Petroleum and Natural Gas Systems in GHG Reporting Program and U.S. GHG Inventory

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

Bill Irving
Alexis McKittrick

November 4, 2014

Greenhouse Gas Reporting Program

Overview of GHG Reporting 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
- 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
  - We now have 4 years of data for 29 source categories and 3 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

Overview of GHG Reporting Program

- An estimated 85-90 percent of the total U.S. GHG emissions from over 8,000 facilities are covered by the GHGRP.
- Reports are submitted annually on March 31 for emissions in the previous calendar year.
- Annual reports are submitted to EPA electronically using an electronic greenhouse gas reporting tool (e-GGRT).
- EPA verifies the data submitted and does not require third party verification.
- Emissions data are published through FLIGHT (ghgdata.epa.gov).

Source Categories Covered by GHG Reporting Program

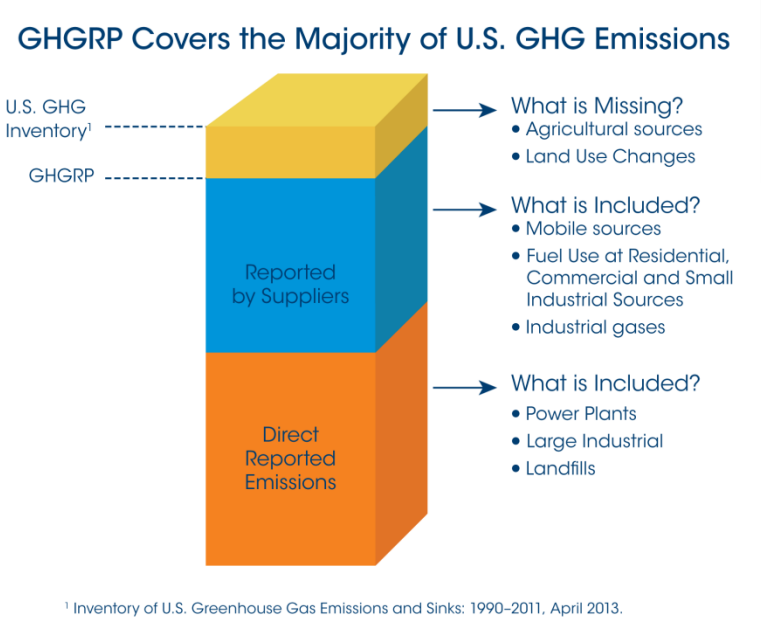
Power	Refining & Petrochem	Other Chemicals	Combustion	Waste	Metals	Minerals	Pulp & Paper	High GWP Gases
- Electricity Generation - Electrical Equipment Mfg. - Electrical Equipment Use	- Petroleum Refineries - Petrochem. Production	- Adipic Acid - Ammonia - Hydrogen Production - Nitric Acid - Phosphoric 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

GHG Reporting Program vs. US GHG Inventory

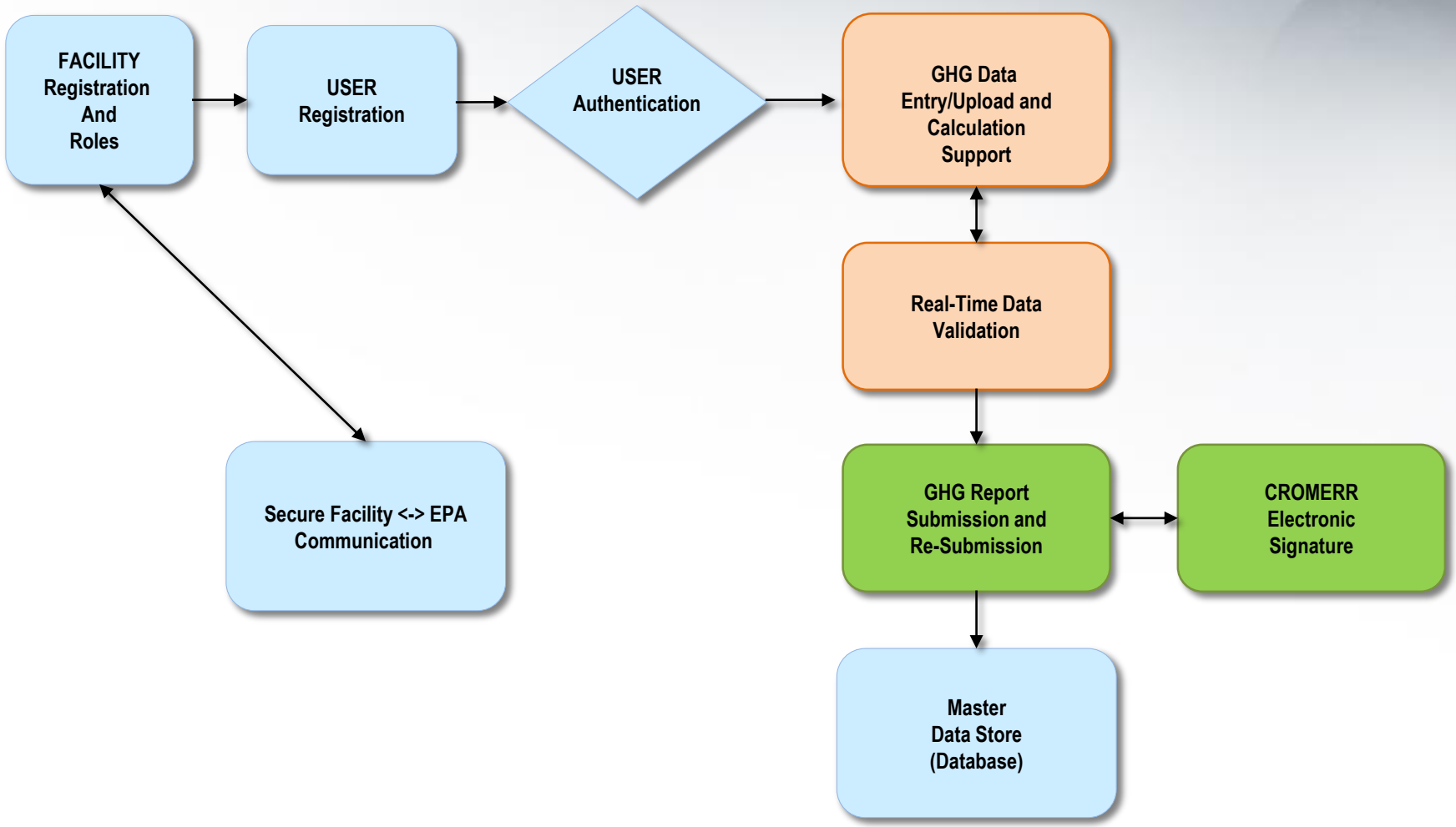
- Inventory of U.S. Greenhouse Gas Emissions and Sinks (Inventory) tracks total annual U.S. emissions across all sectors of the economy using national-level data
- GHGRP collects detailed emissions data from large greenhouse gas emitting facilities in the United States
  - GHGRP covers most, but not all, U.S. GHG emissions
  - GHGRP does not include agriculture, land use, and small sources



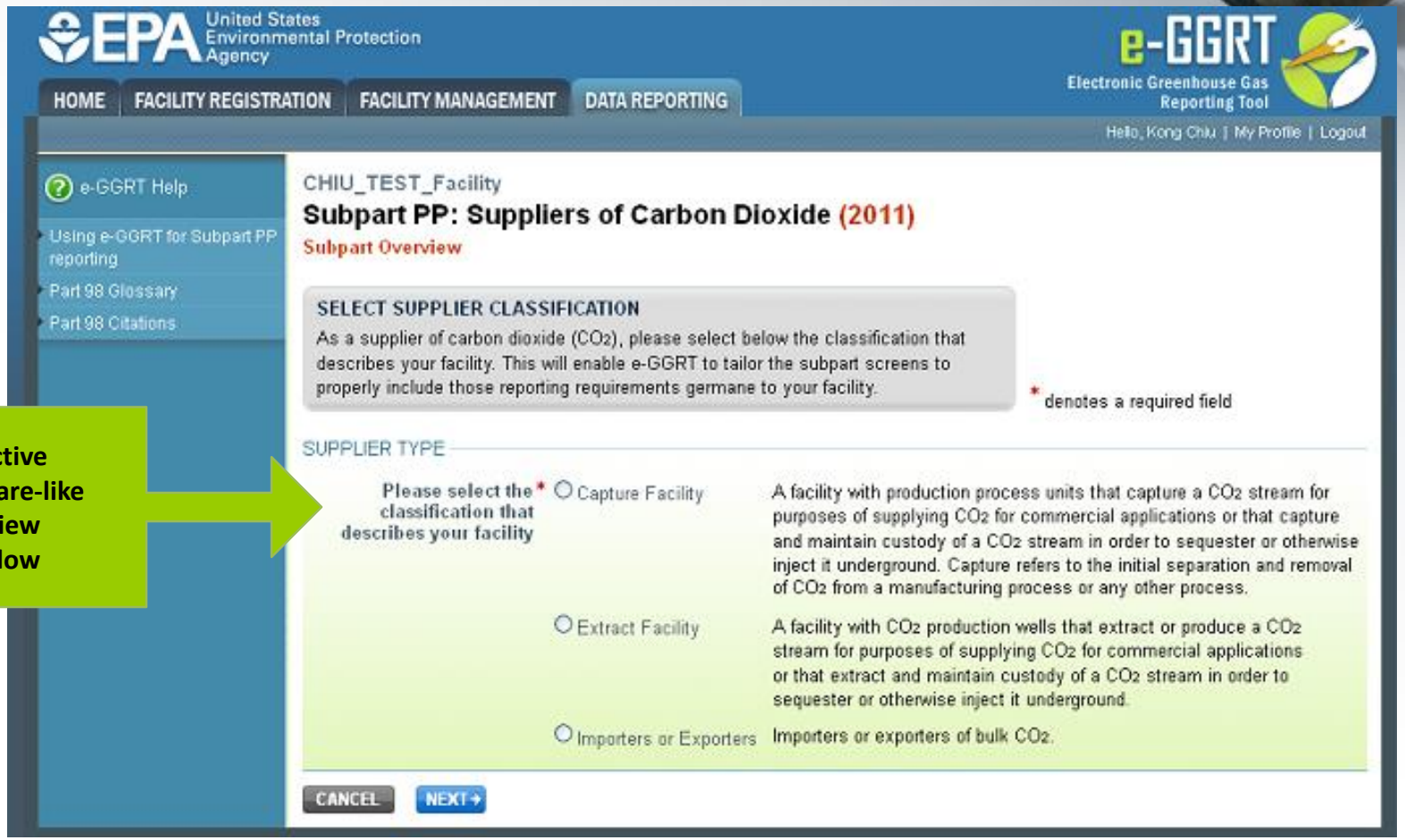
[1] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2011, April 2013.

Task	Inventory	Greenhouse Gas Reporting Program
Find total U.S. emissions	✓	
Review trend data for the past 20 years	✓	
Browse a map to find largest emitters in your area		✓
Compare facility emissions across an industrial sector		✓
Find reported emissions by state		✓

E-GGRT Process Flow



E-GGRT Example

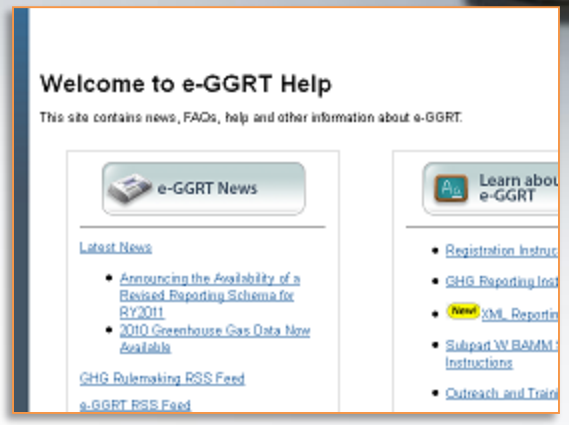


Interactive Tax software-like Interview workflow

Data Verification

- Reporter Self-Certifies
- Electronic Verification
  - Pre-submittal warning for reporters entering data outside reasonable ranges or missing data
  - Post-submittal verification through logic checks, use of outside data sets, and statistical analyses across facilities
  - Improvements to ranges & algorithms over time with real data
- Staff review and direct follow-up
  - Staff review electronic verification results
  - Phone/email follow-up- built in secure communications via e-GGRT
- Resubmissions, as needed

High Quality Data begins with High Quality Submissions

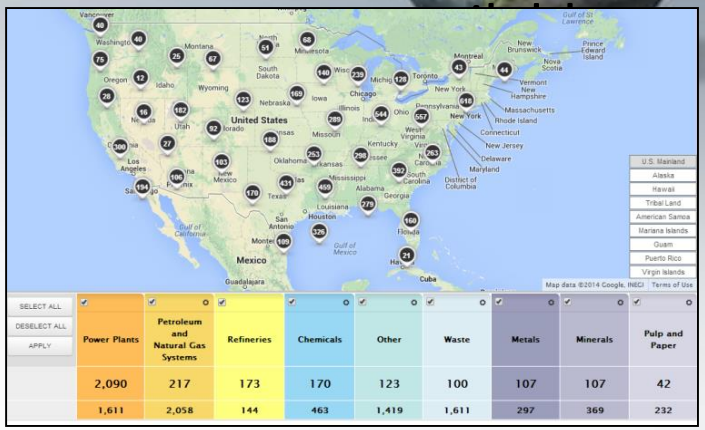


- Real Time Data Quality Feedback
- Comprehensive GHGRP Help Site
- Context-Sensitive Help within e-GGRT
- Staffed Help Desk
- Multi-Tier Ticket Triage
- Training Webinars
  - Part 98 overviews, e-GGRT overviews, registration, testing and subpart webinars
- Beta Testing
  - e-GGRT Sandbox

