natural Gas Storage
7. LNG Storage
8. LNG Import-Export

Distribution
9, 10. Natural Gas Distribution



Not Covered

- Emissions below reporting threshold (25,000 MT CO_2e)
- Process emissions from gathering and boosting
- Vented emissions from hydraulic fracturing of oil wells
- Process emissions from transmission lines between compressor stations

Figure adapted from American Gas Association and EPA Natural Gas STAR Program

How to Access GHGRP Data on Petroleum and Natural Gas Systems

- 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
- A downloadable file of the reported Petroleum and Natural Gas Systems 2011 data is available on the GHGRP website
  - EPA also plans to make detailed data available in EPA's Envirofacts tool
  - Access GHG data sets: http://www.epa.gov/ghgreporting/ghgdata/2011data.html

Important Notes about the GHGRP Data for Petroleum and Natural Gas Systems

- There is a reporting threshold and the GHGRP data does not cover certain emission sources from Petroleum and Natural Gas Systems
- 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
- EPA made available the optional use of Best Available Monitoring Methods (BAMM) for unique or unusual circumstances
  - We will discuss BAMM in more detail later in this presentation
- Because of the nature of the petroleum and natural gas industry, there can be variation in emissions from facility to facility
- Data shown in this presentation reflects the most recent resubmitted reports from facilities as of January 16, 2013

Reported GHG Emissions from Petroleum and Natural Gas Systems

Reported GHG Emissions by Industry Segment

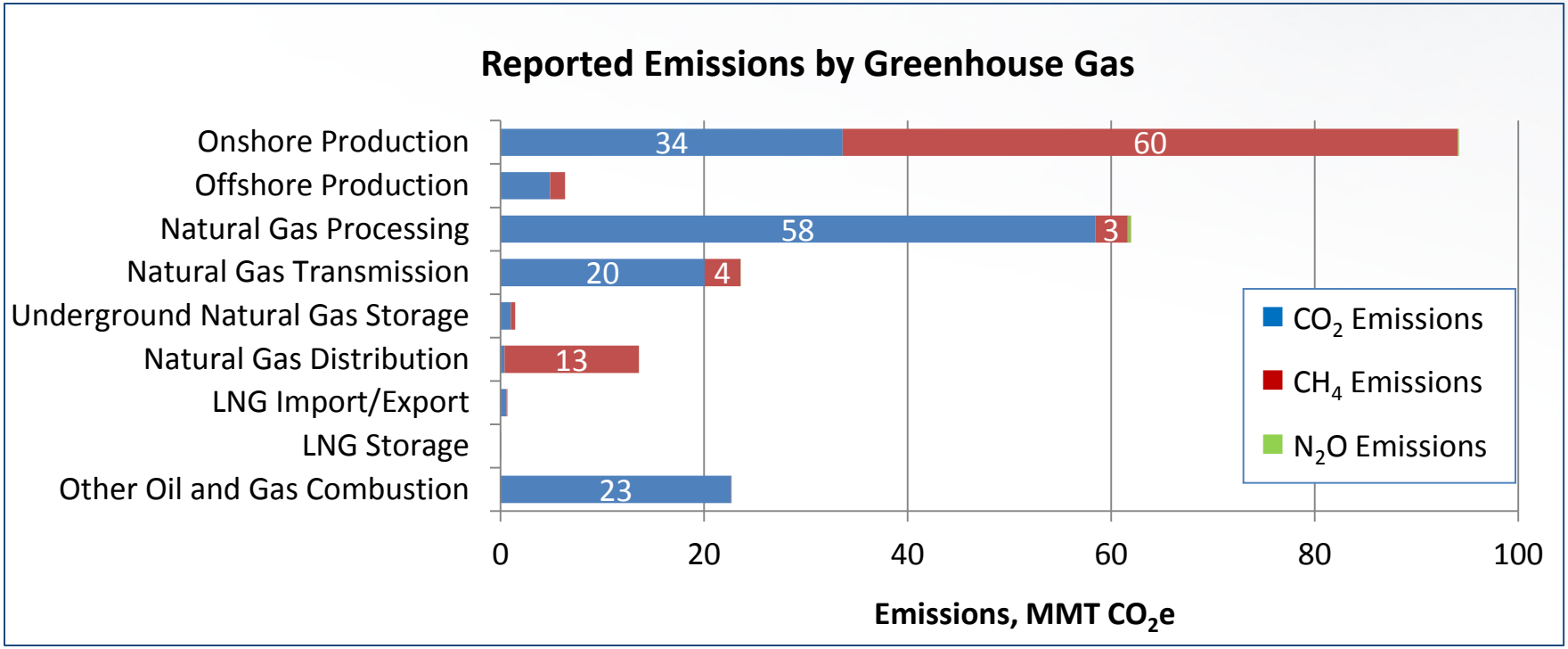
- EPA received reports from over 1,800 facilities
- Reported emissions totaled 225 Million Metric Tons (MMT) CO_2e
- Largest segments in terms of reported GHG emissions were onshore production, natural gas processing, and natural gas transmission

Segment	Number of Facilities	Reported Emissions (Million Metric Tons CO_2e)
Onshore Production	448	94
Offshore Production	99	6
Natural Gas Processing	372	62
Natural Gas Transmission	424	24
Underground Natural Gas Storage	44	1
Natural Gas Distribution	168	14
LNG Import/Export	7	1
LNG Storage	5	< 1
Other Oil and Gas Combustion	331	23
Total	**1,880**	**225**

Note: Total number of facilities is smaller than the sum of facilities from each segment because some facilities reported under multiple segments.

