



# **Oil and Gas Emissions in the 2017 GHG Inventory**



**April 27, 2017**

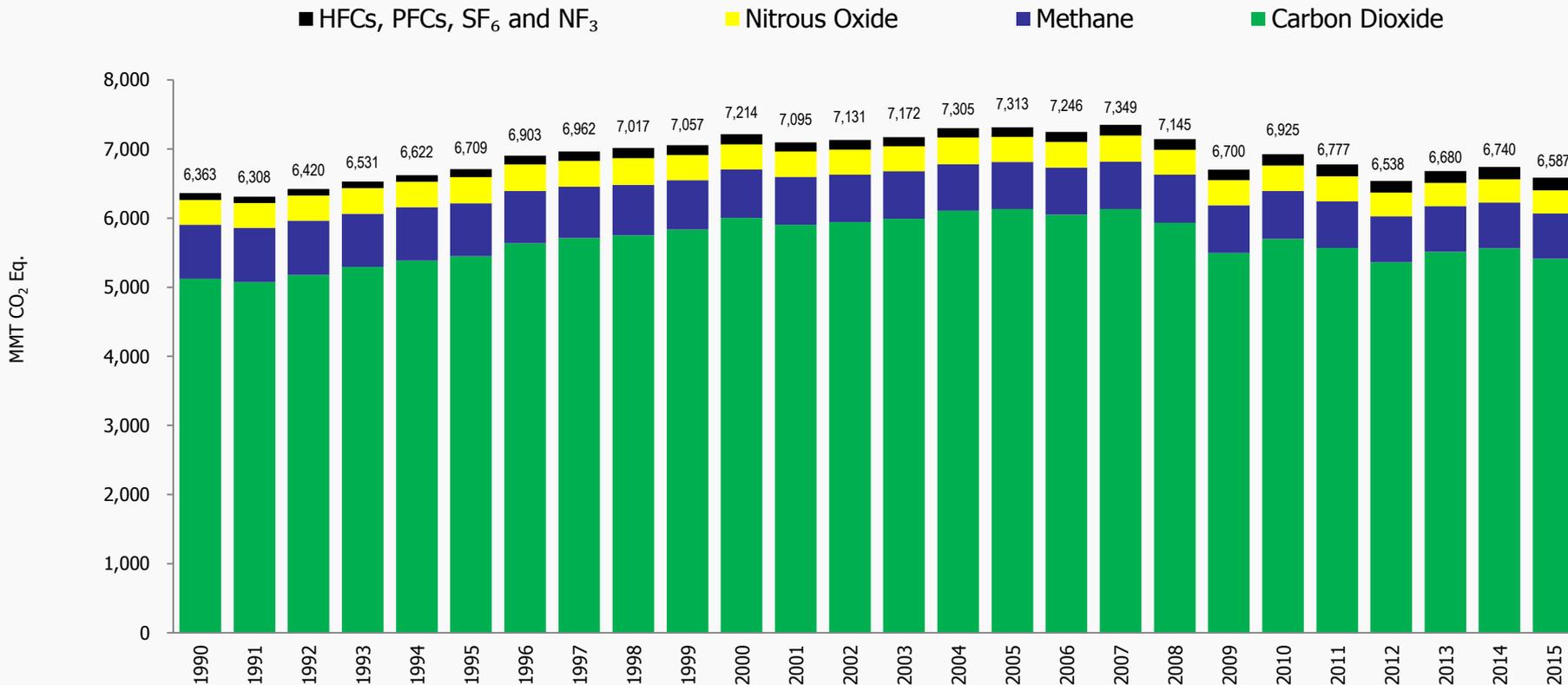


- 2017 GHGI Results Overview
- Oil and Gas CH<sub>4</sub> Trends
- Updates in the 2017 GHGI
- Stakeholder Process for 2018 GHGI
- Planned Improvements
- Areas for Research