Data Publication - FLIGHT

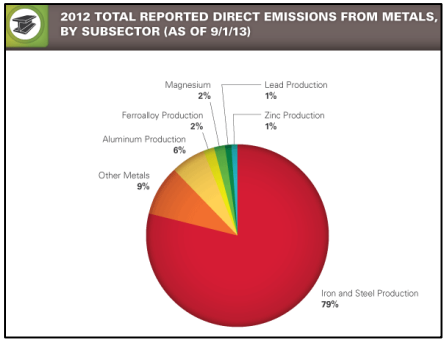
- EPA makes GHGRP data publicly through several websites

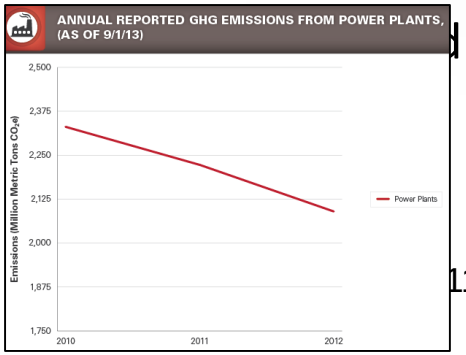
- FLIGHT (http://ghgdata.epa.gov)
  - Allows stakeholders and the public to access the key data elements quickly and easily



- Envirofacts (http://www.epa.gov/enviro/facts/ghg/customized.html)
  - Contains all publicly available data collected by the GHGRP

- Data Highlights (http://www.epa.gov/ghgreporting/ghgdata/reported/index.html)
  - Contains a summary of data in each sector



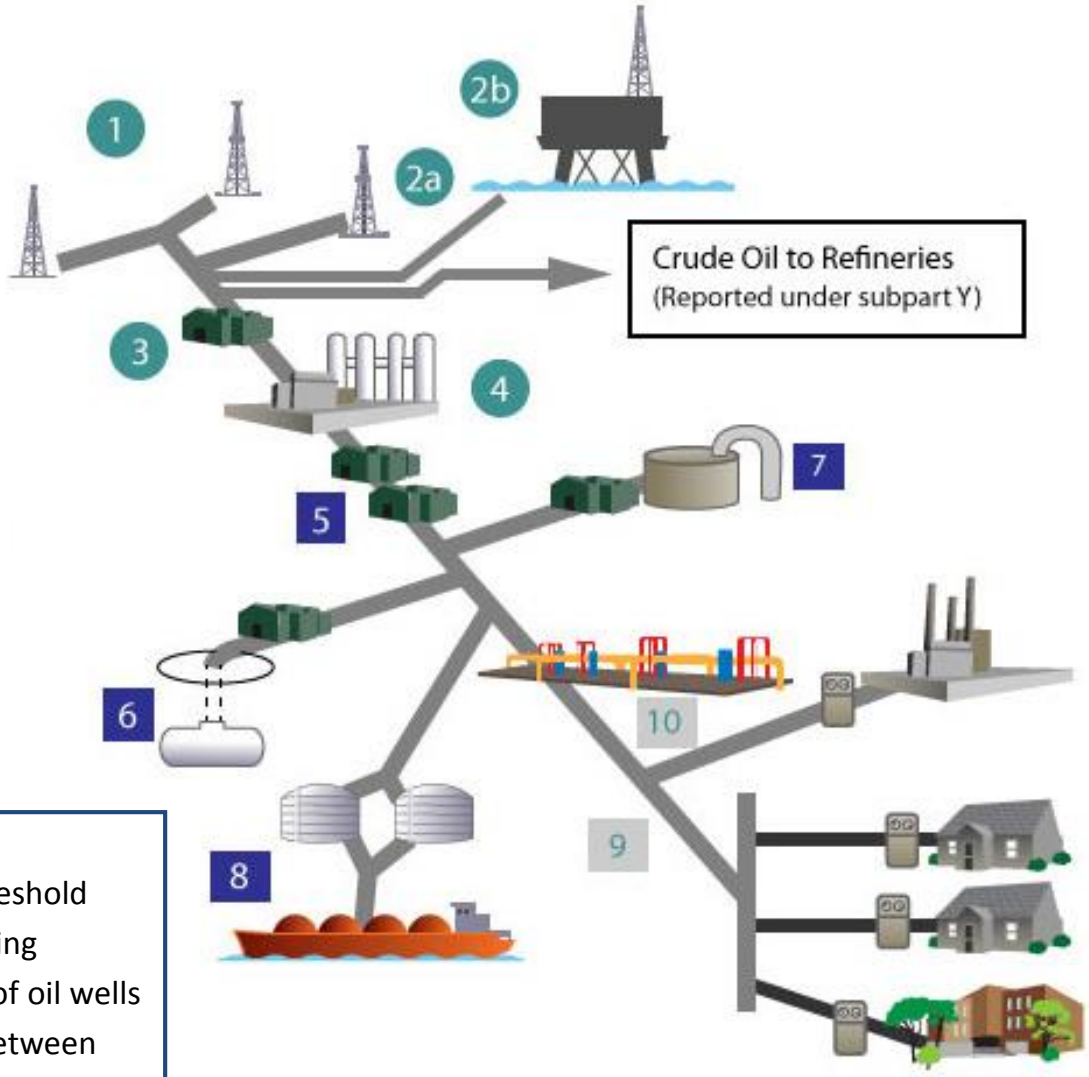


Petroleum and Natural Gas Systems in GHGRP (Subpart W)

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 25,000 metric ton CO_2e threshold
- 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 AGA and Natural Gas STAR

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
- The other industry segments in the Petroleum and Natural Gas Systems source category follow the general GHGRP definition of “facility”

Reported GHG Emissions from Petroleum and Natural Gas Systems

Reported GHG Emissions by Industry Segment

- EPA received annual reports from over 2,000 facilities
- Reported emissions totaled 224 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	2013 Reported Emissions (Million Metric Tons CO_2e)
Onshore Production	503	95
Offshore Production	107	6
Natural Gas Processing	433	59
Natural Gas Transmission	487	23
Underground Natural Gas Storage	48	1
Natural Gas Distribution	173	15
LNG Import/Export	8	< 1
LNG Storage	5	< 1
Other Oil and Gas Combustion	415	25
Total	**2,164**	**224**

GHGRP data as of 8/18/14

Changes in Reported Emissions: 2011-2013

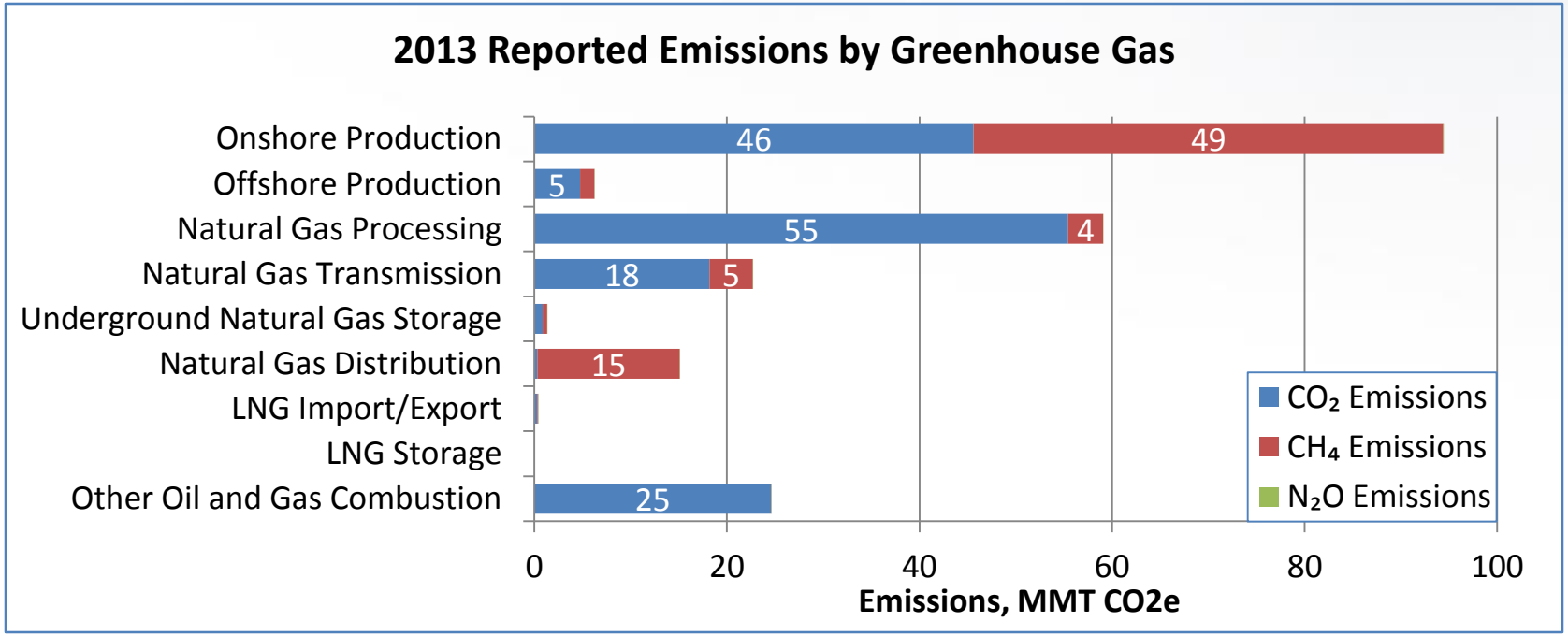
- Total reported emissions slightly increased by about 0.2 MMT CO_2e from 2011 to 2013. Reported carbon dioxide emissions increased by 10.6 MMT CO_2e and reported methane emissions decreased by 10.3 MMT CO_2e

Segment	2011 Reported Emissions (MMT CO_2e)	2012 Reported Emissions (MMT CO_2e)	2013 Reported Emissions (MMT CO_2e)	2012-13 Change in Reported Emissions (MMT CO_2e)	2011-13 Change in Reported Emissions (MMT CO_2e)
Onshore Production	92	93	95	1.5	2.2
Offshore Production	7	7	6	-0.5	-0.4
Natural Gas Processing	58	60	59	-1.5	0.2
Natural Gas Transmission	24	24	23	-0.9	-1.5
Underground Natural Gas Storage	1	1	1	-0.1	-0.2
Natural Gas Distribution	17	16	15	-0.5	-1.4
LNG Import/Export	1	1	< 1	-0.3	-0.4
LNG Storage	< 1	< 1	< 1	0.0	0.0
Other Oil and Gas Combustion	23	25	25	0.0	1.7
Total	**223**	**226**	**224**	**-2.3**	**0.2**

GHGRP data as of 8/18/14

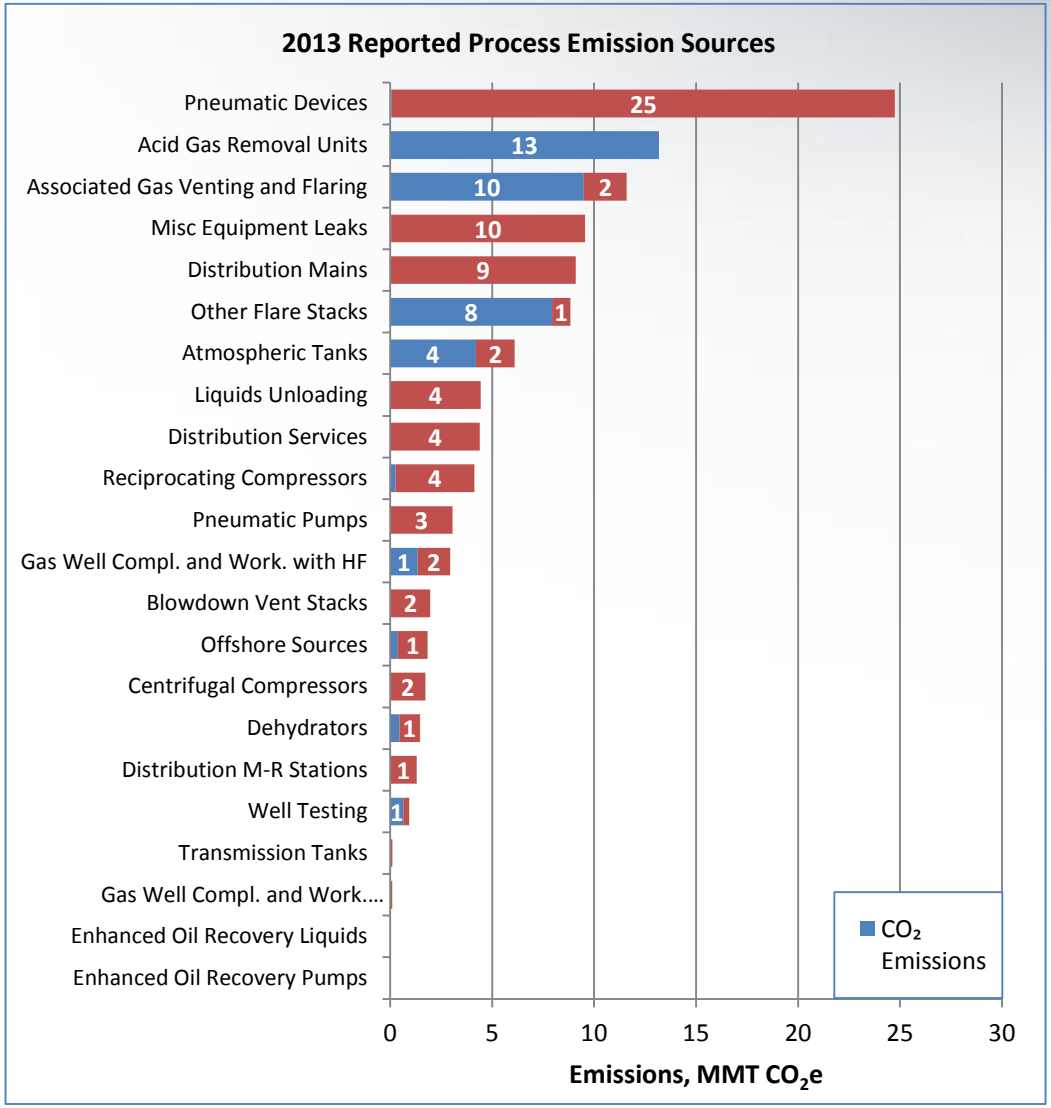
Reported Emissions by Greenhouse Gas

- Carbon dioxide (CO_2) emissions accounted for 150 MMT CO_2e and methane (CH_4) emissions accounted for 74 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