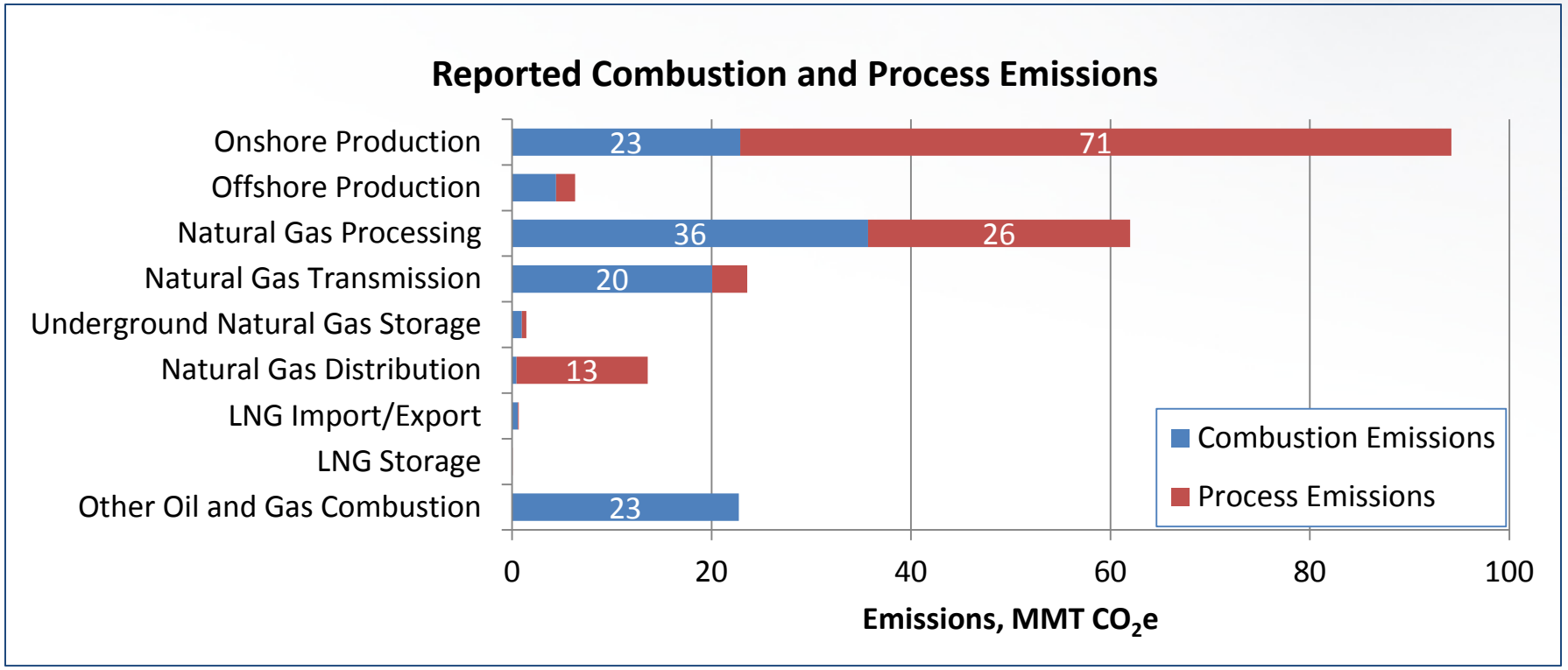
Reported Emissions by Greenhouse Gas

- CO_2 emissions accounted for 142 MMT CO_2e and methane emissions accounted for 82 MMT CO_2e
- Emissions from onshore production were primarily methane while emissions from natural gas transmission, natural gas processing, and other oil and gas combustion were primarily carbon dioxide



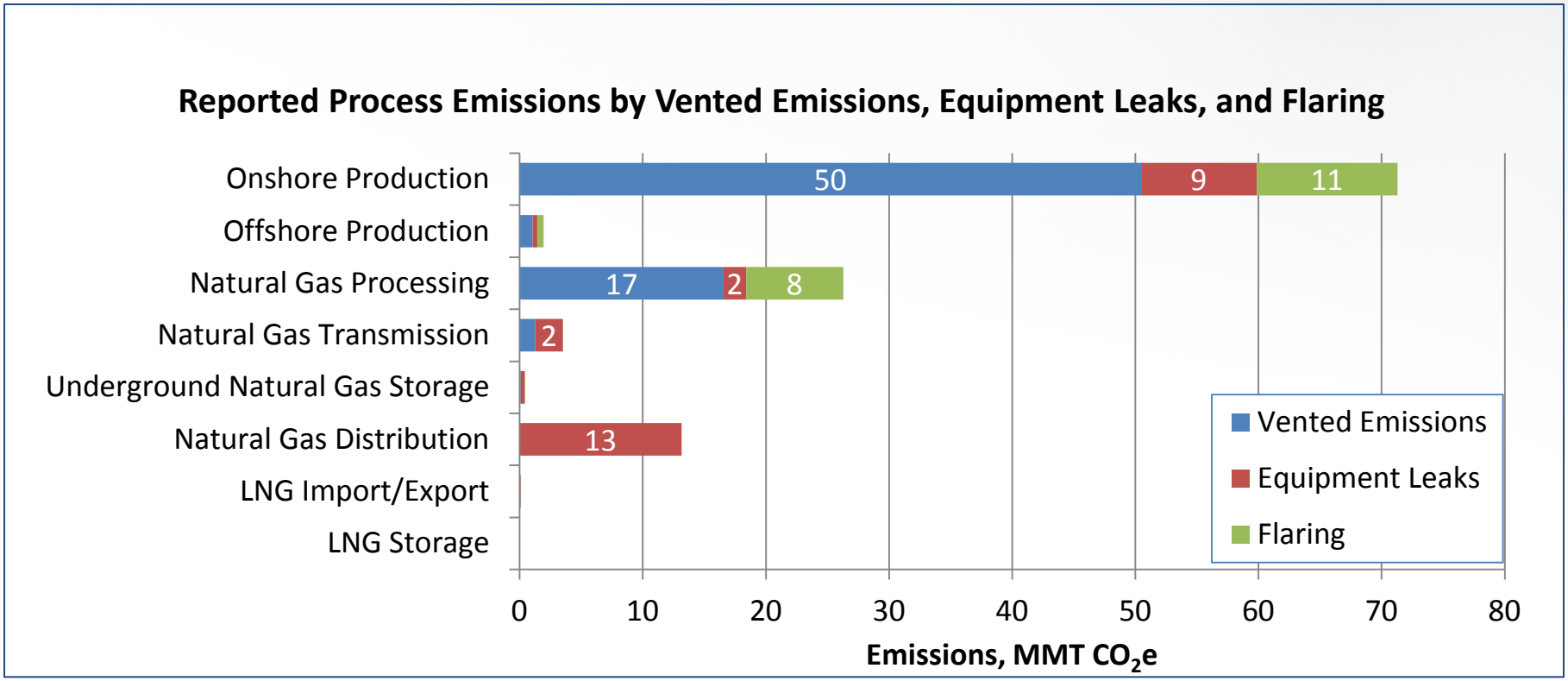
Reported Combustion and Process Emissions

- GHG emissions can result from combustion of fossil fuels, or from process sources that lead to the direct emission of GHGs
- Total process emissions were 117 MMT CO_2e and were primarily from onshore production, natural gas processing, and natural gas distribution
- Total combustion emissions were 108 MMT CO_2e and were primarily from natural gas processing, onshore production, natural gas transmission, and other combustion.