2017 GHGI refers to *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2015* (published April 14, 2017)

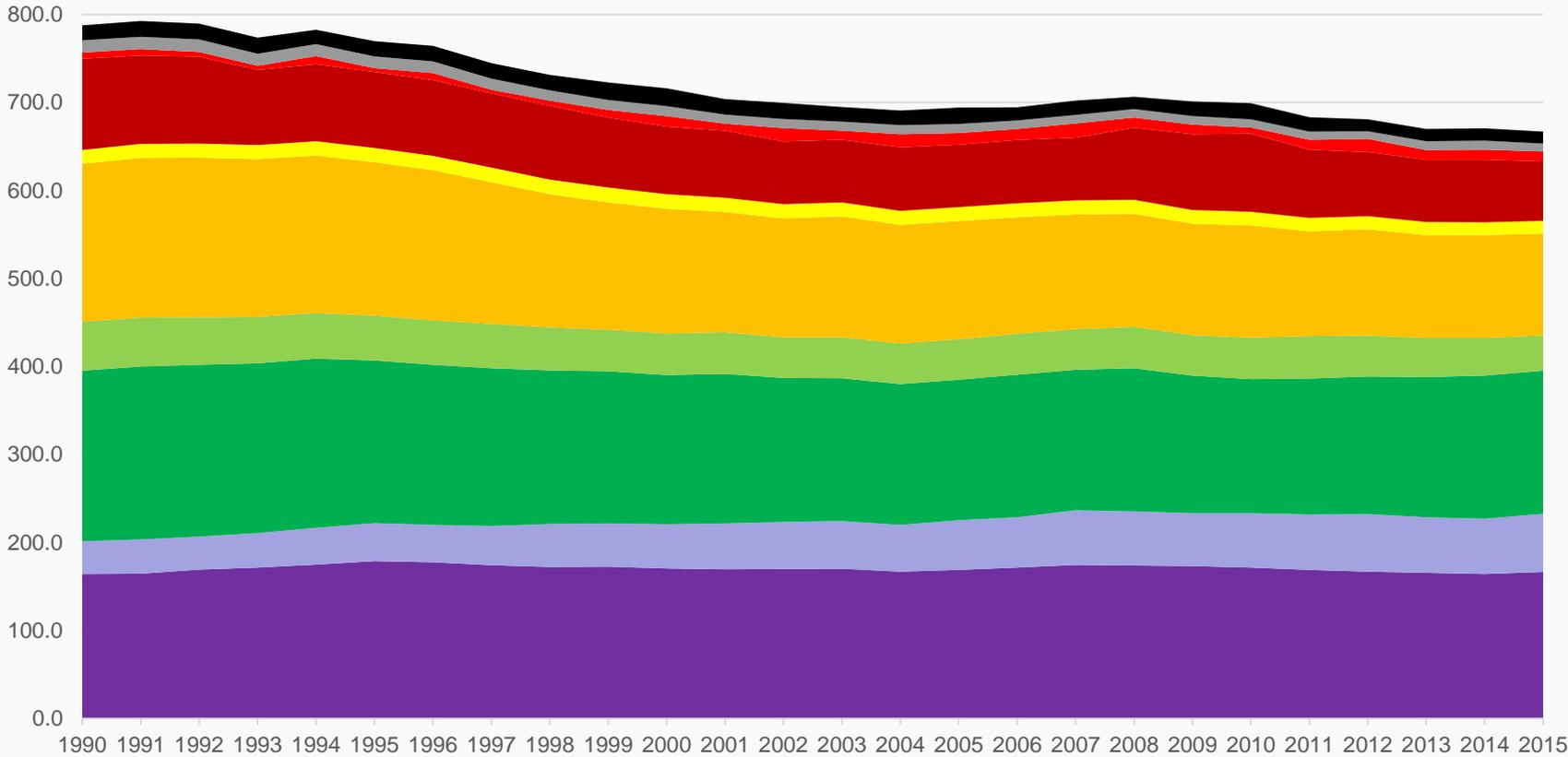
2018 GHGI refers to *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2016* (to be published April 2018)