GHGRP data as of 8/18/14

Reported 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, associated gas venting and flaring, and miscellaneous equipment leaks

GHGRP data as of 8/18/14

Changes in Top Reported Sources: 2011-2013

- Increase in emissions from 2011 to 2013 not attributable to any individual source

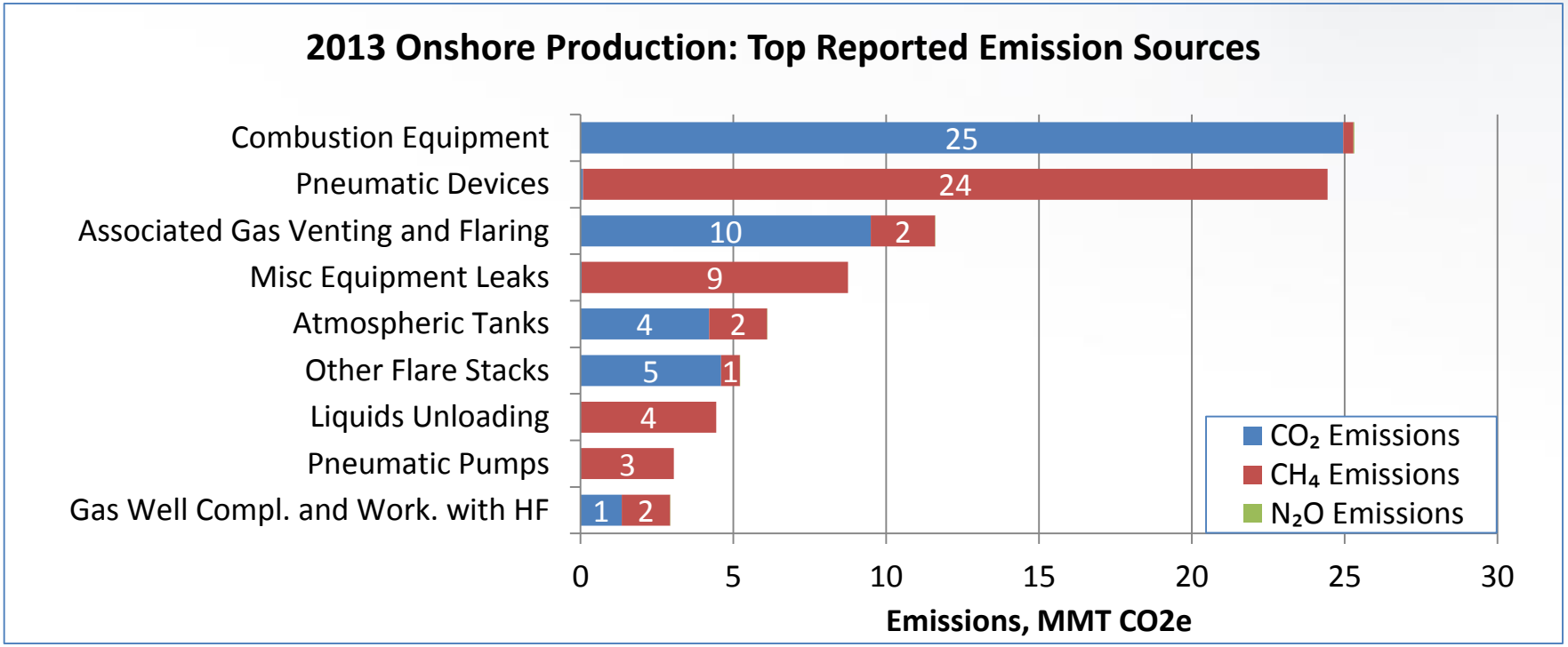
Emission Source	2011 Emissions (MMT CO_2e)	2012 Emissions (MMT CO_2e)	2013 Emissions (MMT CO_2e)	2012-13 Change in Reported Emissions (MMT CO_2e)	2011-13 Change in Reported Emissions (MMT CO_2e)
Combustion Equipment	108.8	111.4	112.4	1.0	3.6
Pneumatic Devices	21.4	22.4	24.7	2.4	3.3
Acid Gas Removal Units	15.9	15.4	13.2	-2.2	-2.7
Associated Gas Venting and Flaring	8.1	11.0	11.6	0.6	3.5
Misc Equipment Leaks	10.7	9.8	9.6	-0.3	-1.1
Distribution Mains	10.2	9.7	9.1	-0.6	-1.1
Other Flare Stacks	5.8	8.2	8.8	0.7	3.0
Atmospheric Tanks	4.2	5.6	6.1	0.5	1.9
Distribution Services	5.2	4.8	4.4	-0.4	-0.8
Liquids Unloading	7.4	6.0	4.4	-1.5	-2.9
Reciprocating Compressors	3.7	3.5	4.0	0.5	0.3
Pneumatic Pumps	3.0	3.4	3.1	-0.3	0.1
Gas Well Completions and Workovers with Hydraulic Fracturing	8.9	4.6	2.9	-1.6	-5.9
Blowdown Vent Stacks	1.5	2.4	2.0	-0.4	0.5

GHGRP data as of 8/18/14

Reported GHG Emissions by Industry Segment and Source

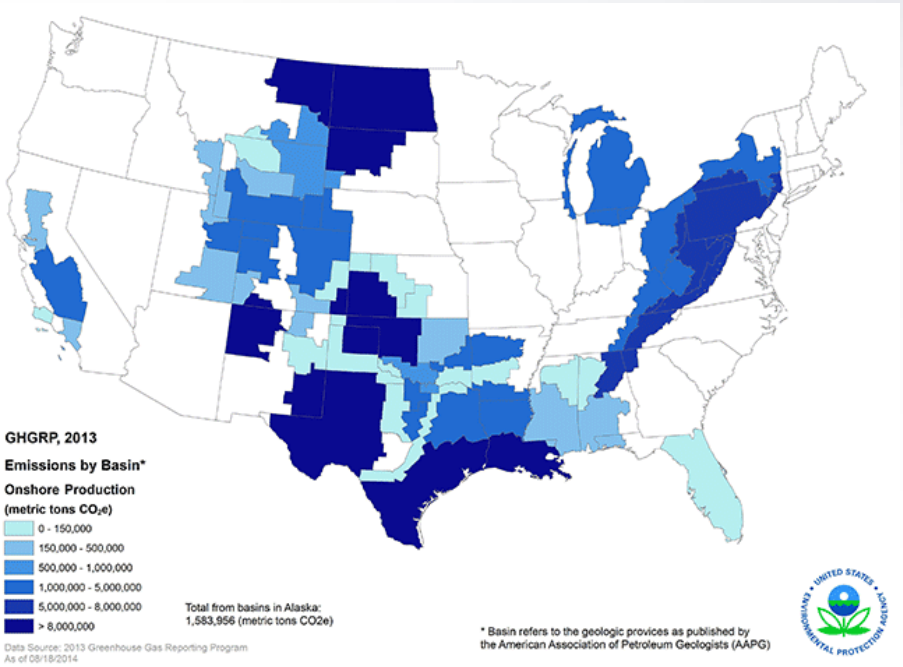
Onshore Production

- Reported emissions in onshore production totaled 95 MMT CO_2e
- Methane emissions totaled 49 MMT CO_2e and carbon dioxide emissions totaled 46 MMT CO_2e
- Combustion equipment (25.3 MMT CO_2e) and pneumatic devices (24.4 MMT CO_2e) were the top reported emission sources in onshore production



GHGRP data as of 8/18/14

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:
  - Williston Basin (12.8 MMT CO_2e)
  - Gulf Coast Basin (12.6 MMT CO_2e)
  - San Juan Basin (10.1 MMT CO_2e)
  - Anadarko Basin (9.2 MMT CO_2e)
  - Permian Basin (9.2 MMT CO_2e)

Note: 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

- 174 onshore production facilities reported emissions from gas well completions and workovers with hydraulic fracturing, which totaled 2.9 MMT CO_2e
- 40 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	Reported Venting CO_2 Emissions (MT CO_2e)	Reported Venting CH_4 Emissions (MT CO_2e)	Reported Flaring CO_2 Emissions (MT CO_2e)	Reported Flaring CH_4 Emissions (MT CO_2e)	Total Reported Emissions (MT CO_2e)
Gas Well Completions with Hydraulic Fracturing	7,053	4,961	3,976	1,367,592	1,330,722	184,495	2,887,546
Gas Well Workovers with Hydraulic Fracturing	732	312	136	36,607	10,525	1,556	48,831
Total	**7,785**	**5,273**	**4,112**	**1,404,198**	**1,341,247**	**186,051**	**2,936,377**

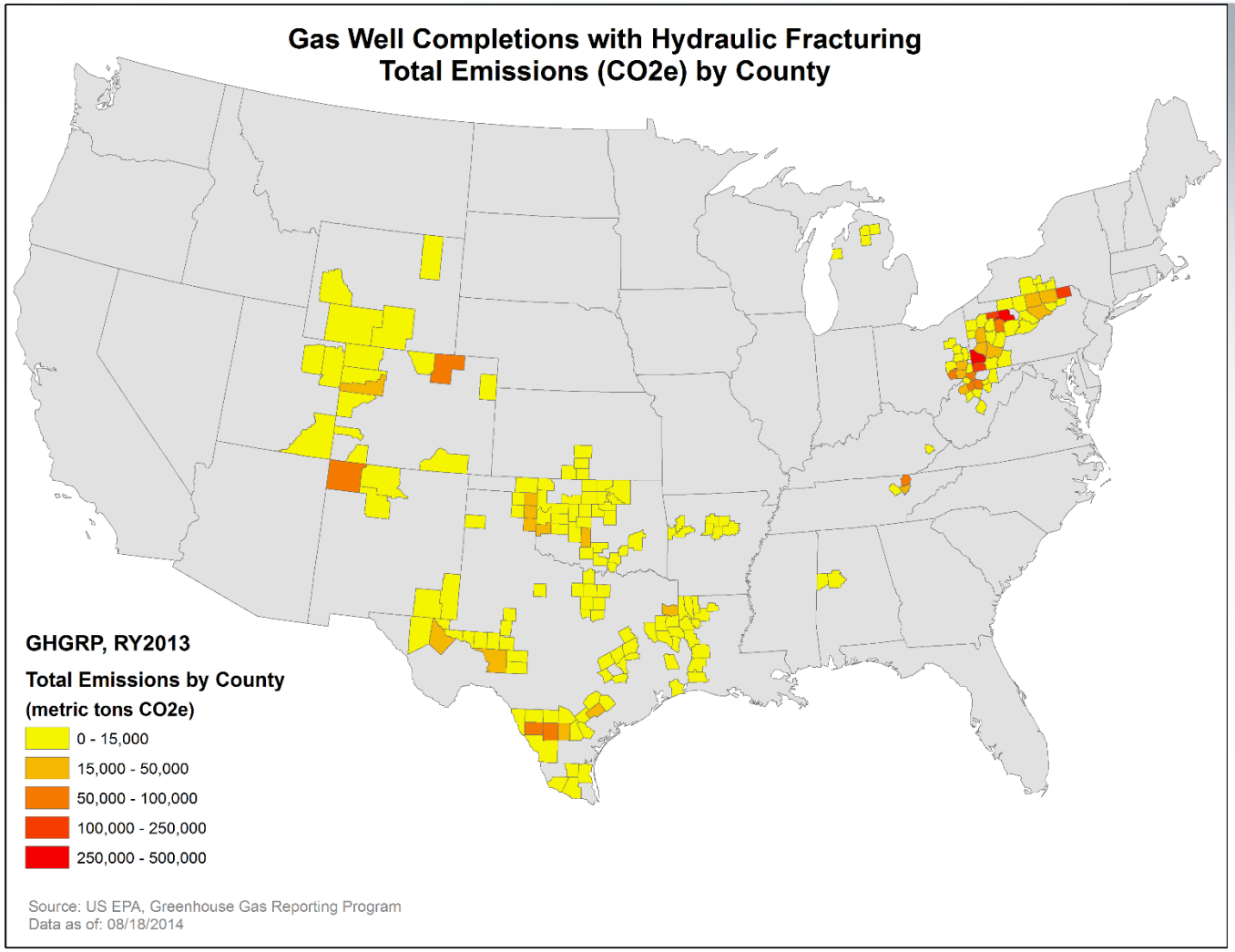
GHGRP data as of 8/18/14

Gas Well Completions with Hydraulic Fracturing

EPA Region	State	Completion Count	Completion Reported CO_2 Emissions (MT CO_2e)	Completion Reported CH_4 Emissions (MT CO_2e)	Completion Reported N_2O Emissions (MT CO_2e)	Completion Total Reported Emissions (MT CO_2e)	Completion Total Reported Emissions by EPA Region (MT CO_2e)
3	PA	644	535,503	950,943	308	1,486,754	1,614,088
3	VA	77	1,044	41,836	1	42,881	
3	WV	53	73,568	10,841	45	84,454	
5	OH	13	21	429	0	450	450
6	AR	15	17	26,486	0	26,503	925,688
6	LA	11	0	0	0	0	
6	NM	95	10,621	64,160	6	74,787	
6	OK	1,343	138,954	158,323	67	297,344	
6	TX	2,985	315,338	211,571	145	527,054	
8	CO	1,770	256,245	86,354	188	342,787	347,320
8	MT	10	0	664	0	664	
8	UT	30	3,388	479	2	3,869	
8	WY	7	0	0	0	0	