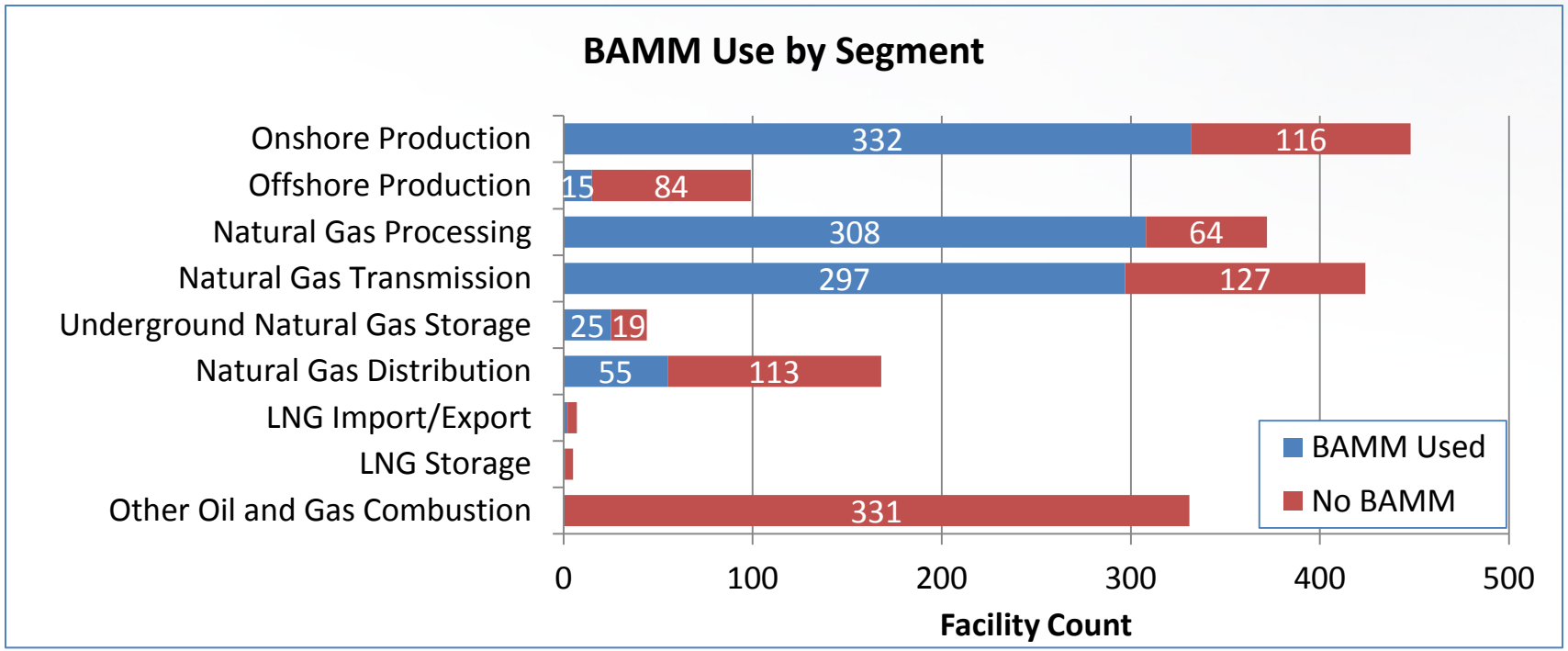
Reported Process Emissions by Type

- Process emissions may be further subdivided by type of process, such as vented emission sources, equipment leaks, and flaring
- Vented emissions totaled 69 MMT CO_2e, equipment leaks totaled 27 MMT CO_2e, and flaring totaled 20 MMT CO_2e



Best Available Monitoring Methods

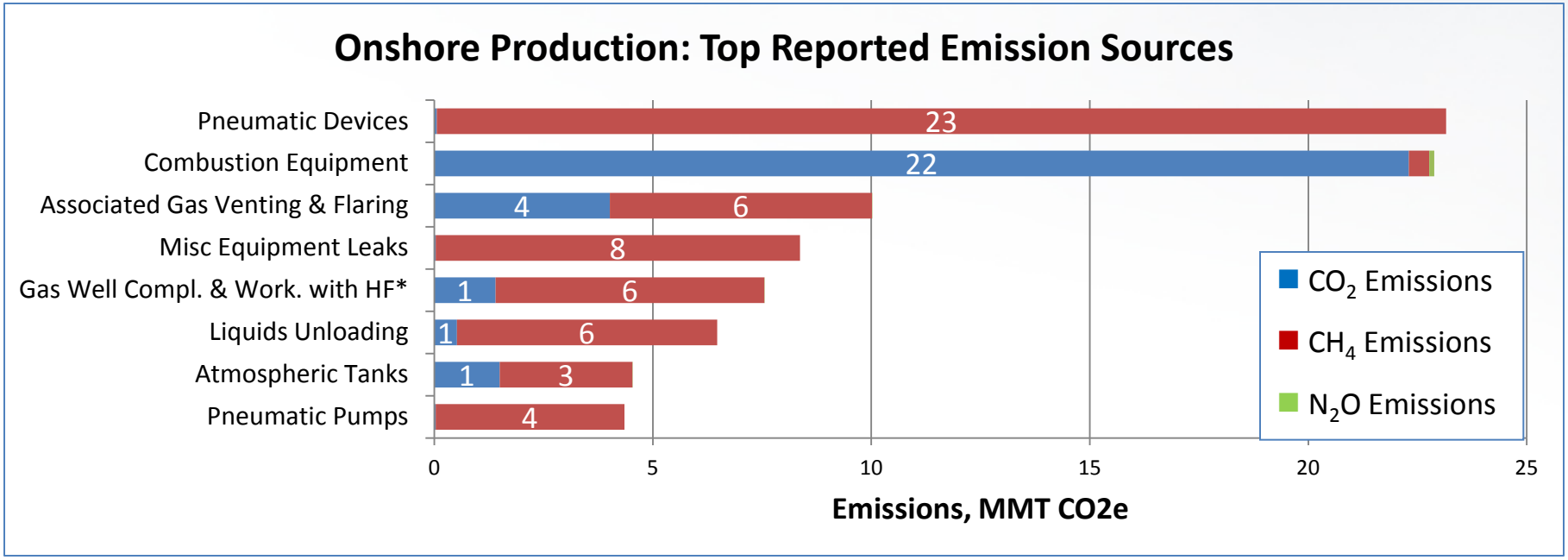
- EPA made available the optional use of Best Available Monitoring Methods (BAMM) for unique or unusual circumstances
- Where a facility used BAMM, it was required to follow emission calculations specified by the EPA, but was allowed to use alternative methods for determining inputs to calculate emissions
- 54% of facilities in petroleum and natural gas systems used BAMM in 2011
- It is not immediately apparent how the use of BAMM affected emissions