# 2017 GHG Inventory Results



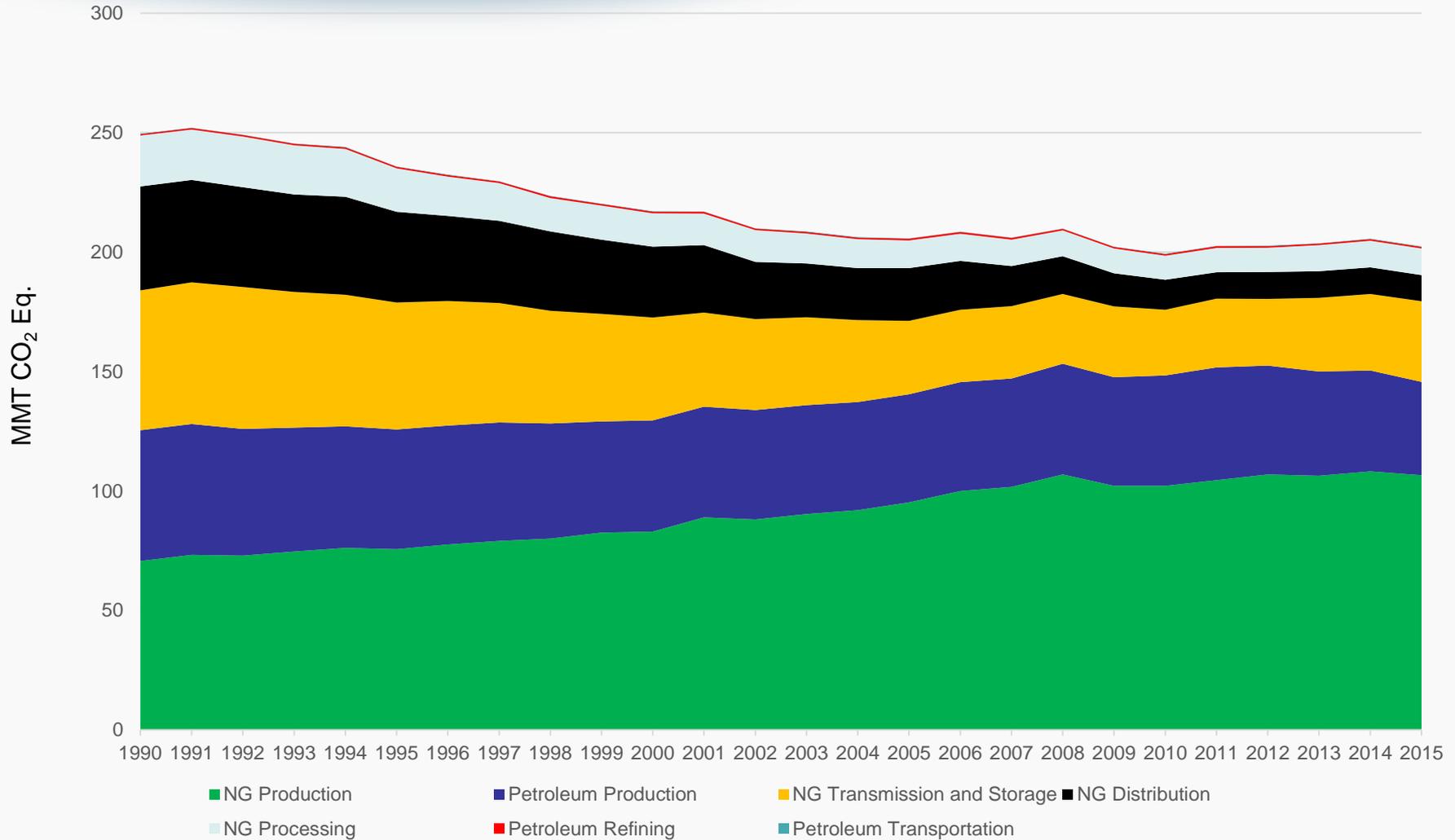
GHG emissions for all anthropogenic (human-caused) sources in the U.S.