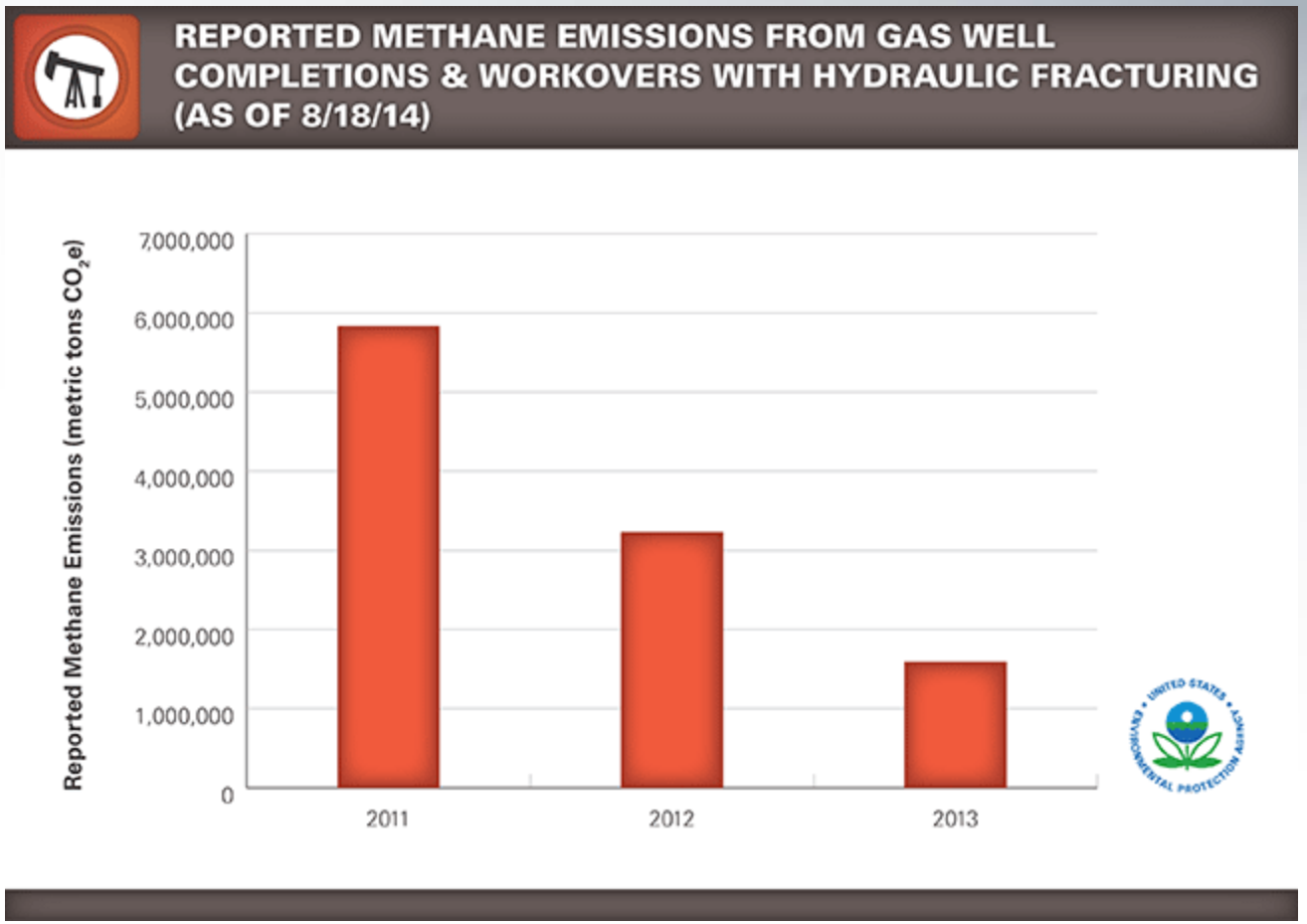
GHGRP data as of 8/18/14

Gas Well Completions with Hydraulic Fracturing: Total Reported CO_2e Emissions



GHGRP data as of 8/18/14

Gas Well Completions and Workovers with Hydraulic Fracturing: 2011-2013 Reported CH_4 Emissions



GHGRP data as of 8/18/14

Liquids Unloading

- 255 facilities reported emissions for liquids unloading, which totaled 4.4 MMT CO_2e
- 32 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	Reported CO_2 Emissions (MT CO_2e)	Reported CH_4 Emissions (MT CO_2e)	Total Reported Emissions (MT CO_2e)
Method 1: Direct Measurement of Representative Well Sample	4,344	2,404	1,285	111,323	112,608
Method 2: Engineering Calculation for Wells without Plunger Lifts	25,539	N/A	4,407	1,990,894	1,995,300
Method 3: Engineering Calculation for Wells with Plunger Lifts	25,610	25,610	3,904	2,333,021	2,336,925
Total	**55,493**	**28,014**	**9,596**	**4,435,237**	**4,444,833**

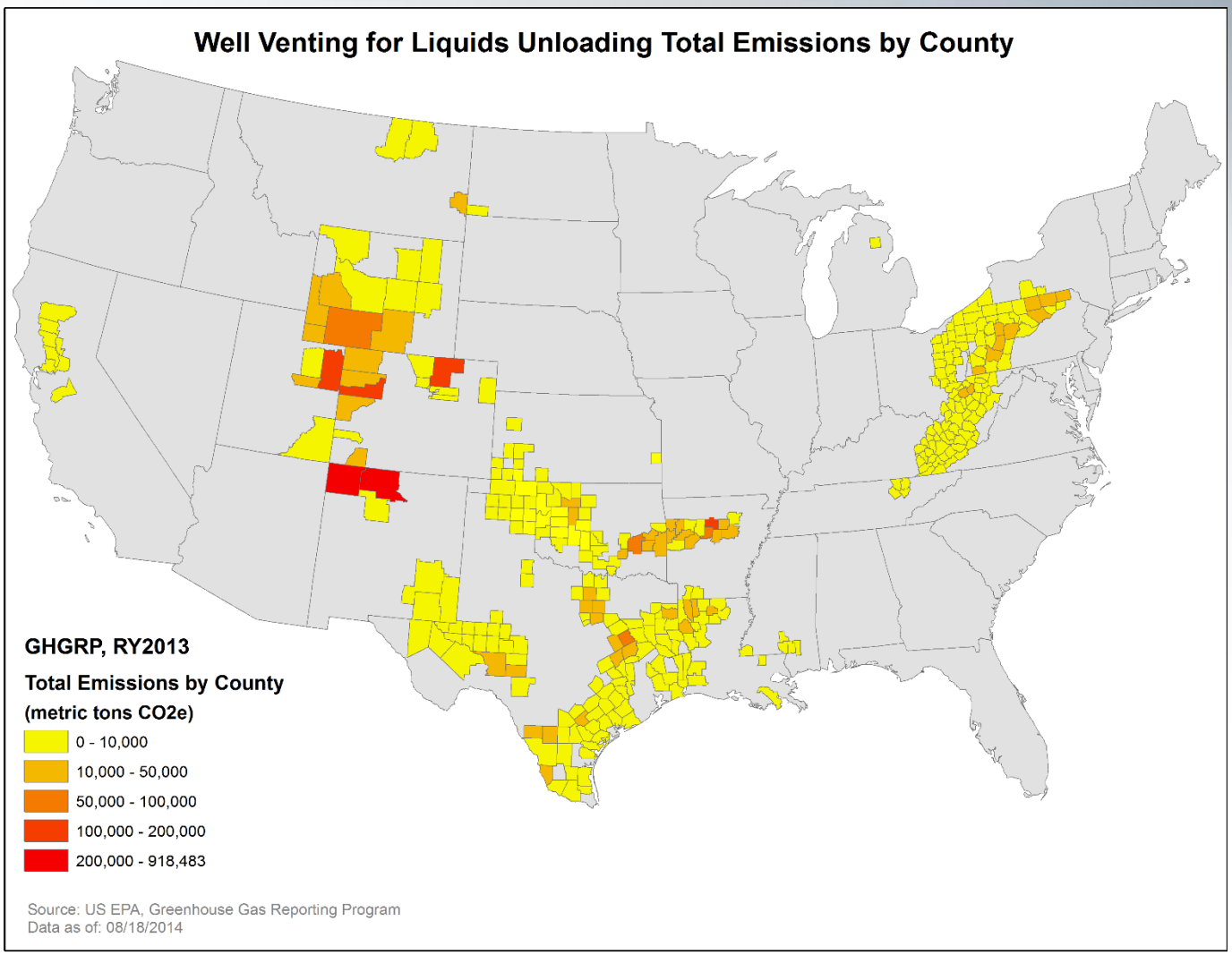
GHGRP data as of 8/18/14

Liquids Unloading

EPA Region	State	Number of Wells Venting During Liquids Unloading	Reported CO_2 Emissions (MT CO_2e)	Reported CH_4 Emissions (MT CO_2e)	Total Reported Emissions (MT CO_2e)	Total Reported Emissions by EPA Region (MT CO_2e)
3	PA	10,379	135	186,328	186,463	191,377
3	WV	716	1	4,913	4,914	
5	OH	10	925	46	972	972
6	AR	252	59	95,106	95,166	3,419,890
6	NM	7,152	3,557	1,844,291	1,847,847	
6	OK	6,418	1,605	644,407	646,012	
6	TX	16,745	1,815	829,051	830,866	
8	CO	12,368	1,192	600,845	602,036	714,034
8	UT	286	48	39,359	39,407	
8	WY	567	195	72,396	72,591	
9	CA	567	31	28,791	28,822	28,822
10	AK	33	38	89,708	89,746	89,746