Reported GHG Emissions by Industry Segment and Source

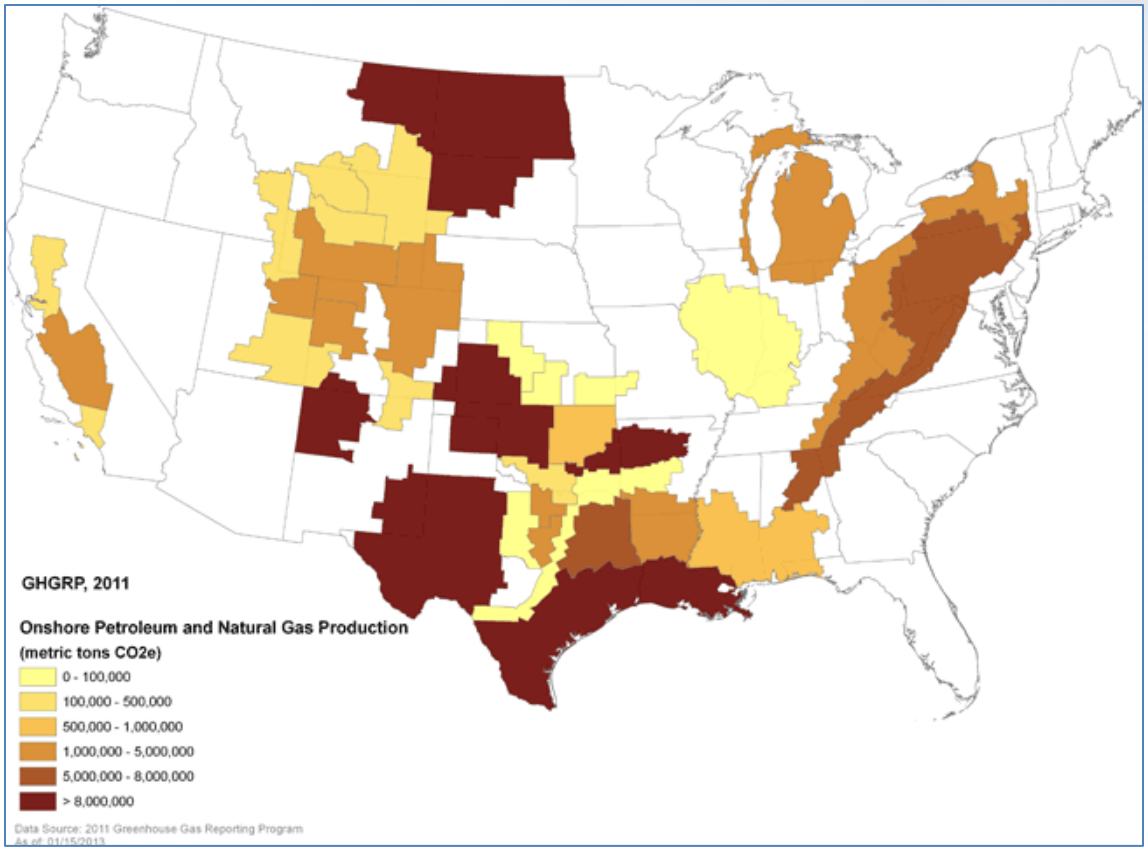
Onshore Production

- Reported emissions in onshore production totaled 94 MMT CO_2e
- Pneumatic devices (23.2 MMT CO_2e) and combustion equipment (22.9 MMT CO_2e) were the top reported emission sources in onshore production
- Emissions in onshore production were primarily methane (60.4 MMT CO_2e)



**Abbreviation for Gas Well Completions and Workovers with Hydraulic Fracturing*

Onshore Production Basins



- Emissions in onshore production are reported by basin*
- The map to the left shows reported emissions aggregated for all onshore production facilities by basin
- The basins with highest reported emissions were the Anadarko Basin (10.7 MMT CO_2e) and San Juan Basin (9.6 MMT CO_2e)

**For the onshore production segment, the "facility" includes all emissions associated with wells owned or operated by a single company in a specific hydrocarbon producing basin. A basin refers to a geologic region where sediment infilling has occurred. The GHG Reporting Program definition of basin refers to the geologic provinces as published by the American Association of Petroleum Geologists (AAPG).*

Gas Well Completions and Workovers with Hydraulic Fracturing

- 224 onshore production facilities reported emissions from gas well completions and workovers with hydraulic fracturing, which totaled 7.6 MMT CO_2e
- 144 of those facilities reported using BAMM to calculate emissions from gas well completions and workovers
- GHGRP calculation methods allow facilities to measure or estimate the backflow rate in order to report emissions using an engineering calculation, or the backflow vent or flare volume may be measured directly

Activity	Total Number	Number of RECs	Venting CO_2 (MT CO_2e)	Venting CH_4 (MT CO_2e)	Flaring CO_2 (MT CO_2e)	Flaring CH_4 (MT CO_2e)	Total Reported Emissions (MT CO_2e)
Gas Well Completions with Hydraulic Fracturing	9,811	4,296	23,854	5,186,272	1,250,742	532,893	6,994,497
Gas Well Workovers with Hydraulic Fracturing	1,868	539	1,641	439,555	127,004	2,503	570,783
Total	**11,679**	**4,835**	**25,495**	**5,625,827**	**1,377,746**	**535,396**	**7,565,280**