# Methane in the 2017 GHGI



- Enteric Fermentation
- Manure Management
- Natural Gas Systems
- Petroleum Systems
- Landfills
- Wastewater Treatment
- Coal Mining, inc. Abandoned Mines
- Land Use Emissions
- Stationary and Mobile combustion
- Other sources

# Oil and Gas CH<sub>4</sub> in the 2017 GHGI



# Oil and Gas CH<sub>4</sub> in the 2017 GHGI



- Large amount of data and information newly available
- Opportunity to re-evaluate and make updates to GHG Inventory
- Stakeholder process
  - Webinar
  - Memos
- Public review draft comments

# Overview of Revisions in 2017 GHGI



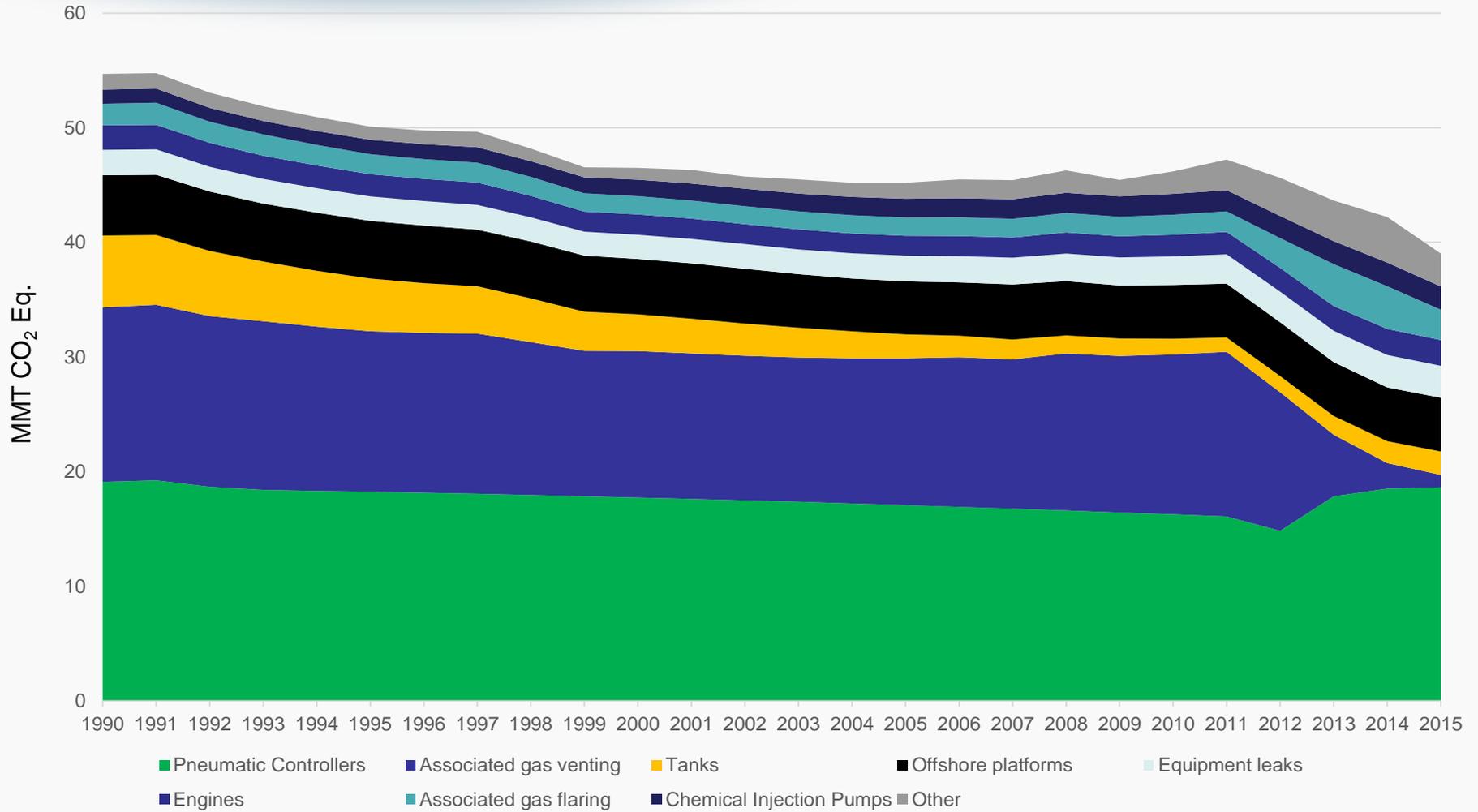
Segment	Last year's 2014 GHGI Estimate	Updates in the 2017 GHGI	Updated 2014 GHGI Estimate
Production	176 MMT CO <sub>2</sub> e	<ul style="list-style-type: none"> <li>• Updated well counts</li> <li>• Additional scaled up GHGRP data-tanks, liquids unloading, associated gas venting and flaring</li> <li>• Improvements to existing incorporation of GHGRP data</li> <li>• Use of Marchese et al. data (EDF) for episodic events in gathering</li> <li>• Reduced use of Gas STAR data</li> </ul>	151 MMT CO <sub>2</sub> e
Processing	24 MMT CO <sub>2</sub> e	<ul style="list-style-type: none"> <li>• Use of GHGRP data for most sources</li> <li>• Removal of Gas STAR data</li> </ul>	11 MMT CO <sub>2</sub> e
Transmission and Storage	32 MMT CO <sub>2</sub> e	No revisions	32 MMT CO <sub>2</sub> e
Distribution	11 MMT CO <sub>2</sub> e	No revisions	11 MMT CO <sub>2</sub> e
<b>Total</b>	<b>244 MMT CO<sub>2</sub>e</b>		<b>206 MMT CO<sub>2</sub>e</b>