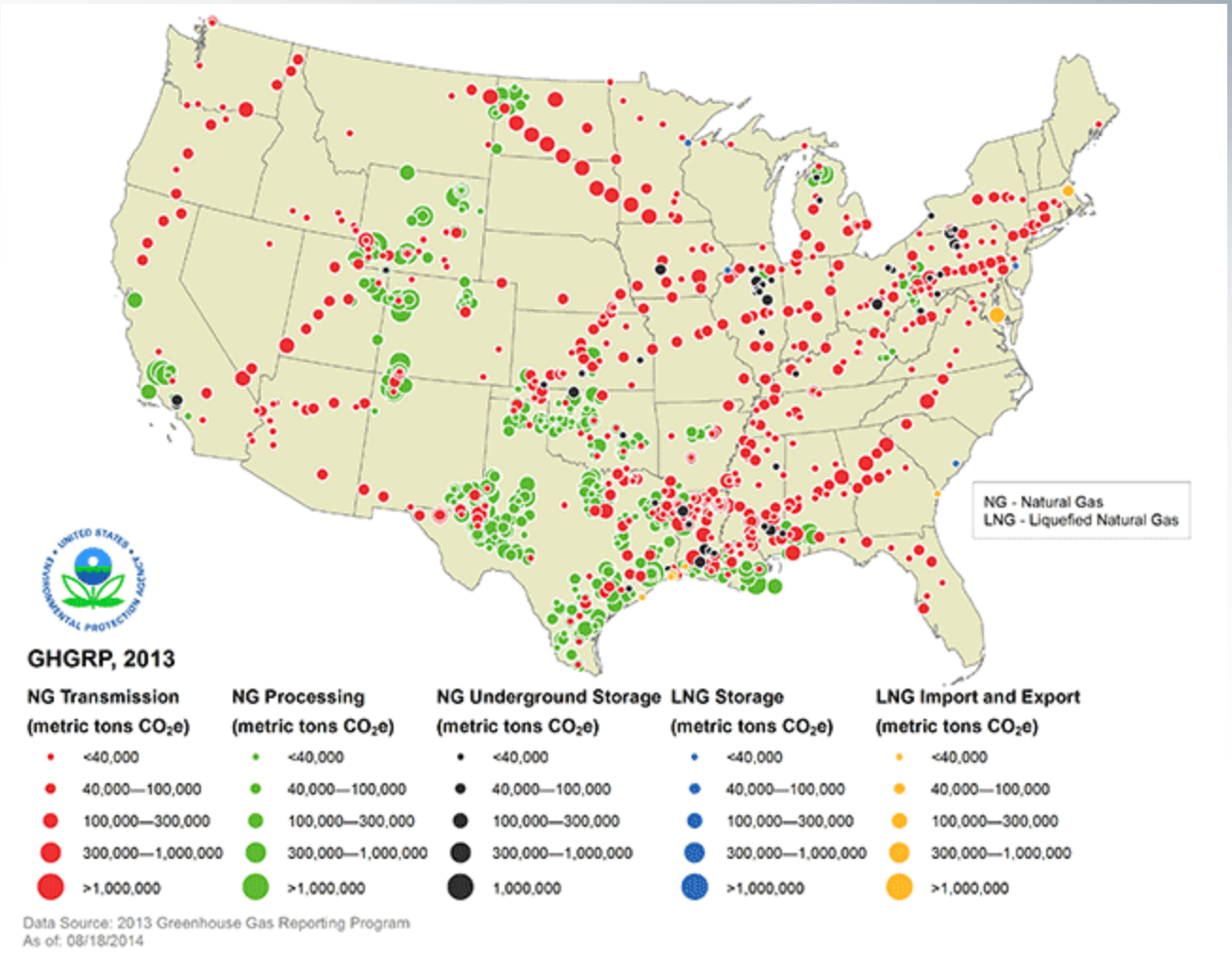
GHGRP data as of 8/18/14

Liquids Unloading: Total Reported CO_2e Emissions



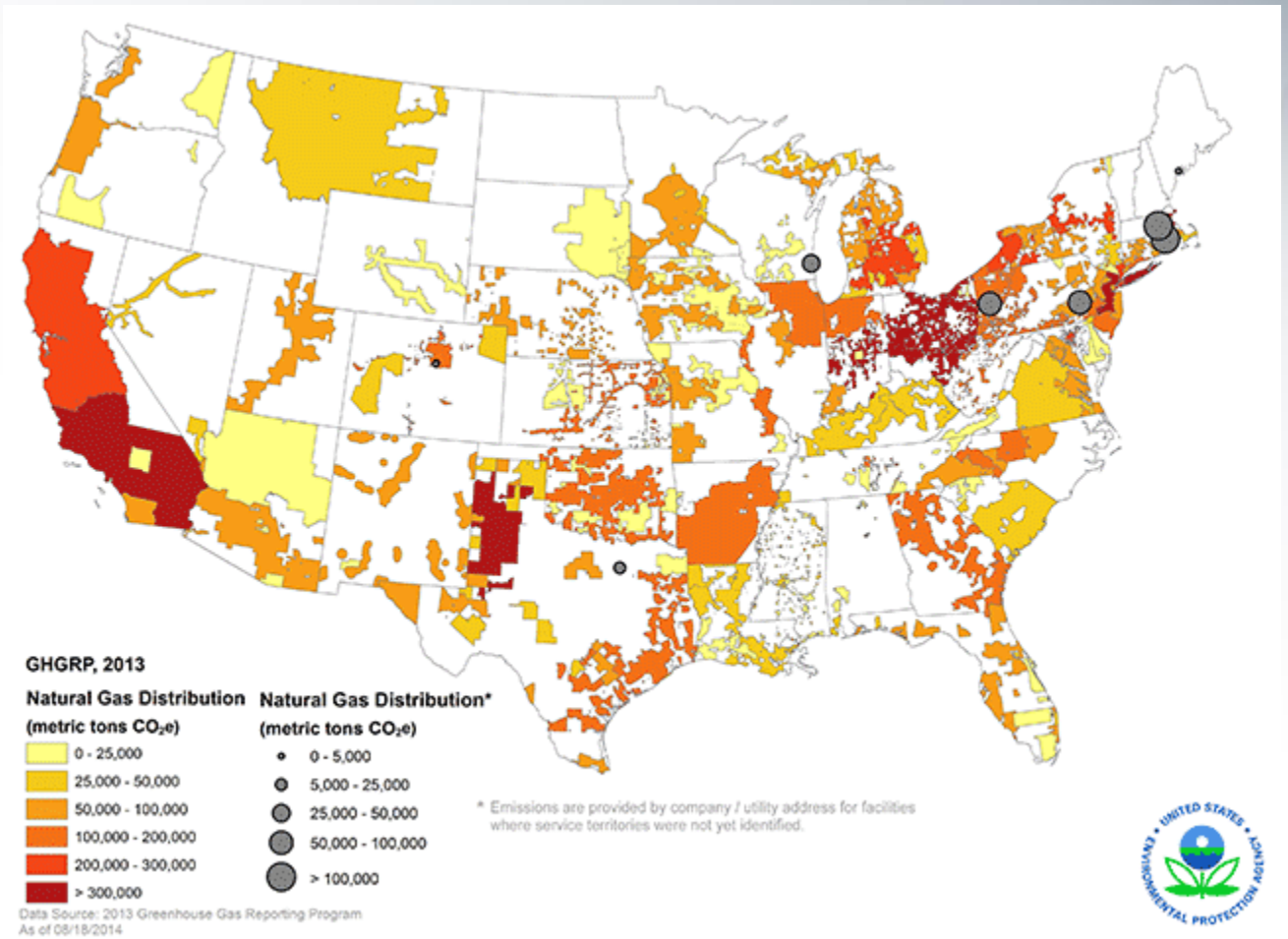
GHGRP data as of 8/18/14

NG Processing, Storage, Transmission, LNG



GHGRP data as of 8/18/14

Natural Gas Distribution



Inventory of U.S. Greenhouse Gas Emissions and Sinks

U.S. Greenhouse Gas Emissions Inventory

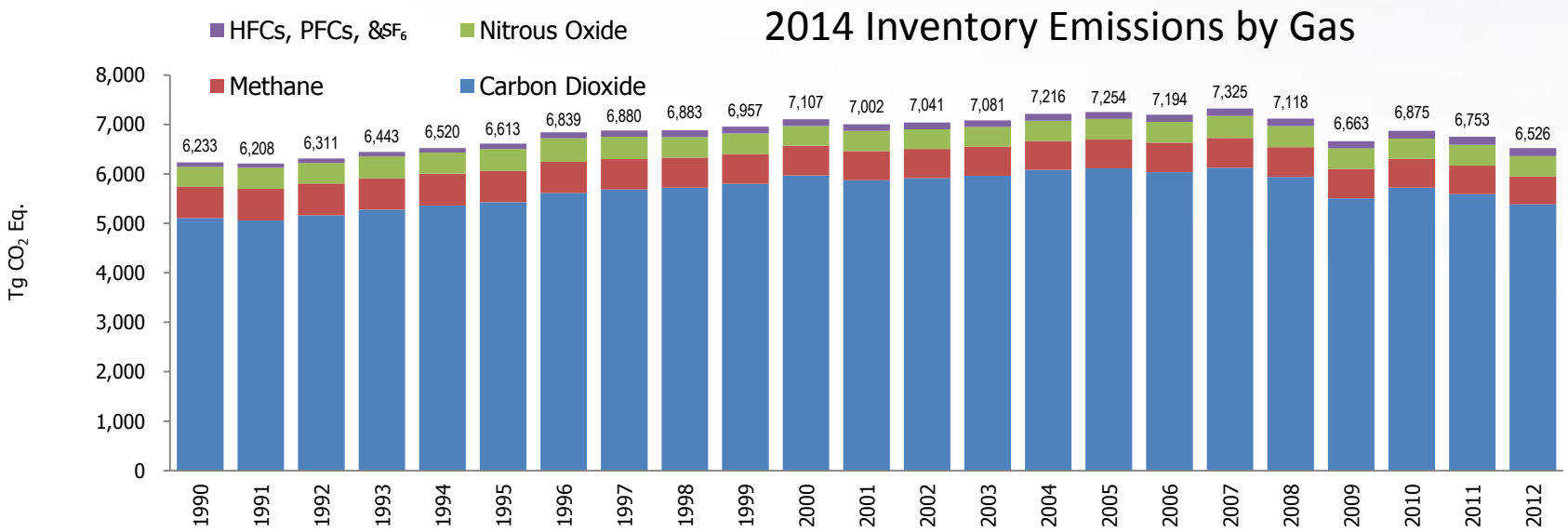
- Official U.S. estimate of greenhouse gas emissions for reporting to United Nations Framework Convention on Climate Change (UNFCCC)
  - Annual national-level inventory submissions to the UNFCCC since 1994
- EPA leads Inventory development, working with several agencies
  - e.g. input data on forestry from USFS, data on energy from EIA
- Sectors Covered
  - Energy, Industrial Processes, Agriculture, Land-Use Change and Forestry, and Waste
- Gases Covered
  - CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
  - Reported in Gg of each gas, and as global warming potential (GWP)-weighted CO_2e emissions
    - Inventories up to and including current use SAR GWP of 21 for CH_4
    - Future inventories will use AR4 GWP of 25
- Record of emissions trends over time
- Each year, Inventory undergoes expert review, public review, and UNFCCC review

GHG Inventory: Methods

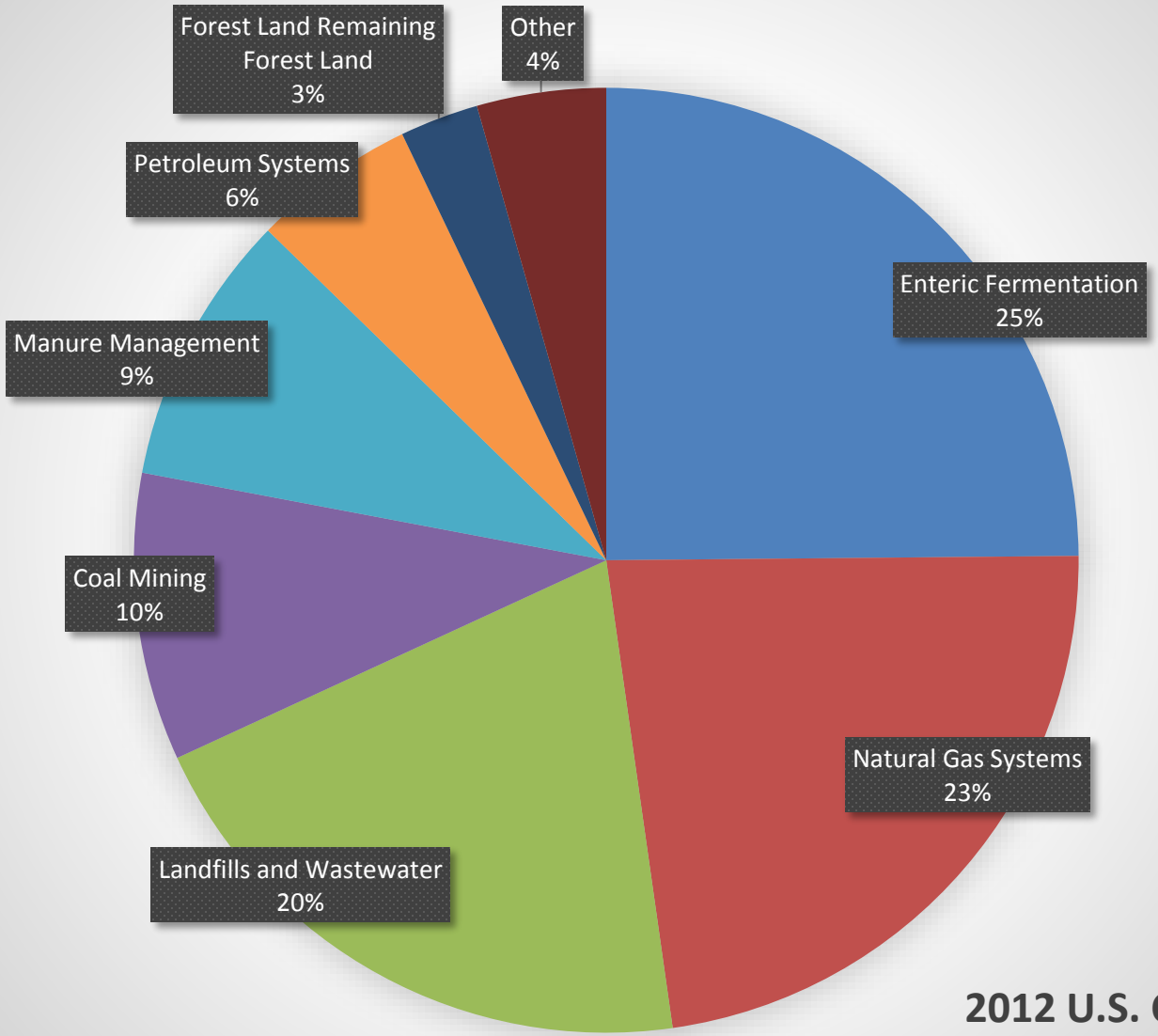
- UNFCCC Reporting Guidelines
- IPCC Guidelines
  - Internationally agreed methods
  - Bottom-up inventories
  - Tiered methods
- U.S. application of guidance
  - General use of higher tiers and 2006 IPCC Guidance
  - National or regional statistics for activity data
    - e.g. input data on forestry from USFS, data on energy from EIA
  - Country-specific models and emission factors
    - Emission factors typically developed from direct measurement
  - Use of facility-level reporting program data (GHGRP)

2014 Inventory Results Overview

- US GHG emissions declined 3.4% from 2011 to 2012
  - Increase of 4.7% from 1990, decrease of 10% from 2005
- CO_2 from fuel combustion dominate emissions and trends
  - Major contributors to the 2011-2012 decrease in emissions were decrease in energy consumption across all sectors in the U.S. economy, and decreases in carbon intensity for electricity generation due to fuel switching from coal to natural gas