REC = Reduced Emission Completion
MT CO_2e = metric tons CO_2 equivalent

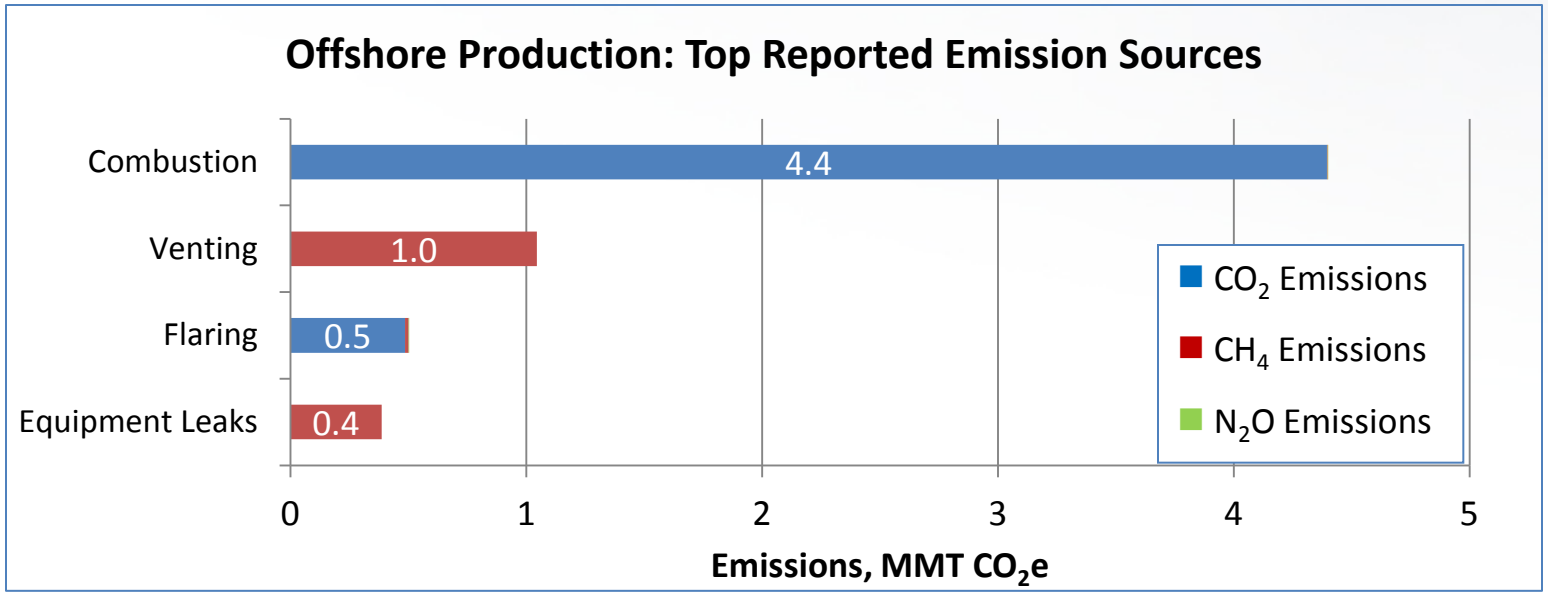
Liquids Unloading

- 246 facilities reported emissions for liquids unloading, which totaled 6.5 MMT CO_2e
- 167 of those facilities reported using BAMM to calculate emissions for liquids unloading
- GHGRP calculation methods give facilities the option of using representative sampling based on direct measurement or engineering calculations to estimate emissions

Calculation Method	Number of Wells Venting During Liquids Unloading	Number of Wells Equipped With Plunger Lifts	CO_2 Emissions (MT CO_2e)	CH_4 Emissions (MT CO_2e)	Total Reported Emissions (MT CO_2e)
Method 1: Direct Measurement of Representative Well Sample	8,800	7,173	65,615	2,602,058	2,667,673
Method 2: Engineering Calculation for Wells without Plunger Lifts	24,940	N/A	393,616	1,501,695	1,895,311
Method 3: Engineering Calculation for Wells with Plunger Lifts	35,555	35,555	57,906	1,849,656	1,907,562
Total	**69,295**	**42,728**	**517,137**	**5,953,409**	**6,470,546**