# 2017 Updates: Petroleum Production



- Well count data
  - Revised DrillingInfo data set
- Tanks
  - GHGRP and throughput approach
- Equipment counts
  - Improved split between oil and gas wells in GHGRP
- Associated gas well venting and flaring
  - GHGRP data
- Gas STAR reductions
  - Removal of reductions
- Change in calculated emissions
  - Decrease in emissions calculated for 2014 of 25 MMT CO<sub>2</sub> Eq., or 37% (comparing the 2014 value from the previous (2016) GHGI to the 2017 GHGI)
  - Average change in calculated emissions in each year over the time series was an increase of 6%

# Petroleum Production 2017 GHGI

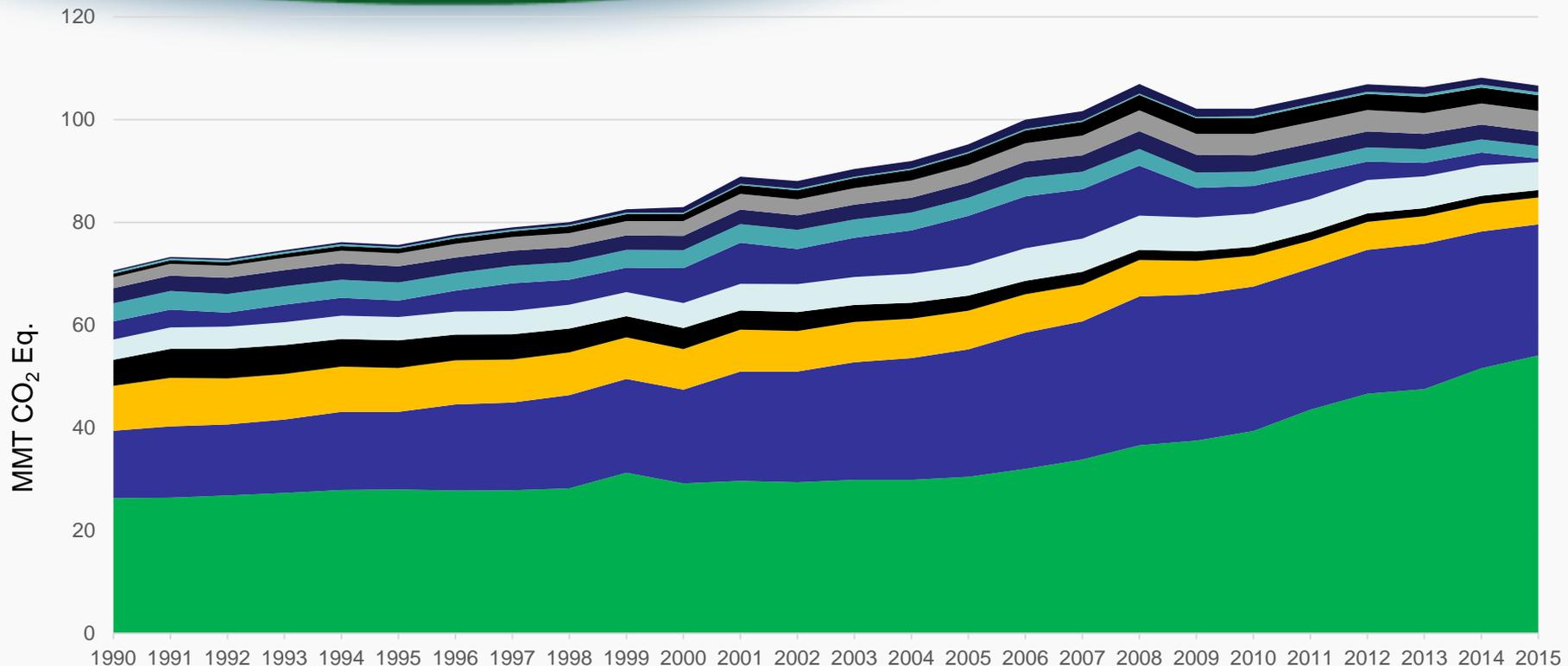


# 2017 Updates: Gas Production



- Well count data
  - Revised DrillingInfo data set
- Tanks
  - GHGRP and throughput approach
- Equipment counts
  - Improved split between oil and gas wells in GHGRP
- Liquids Unloading
  - GHGRP data
- Gathering and boosting episodic emissions
  - Marchese et al. estimate
- Gas STAR reductions
  - Adjustment to reductions
- Change in calculated emissions
  - Decrease in emissions calculated for 2014 of 1 MMT CO<sub>2</sub> Eq., or 1 percent (comparing the 2014 value from the previous (2016) Inventory to the 2017 GHGI)
  - Average change in calculated emissions in each year over the time series was a decrease of 11 MMT CO<sub>2</sub> Eq., or 11 percent.

# NG Production 2017 GHGI



- Gathering and boosting stations (and episodic)
- Pneumatic controllers
- Liquids unloading
- Kimray Pumps and dehydrator vents
- Equipment leaks
- HF gas completions and workovers
- Offshore platforms
- Gas Engines
- Pipeline leaks
- Chemical Injection Pumps
- Tanks
- Other