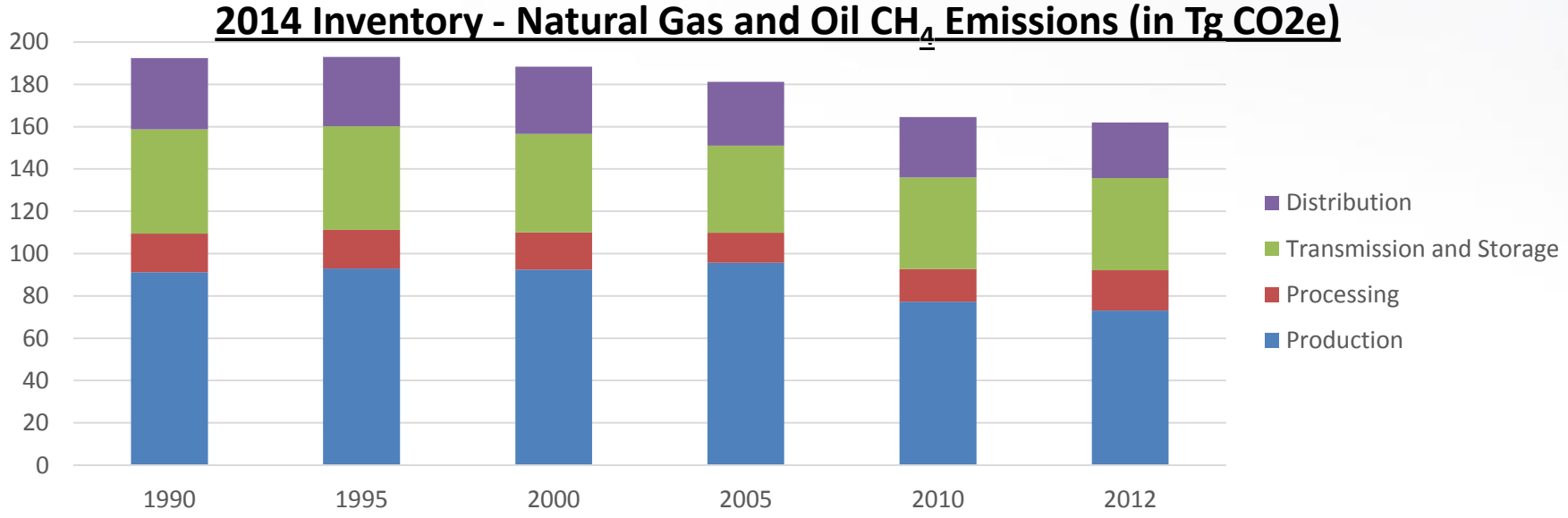
2012 Methane in GHG Inventory



2012 U.S. CH_4 Emissions

Oil and Gas Emission Estimates in the US GHG Inventory

- Oil and gas CH_4 account for 2% of total U.S. GHG emissions, and 29% of U.S. CH_4 emissions
- 162 Tg CO_2e total CH_4 emissions from natural gas systems
  - 73 Tg CO_2e from oil and gas production segments
  - 19 Tg CO_2e from processing segment
  - 43 Tg CO_2e from transmission and storage segment
  - 26 Tg CO_2e from distribution segment
- Emissions decreased 31 Tg CO_2e, or 16%, from 1990-2012
- EPA continues to update estimates to reflect best available information



Calculations for Oil and Gas

- Oil and gas in inventory covers hundreds of sources
  - Largest emissions from pneumatic controllers, compressors, pipelines
- Oil and gas estimates in the inventory generally based on EPA/GRI
  - Comprehensive assessment of CH_4 emissions across the entire oil and gas sector
  - Based on typical emission rates per activity or equipment
  - Used engineering judgment and measurements
- Recent updates for several sources
- Considerations for updating from EPA/GRI
  - Time series

Recent Updates to GHG Inventory for Oil and Gas

Inventory Year	Update to GHG Inventory Natural Gas Systems Estimate
Inventories through 2010	GHG estimates for all activities were based on a 1996 GRI/EPA study (1992 data)
2011/2012 Inventories	EPA updated the natural gas production sector estimates • Updated estimates of liquids unloading using engineering calculations • Included hydraulically fractured gas well completions/workovers
2013 Inventory	EPA updated the natural gas estimates for the production sector based on new data • Further improvements to liquids unloading estimates using API/ANGA study • Updated hydraulic fracturing gas well completions/workovers estimates
2014 Inventory	• Update to approach for estimating emissions from hydraulically fractured gas well completions/workovers using GHGRP data • Use of 4 practice-specific emission factors

Updating Estimates for Future GHG Inventories

- Enhancing the US Greenhouse Gas Inventory is a key part of the Climate Action Plan Strategy to Reduce Methane Emissions
  - Incorporation of GHGRP
  - Work with USDA and DOE
  - Promoting transparency and stakeholder input
- Evaluation of updates to estimates key to maintaining GHG Inventory quality
  - Continuous improvement - if better data become available, IPCC good practice and UNFCCC obligates its consideration
  - Emphasis on improving estimates and devoting resources to large sources, or rapidly changing sources ("Key Sources")
  - Annual reassessment of methodologies and refinements for each source category
- EPA notes updates under consideration in "Planned Improvements" section of Inventory

Planned Oil and Gas Improvements for Future Inventories

- Continued review of GHGRP data
- Continued review of external studies (e.g. EDF, GTI)
- Updates to uncertainty analysis
- Gas STAR reductions
- Gas well completion and workover counts
- HF oil well completions and workovers
- Pneumatic devices
- Petroleum refineries

Oil and Gas GHGRP data in GHG Inventory

- QC of key updates
  - Data from GHGRP used to check Inventory updates under consideration
  - Liquids unloading update to 2013 Inventory
    - 2012 Inventory total emissions significantly higher than GHGRP results
    - GHGRP data used to validate a new data sources and updated emissions totals
- Use of GHGRP data to update methods
  - Hydraulic fracturing update to 2014 Inventory
    - 2013 Inventory total emissions were higher than GHGRP total emissions
      - GHGRP data showed more RECs and flaring than GHG Inventory
      - GHGRP data showed similar activity data (# of completions)
    - 2014 Inventory used GHGRP data to update HF emissions methodology with practice-specific factors instead of potential factor
- Future use of GHGRP
  - Petroleum refineries and review of other sources
  - Activity data available in 2015

Methane Measurement Studies

- Several recent studies have measured CH_4 emissions at the national or regional level, with estimates that differ from EPA's emissions estimate
  - Some studies compare to GHG inventory or GHGRP; many to other bottom-up data such as EDGAR
- EPA is considering how such measurement studies can be used to update Inventory estimates
  - Verification tool?
  - Prioritizing sources for improvement?
  - Incorporation into inventory?
- Some factors for consideration
  - Attribution—including calculations and assumptions regarding natural sources other emissions that are not the target of the study
  - How such measurements can inform emission factors and activity data used to calculate a time series for national emissions

Attribution Considerations

Sources not included in GHG Inventory

- Non-anthropogenic emissions not included in GHG Inventory
  - Natural sources include both fossil (e.g. geological seepage) and biological sources of carbon (e.g. wetlands)
  - Likely large sources in U.S. include wetlands and geological seepage
  - Global estimates (EPA 2010 and IPCC 2013) ~40% of total global CH_4 from non-anthropogenic activities
    - Wetlands (60-80%), geological seepage (~20%), and smaller amounts from lakes, termites and wild animals
- Anthropogenic emissions not included in GHG Inventory
  - Abandoned oil and gas wells

Scaling Considerations

Regional and seasonal considerations

- Livestock
  - Livestock populations and production practices vary greatly regionally
  - Population size varies with production cycle
  - Emissions from manure management systems temperature-dependent
- Waste
  - Waste management practices vary by region
  - Landfill emissions impacted by precipitation
- Oil and gas
  - Practices and emissions can vary regionally (e.g. formation types, regulations)

Informing Emission Factors and Activity Data

- Activities taking place at the time of measurement
  - General operating conditions
  - High-emission venting events
  - Maintenance schedule
- Regional versus national factors
- Controlled versus uncontrolled
- Super emitters
  - Where do they occur (e.g. which processes or equipment)?
  - How common are they?
- Corresponding activity data
  - Is national data available?

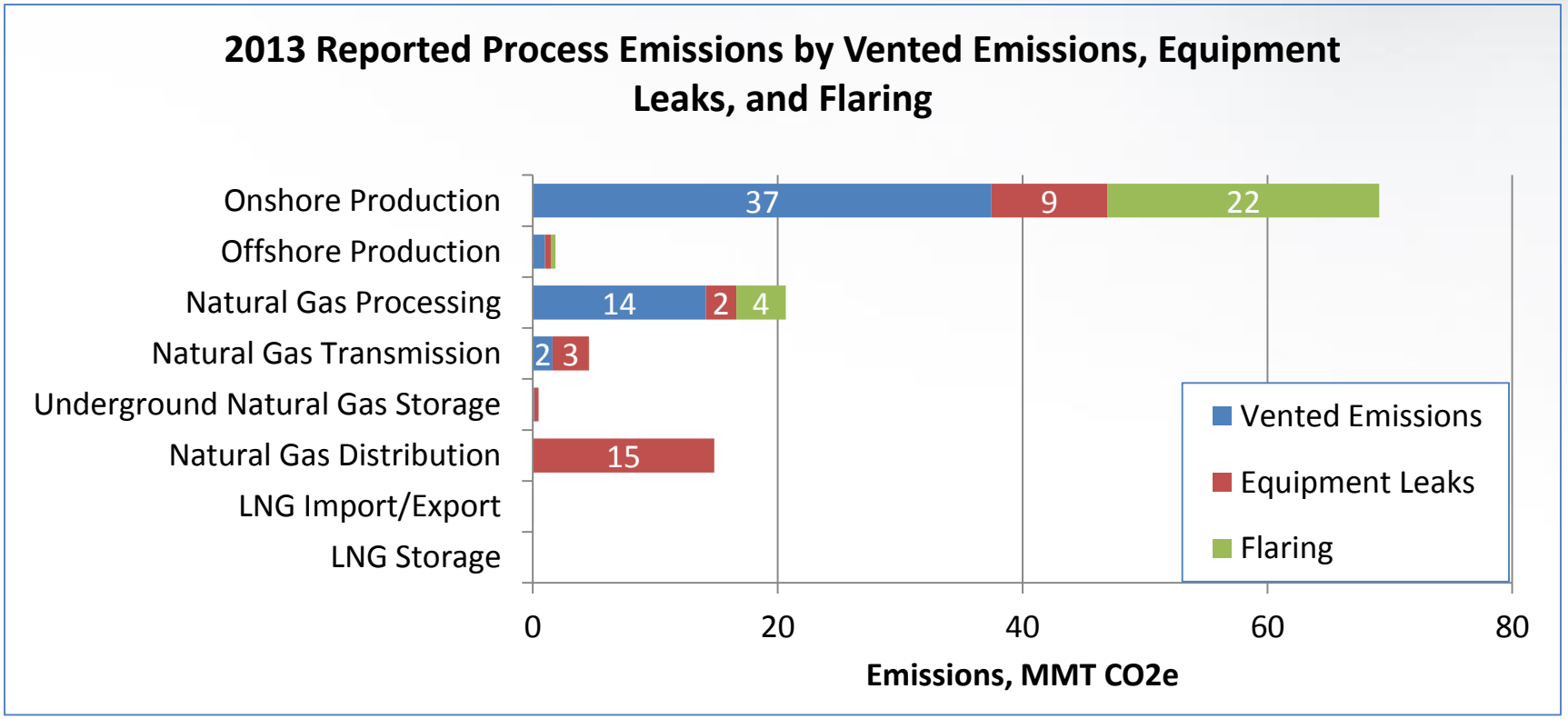
How to Access GHG Inventory Oil and Gas Emissions Data

- Detailed source descriptions, methodologies, emissions data and activity data available at
  - Energy Chapter of GHG Inventory (pages 3.54-3.75)
    - http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Chapter-3-Energy.pdf
  - Annex 3 of GHG Inventory (pages A.175-A.208)
    - http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2014-Annex-3-Additional-Source-or-Sink-Categories.pdf
- Data tables available at
    - http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

Back-Up Slides – GHGRP

Reported Process Emissions by Type

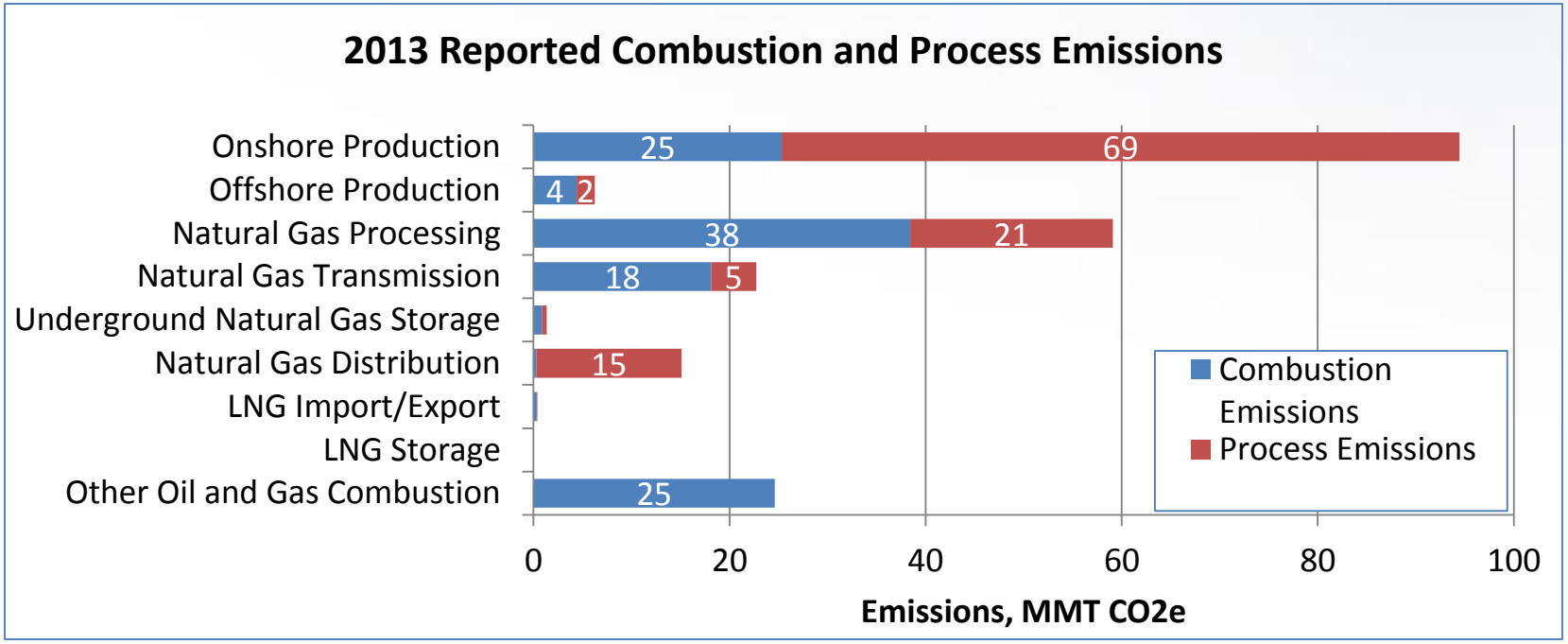
- Process emissions may be further subdivided by type of process, such as vented emission sources, equipment leaks, and flaring
- Vented emissions totaled 54 MMT CO_2e, equipment leaks totaled 31 MMT CO_2e, and flaring totaled 27 MMT CO_2e