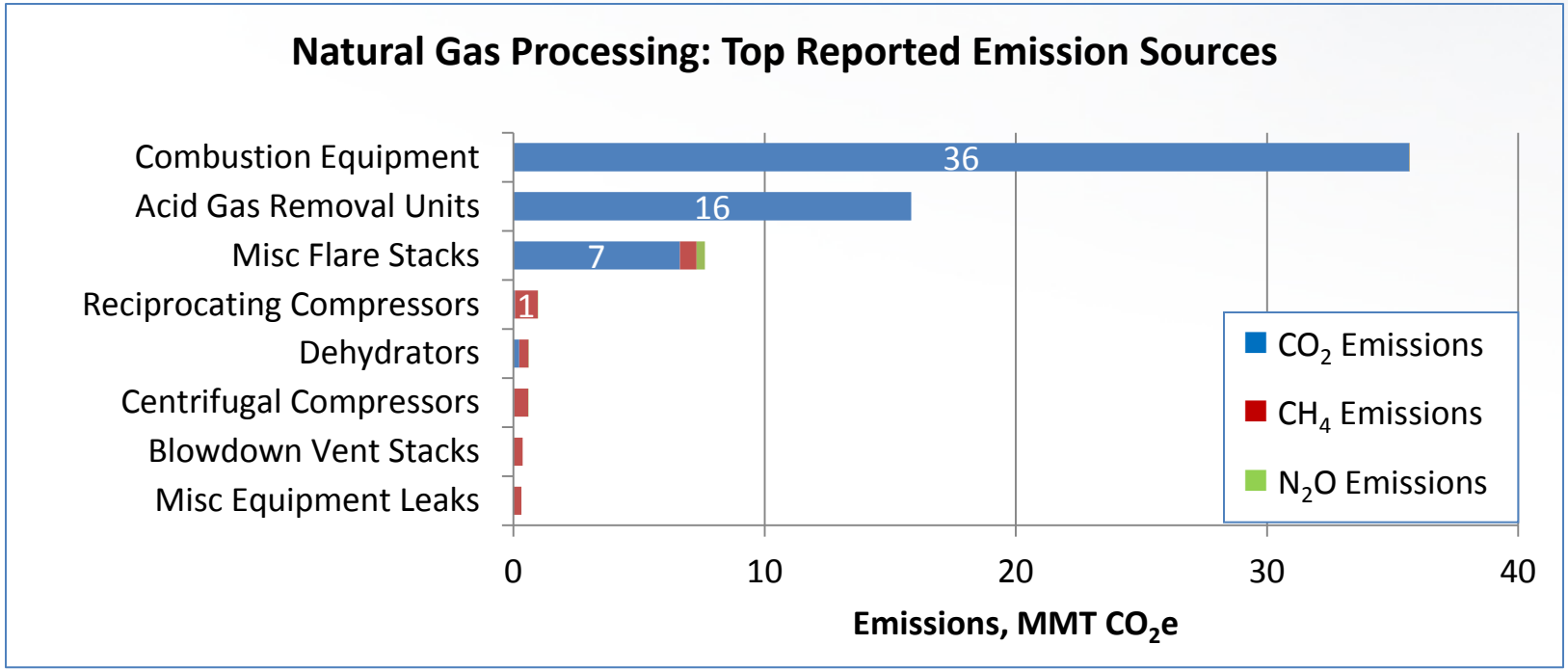
Offshore Production

- Reported emissions from offshore production totaled 6.3 MMT CO_2e
- The top reported emission source was combustion equipment (4.4 MMT CO_2e)
- GHGRP calculation methods for process emissions are based on requirements that were established by the Bureau of Ocean Energy Management (BOEM)



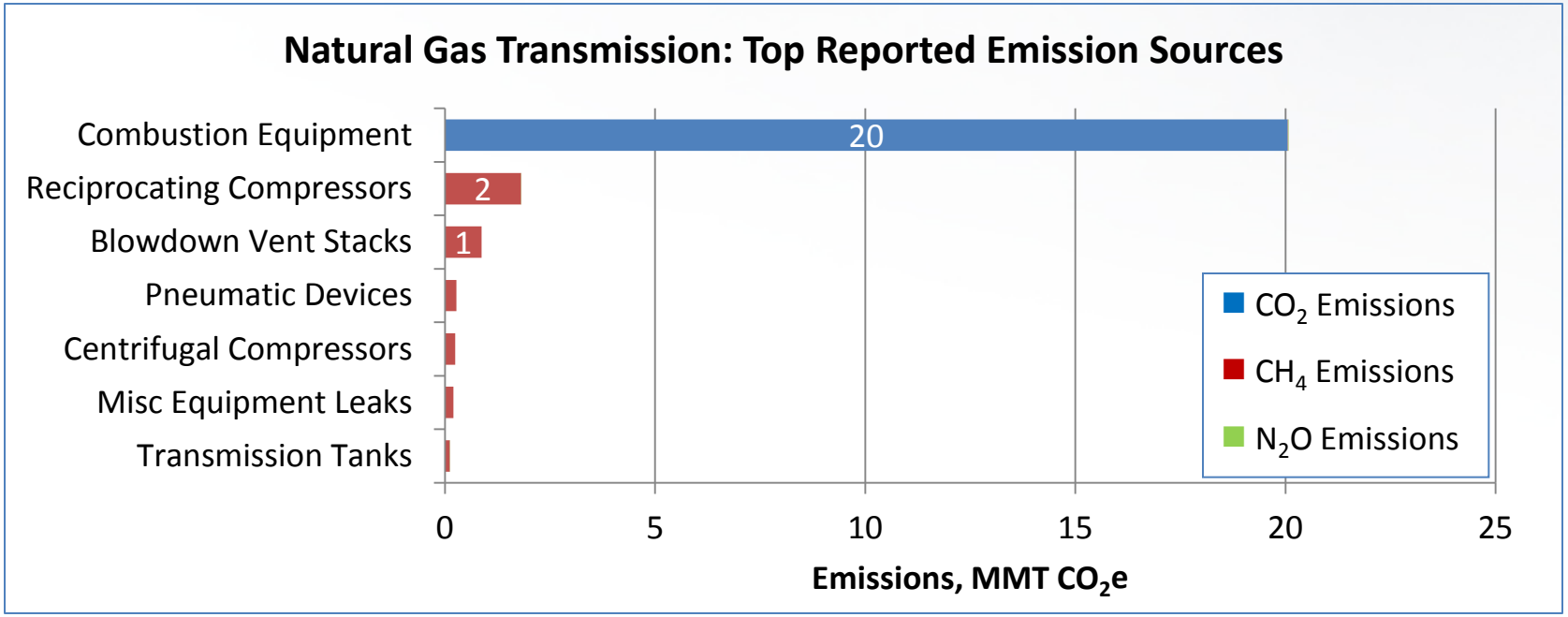
Natural Gas Processing

- Reported emissions from natural gas processing totaled 62.0 MMT CO_2e
- The top reported emission sources were combustion equipment (35.7 MMT CO_2e), acid gas removal units (15.8 MMT CO_2e), and miscellaneous flare stacks (7.6 MMT CO_2e)
- Reported emissions were primarily CO_2 (58.4 MMT CO_2e)