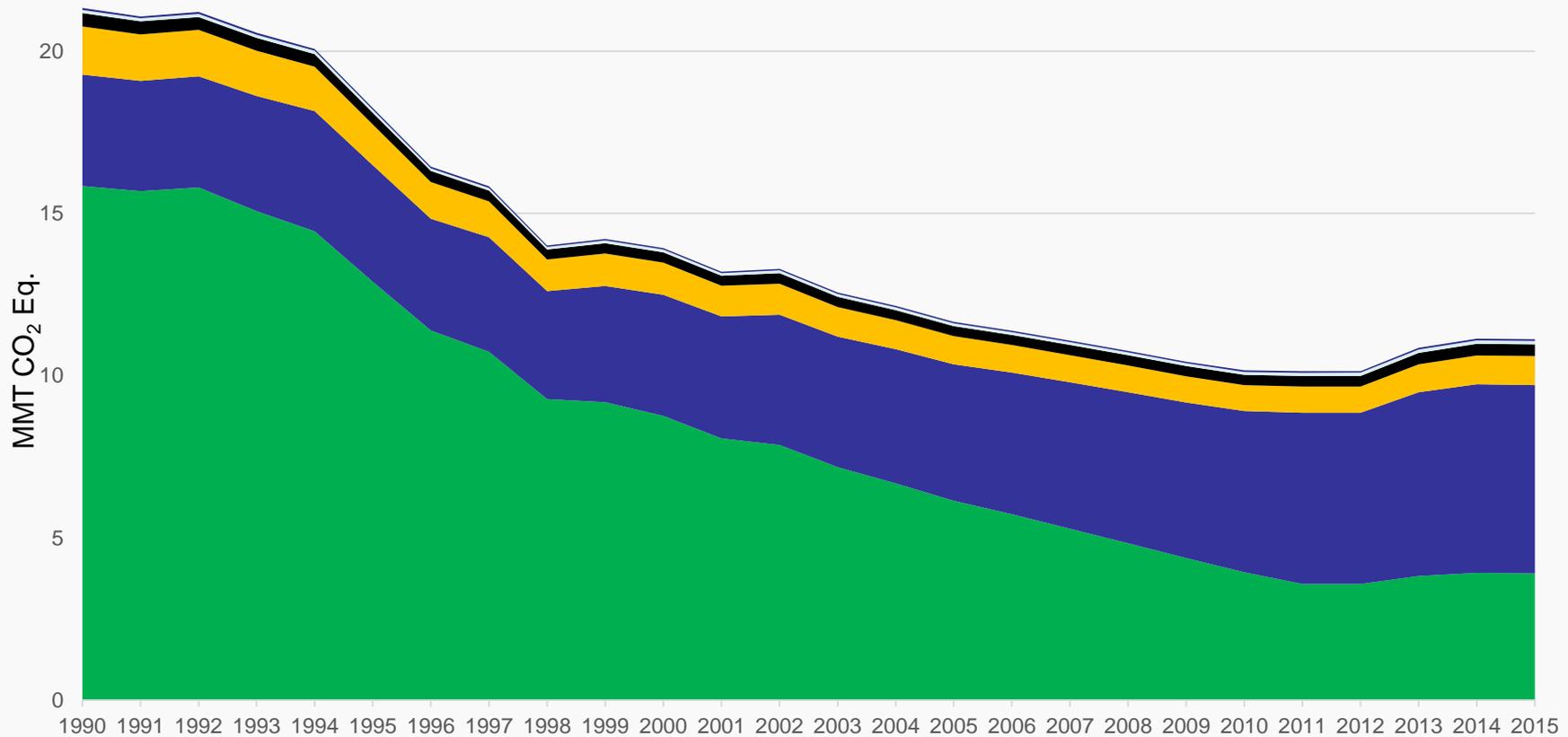
# 2017 Updates: Gas Processing



- Use of GHGRP data
  - Fugitives, compressors, flares, and dehydrators
    - Grouped sources (GRI/EPA and GHGRP cannot be directly compared across individual sources for these sources)
  - Gas engines and turbines
  - Blowdown venting
- Gas STAR reductions
  - Removal of reductions
- Results in a decrease in calculated emissions
  - Decrease in emissions calculated for 2014 of 12.8 MMT CO<sub>2</sub> Eq., or 54% (comparing the 2014 value from the previous (2016) Inventory to the 2017 GHGI)
  - Average change in calculated emissions in each year over the time series was a decrease of 29%