GHGRP data as of 8/18/14

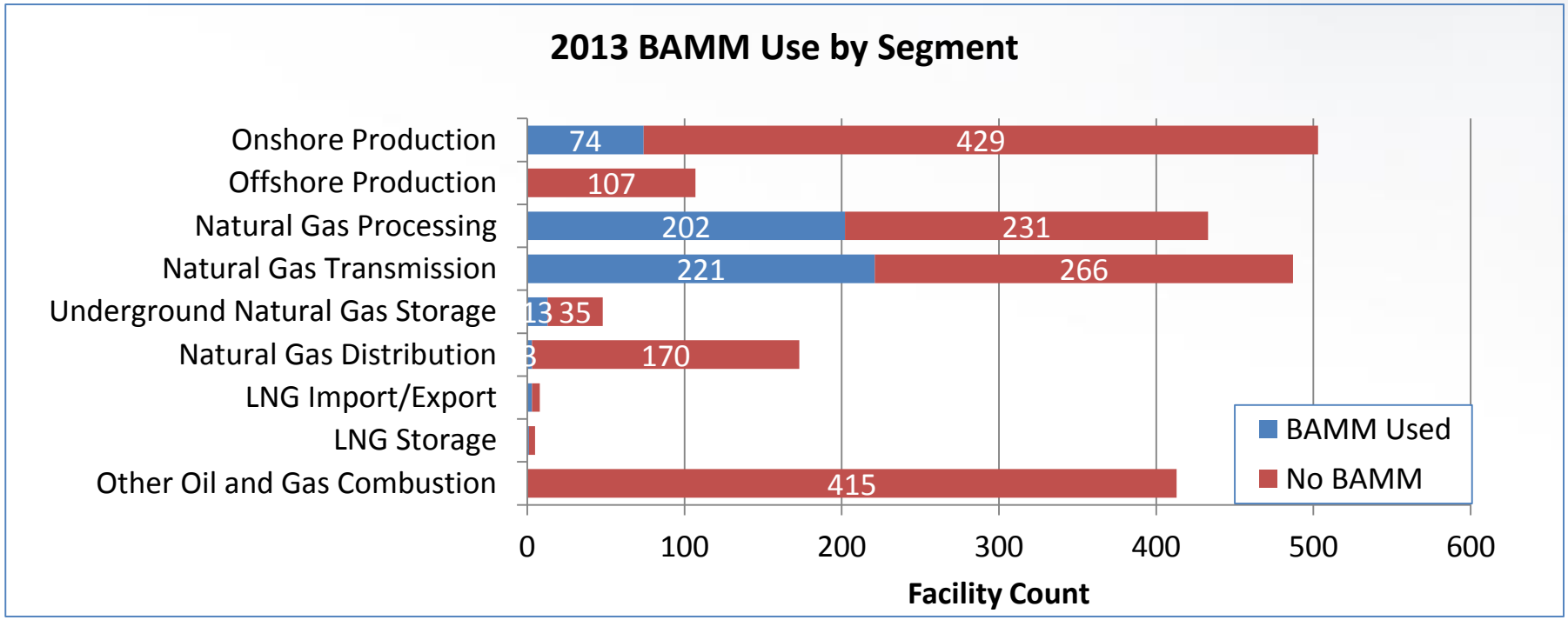
Reported Combustion and Process Emissions

- GHG emissions can result from combustion of fossil fuels, or from process sources that lead to the direct emission of GHGs
- Total combustion emissions were 112 MMT CO_2e and were primarily from natural gas processing, onshore production, natural gas transmission, and other combustion
- Total process emissions were 112 MMT CO_2e and were primarily from onshore production, natural gas processing, and natural gas distribution



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
- 24% of facilities in petroleum and natural gas systems used BAMM in 2013



GHGRP data as of 8/18/14

Changes in BAMM Use: 2011-2013

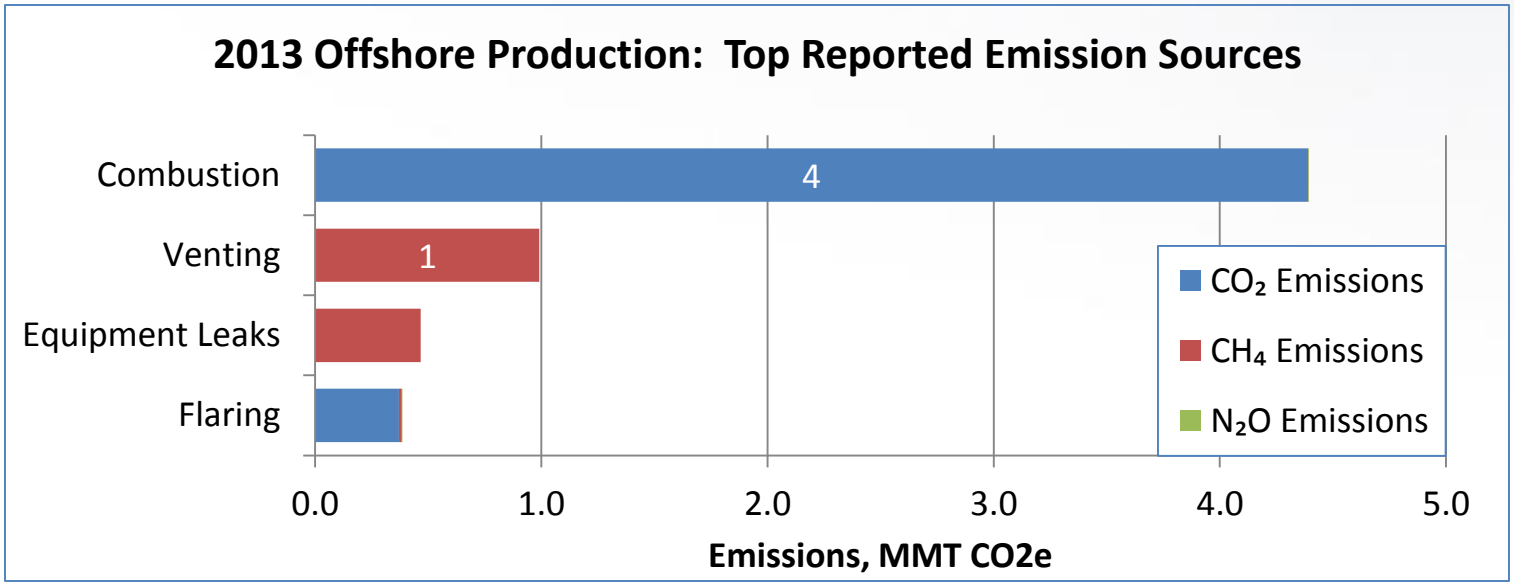
- Total number of facilities reporting BAMM use decreased from 1,053 facilities in 2011 to 515 facilities in 2013

Segment	2011 BAMM Use	2012 BAMM Use	2013 BAMM Use	2012-2013 Change in BAMM Use	2011-2013 Change in BAMM Use
Onshore Production	73%	44%	15%	-66%	-78%
Offshore Production	15%	4%	0%	-100%	-100%
Natural Gas Processing	84%	53%	47%	-3%	-36%
Natural Gas Transmission	71%	45%	45%	6%	-26%
Underground Natural Gas Storage	56%	35%	27%	-24%	-48%
Natural Gas Distribution	36%	12%	2%	-86%	-95%
LNG Import/Export	50%	25%	38%	50%	-25%
LNG Storage	50%	20%	20%	0%	-67%
Other Oil and Gas Combustion	0%	0%	0%	0%	0%
Total	**55%**	**33%**	**24%**	**-24%**	**-51%**

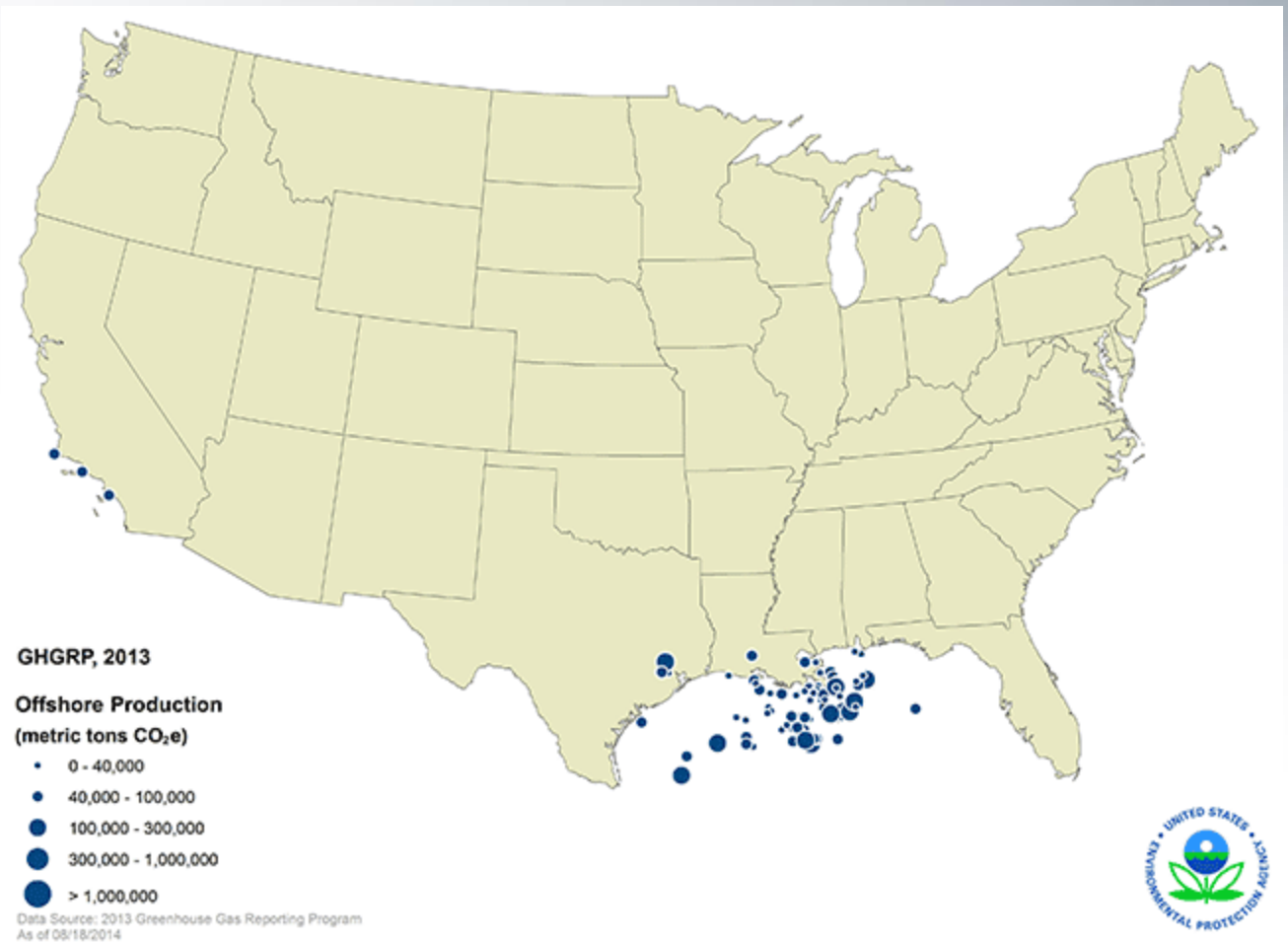
GHGRP data as of 8/18/14

Offshore Production

- Reported emissions from offshore production totaled 6.2 MMT CO_2e
- Methane emissions totaled 1.5 MMT CO_2e and carbon dioxide emissions totaled 4.7 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)