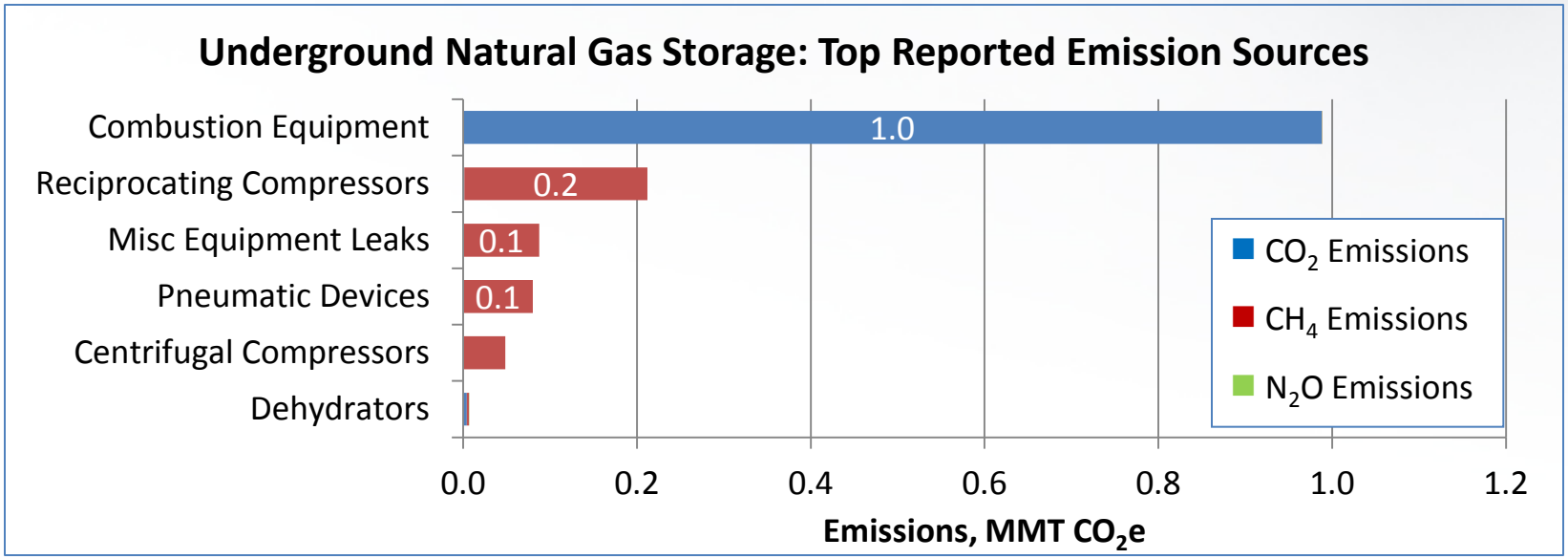
Natural Gas Transmission

- Reported emissions from natural gas transmission totaled 23.6 MMT CO_2e
- Top reported emission source was combustion equipment (20.1 MMT CO_2e)
- Reported emissions were primarily CO_2 (20.0 MMT CO_2e)



Underground Natural Gas Storage

- Reported emissions from underground natural gas storage totaled 1.4 MMT CO_2e
- The top reported emission source was combustion equipment (1.0 MMT CO_2e)



Reciprocating Compressors

- Downstream (all segments excluding production) reported process emissions from reciprocating compressors were 3.1 MMT CO_2e
- Reciprocating compressors in natural gas transmission were the largest emission contributor with 1.8 MMT CO_2e followed by natural gas processing with 1.0 MMT CO_2e
- 64% of reciprocating compressors used BAMM to calculate emissions, including 70% BAMM use for natural gas processing and 60% BAMM use for natural gas transmission

Industry Segment	Total Number of Reciprocating Compressors	Number of Reciprocating Compressors that used BAMM	CO_2 Emissions (MT CO_2e)	CH_4 Emissions (MT CO_2e)	Total Reported Process Emissions (MT CO_2e)
Natural Gas Processing	1,992	1,402	55,768	959,727	1,015,740
Natural Gas Transmission	1,925	1,160	5,215	1,819,143	1,824,359
Underground Natural Gas Storage	268	143	1,506	213,839	215,344
LNG Import/Export	20	7	426	9,630	10,530
LNG Storage	4	2	1	1,164	1,164
Total	**4,209**	**2,714**	**62,915**	**3,003,502**	**3,067,138**

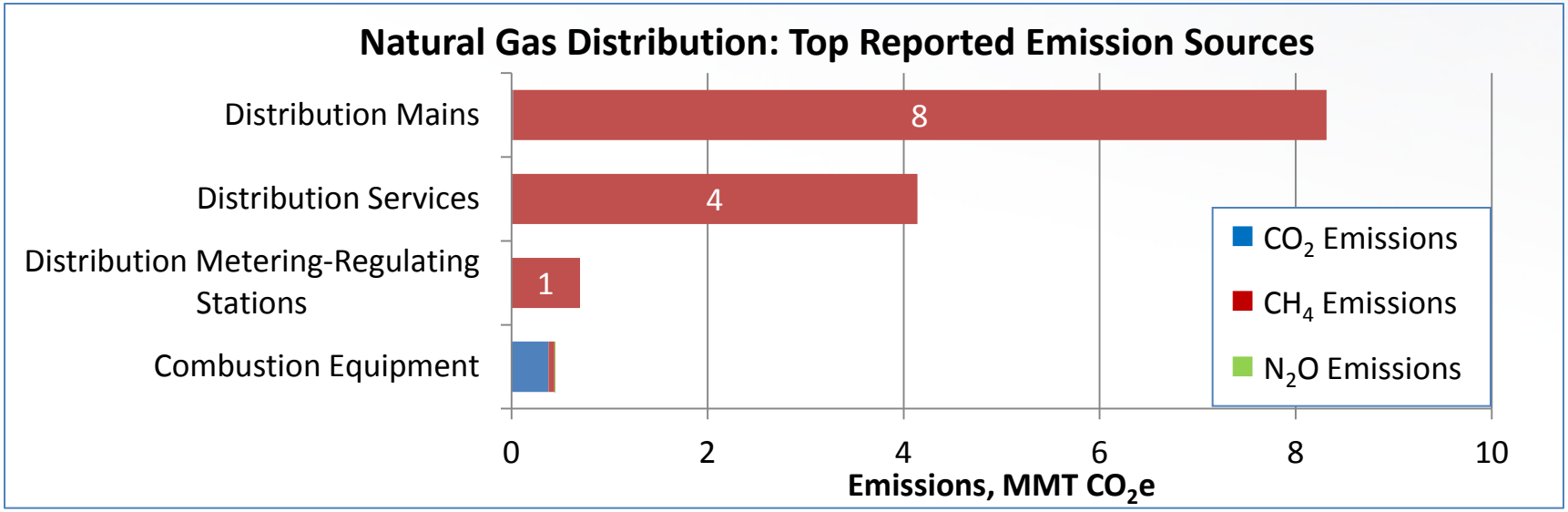
Centrifugal Compressors

- Downstream (all segments excluding production) reported process emissions from centrifugal compressors were 1.0 MMT CO_2e
- Centrifugal compressors in natural gas processing were the largest emission contributor with 0.6 MMT CO_2e followed by natural gas transmission with 0.2 MMT CO_2e
- Compressors with wet seals accounted for 48% of reported centrifugal compressors, with 75% of centrifugal compressors in natural gas processing having wet seals
- 59% of centrifugal compressors used BAMM to calculate emissions, including 73% BAMM use for natural gas processing and 47% for natural gas transmission