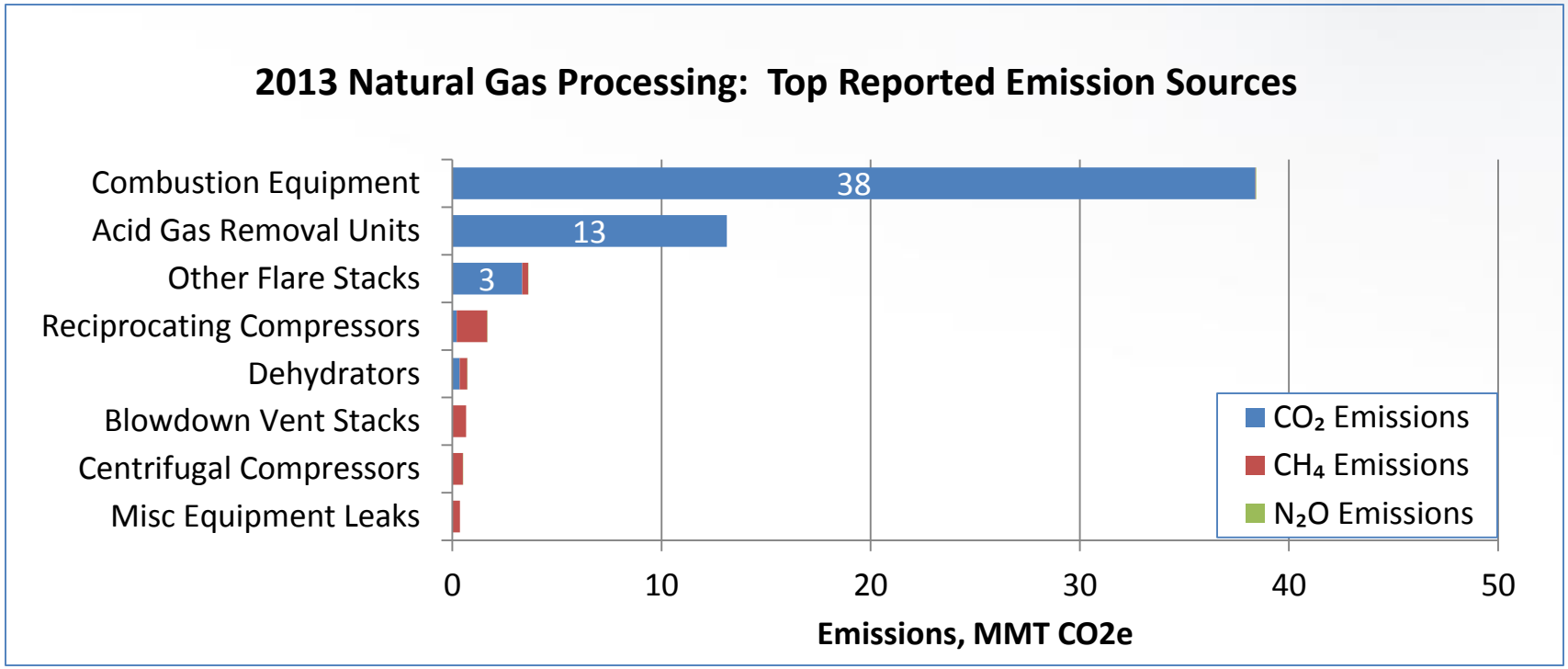
Offshore Production



GHGRP data as of 8/18/14

Natural Gas Processing

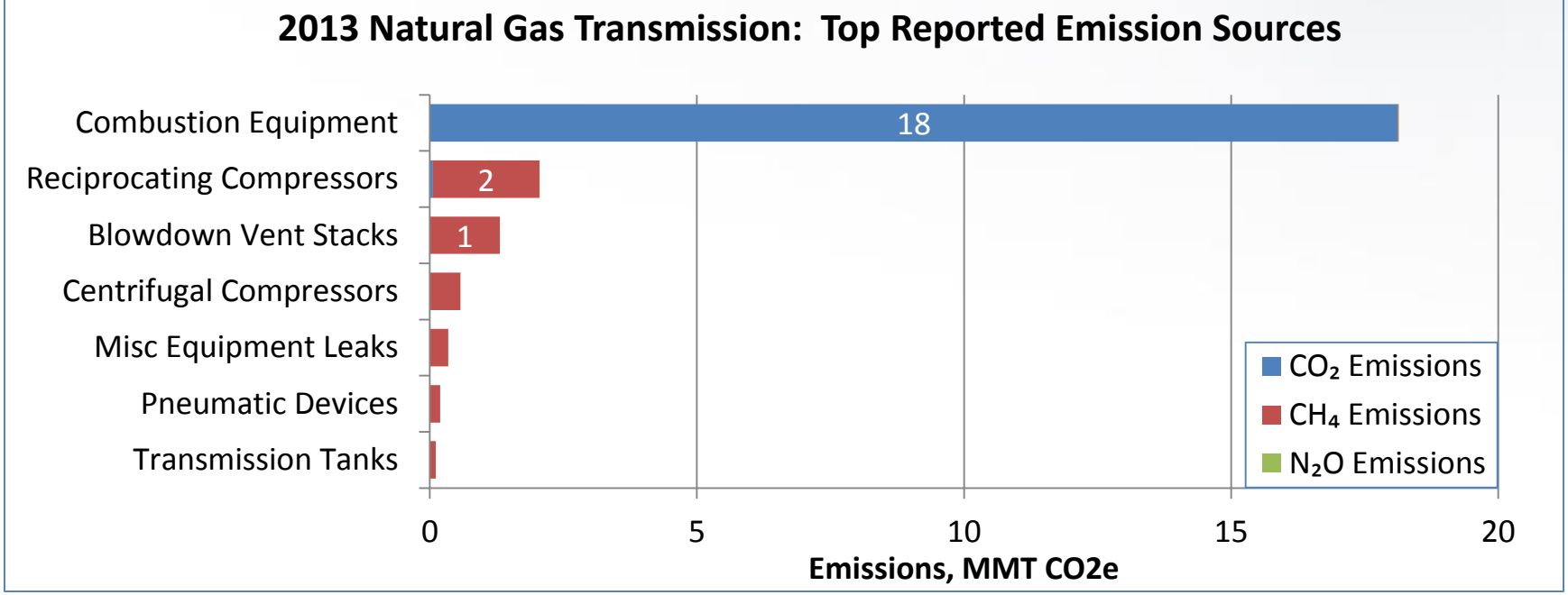
- Reported emissions from natural gas processing totaled 59.0 MMT CO_2e
- Methane emissions totaled 3.6 MMT CO_2e and carbon dioxide emissions totaled 55.4 MMT CO_2e
- The top reported emission sources were combustion equipment (38.4 MMT CO_2e), acid gas removal units (13.1 MMT CO_2e), and miscellaneous flare stacks (3.6 MMT CO_2e)



GHGRP data as of 8/18/14

Natural Gas Transmission

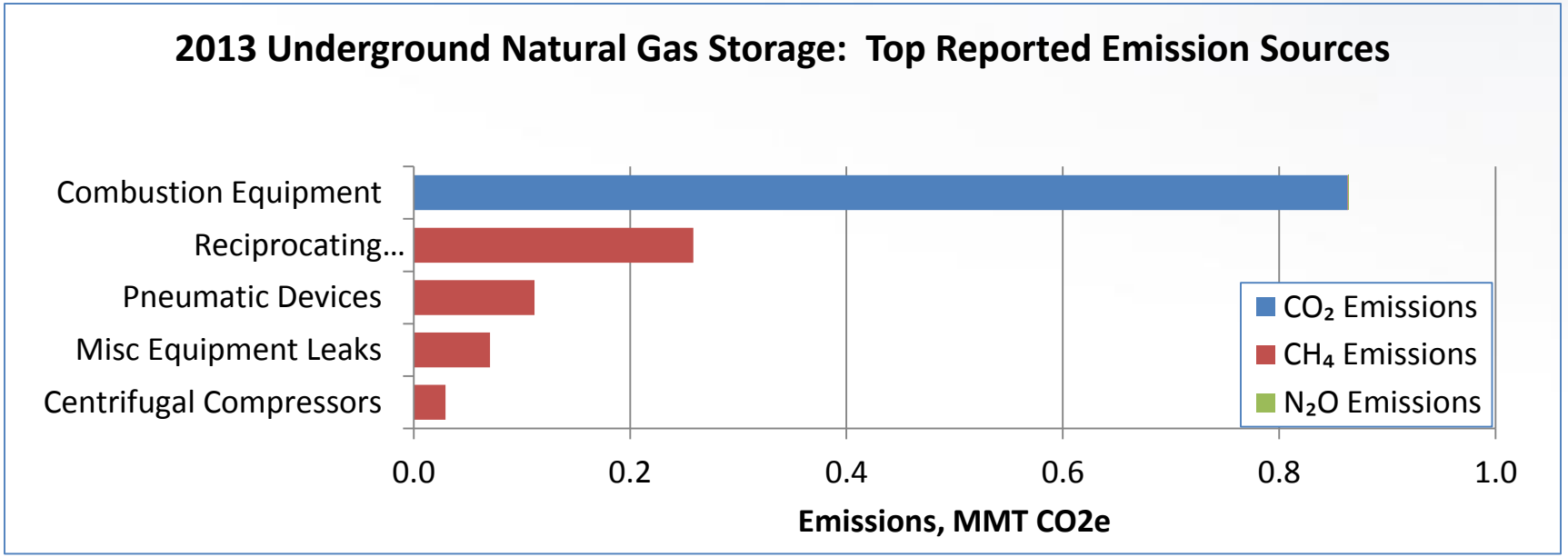
- Reported emissions from natural gas transmission totaled 23.0 MMT CO_2e
- Methane emissions totaled 4.5 MMT CO_2e and carbon dioxide emissions totaled 18.1 MMT CO_2e
- Top reported emission source was combustion equipment (18.1 MMT CO_2e)



GHGRP data as of 8/18/14

Underground Natural Gas Storage

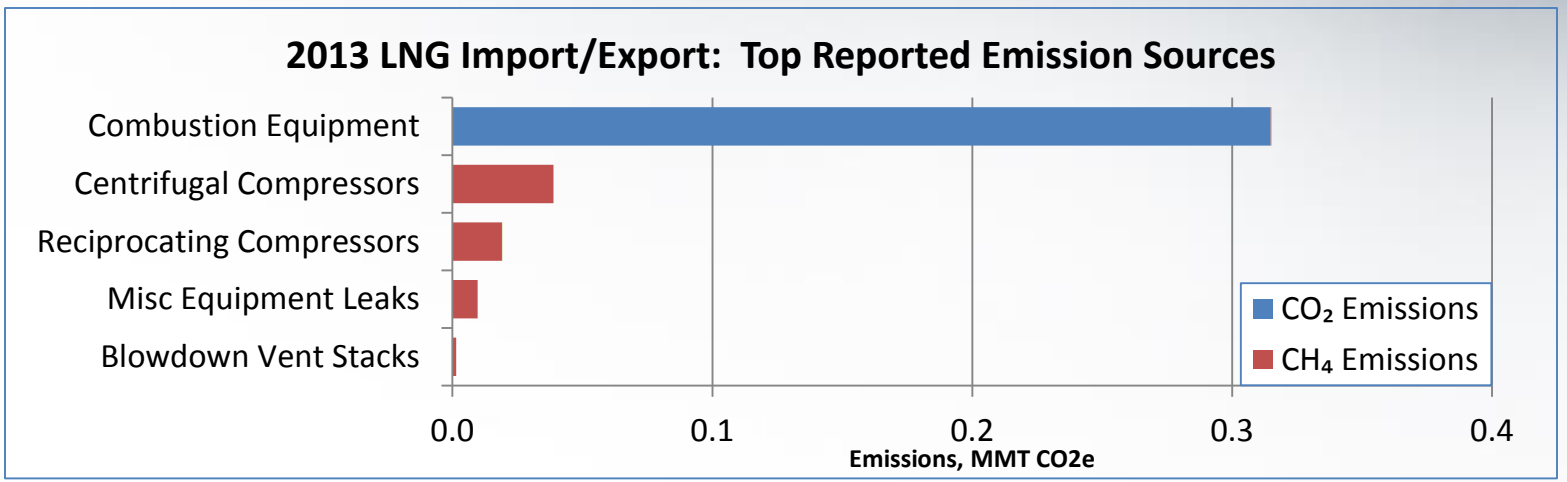
- Reported emissions from underground natural gas storage totaled 1.3 MMT CO_2e
- Methane emissions totaled 0.5 MMT CO_2e and carbon dioxide emissions totaled 0.9 MMT CO_2e
- The top reported emission source was combustion equipment (0.9 MMT CO_2e)

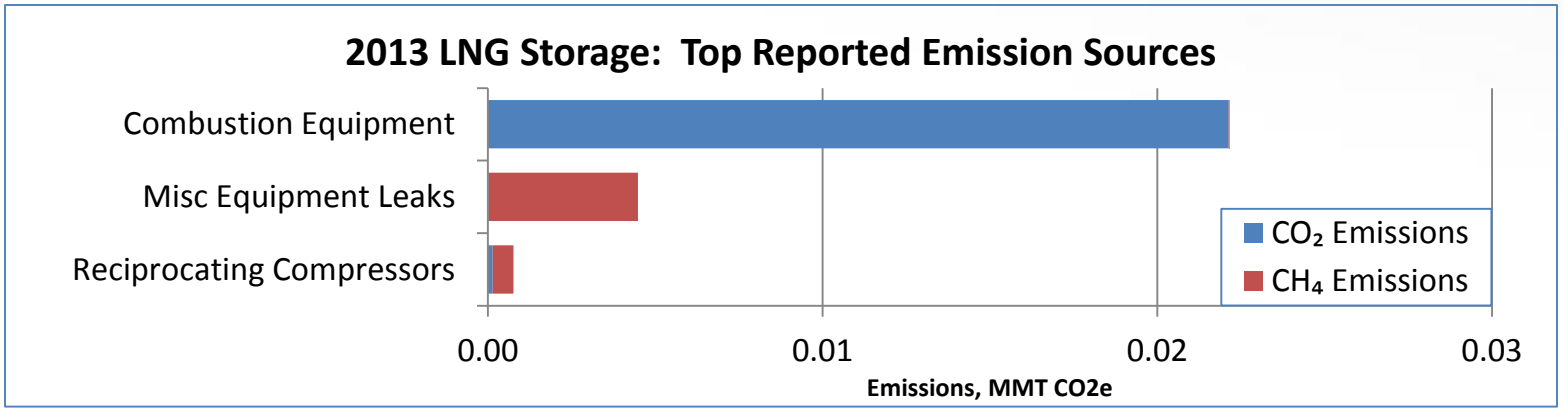


GHGRP data as of 8/18/14

LNG Import/Export and LNG Storage

- Reported emissions from LNG Import/Export totaled 0.4 MMT CO_2e
- Reported emissions from LNG storage totaled 0.03 MMT CO2e





GHGRP data as of 8/18/14

Natural Gas Distribution

- Reported emissions from natural gas distribution totaled 15.1 MMT CO_2e
- Methane emissions totaled 14.8 MMT CO_2e and carbon dioxide emissions totaled 0.3 MMT CO_2e
- Distribution mains (9.1 MMT CO_2e) and distribution services (4.4 MMT CO_2e) accounted for the majority of reported emissions