Industry Segment	Total Number of Centrifugal Compressors	Number of Centrifugal Compressors that used BAMM	Number of Centrifugal Compressors with Wet Seals	CO_2 Emissions (MT CO_2e)	CH_4 Emissions (MT CO_2e)	Total Reported Process Emissions (MT CO_2e)
Natural Gas Processing	424	309	319	21,213	614,524	635,850
Natural Gas Transmission	622	291	264	737	244,379	245,115
Underground Natural Gas Storage	33	30	26	64	48,486	48,550
LNG Import/Export	9	8	7	47	34,381	34,429
Total	**1,088**	**638**	**529**	**22,061**	**941,771**	**963,944**

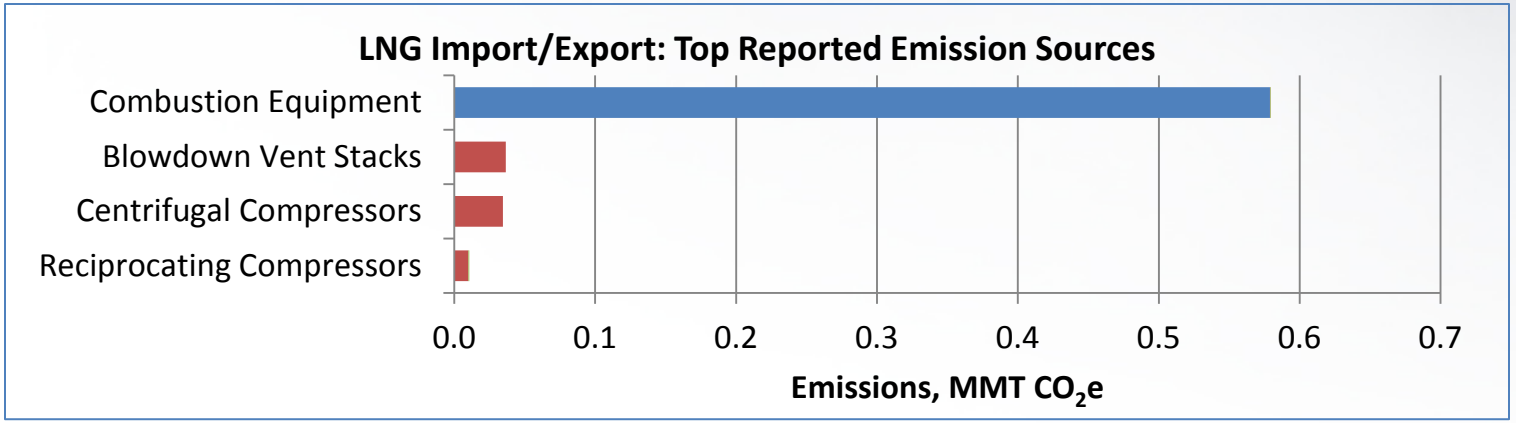
Natural Gas Distribution

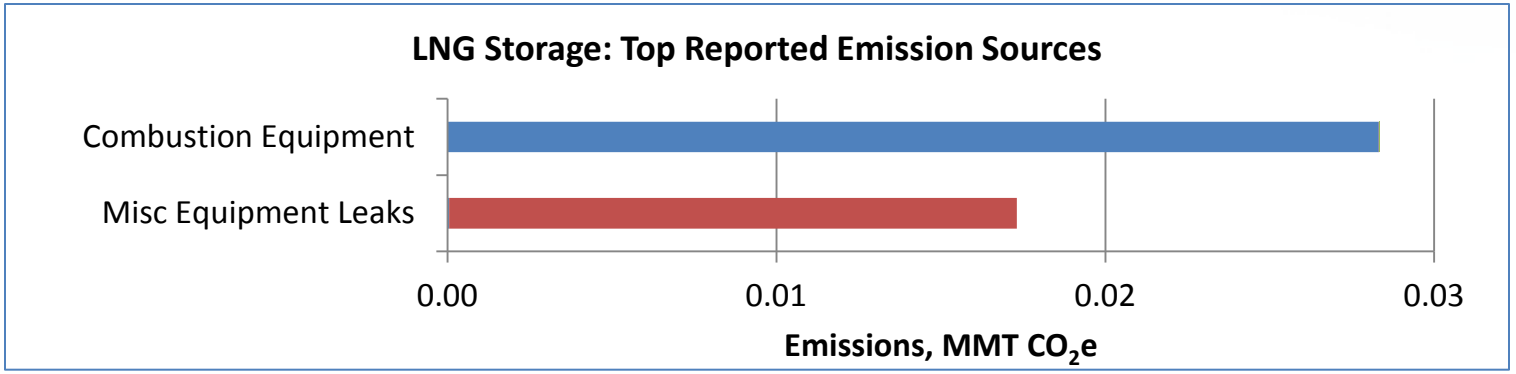
- Reported emissions from natural gas distribution totaled 13.6 MMT CO_2e
- Distribution mains (8.3 MMT CO_2e) and distribution services (4.1 MMT CO_2e) accounted for the majority of reported emissions
- Reported emissions from natural gas distribution were predominantly methane (13.2 MMT CO_2e)



LNG Import/Export and LNG Storage

- Reported emissions from LNG Import/Export totaled 0.67 MMT CO_2e
- Reported emissions from LNG storage totaled 0.05 MMT CO2e





Additional Information

- View and download GHGRP data:
  http://www.epa.gov/ghgreporting/ghgdata/index.html

- Petroleum and Natural Gas Systems in the GHGRP:
  http://www.epa.gov/ghgreporting/reporters/subpart/w.html

- Questions?
  Email: GHGReporting@epa.gov