# Processing 2017 GHGI

25



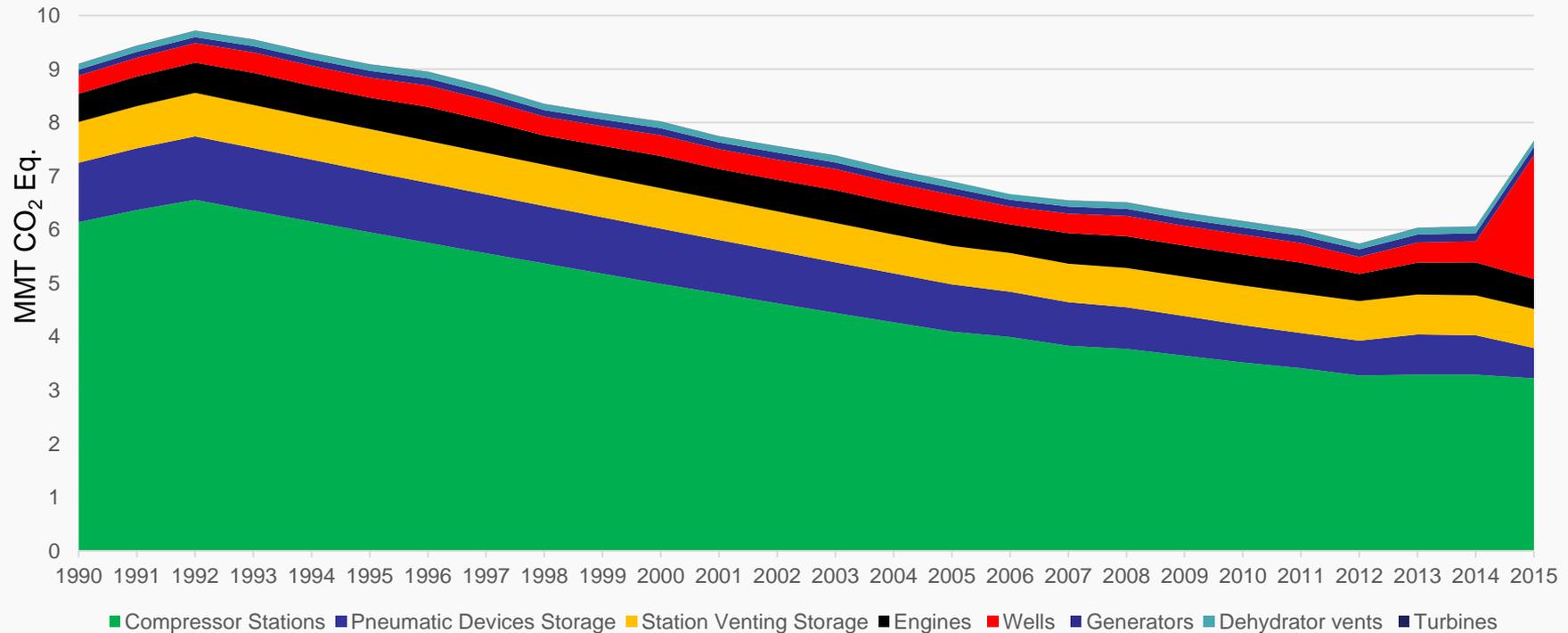
■ Plant grouped emission sources (see below) ■ Gas Engines ■ Blowdowns/Venting ■ AGR Vents ■ Gas Turbines ■ Pneumatic Devices

# 2017 Update: Storage



## Inclusion of Aliso Canyon leak

- Use of ARB estimate, developed from multiple measurements



## Aliso leak in context

- 26% of emissions from storage segment
- 1% of emissions from natural gas systems
- 0.3% of U.S. methane emissions



- Series of webinars and workshops
- EPA invites stakeholder presentations with new data or analyses that could be used to update the GHG Inventory
- EPA invites stakeholder feedback on updates under consideration (Planned Improvements listed in 2017 GHGI), including
  - CO<sub>2</sub> data update
  - Uncertainty
  - Abandoned wells



- EPA considering using GHGRP CO<sub>2</sub> data
  - Improves consistency of data sources and methods between CH<sub>4</sub> and CO<sub>2</sub> in the GHGI
- Would likely result in increase in CO<sub>2</sub> from Petroleum and decrease in CO<sub>2</sub> from Natural Gas Systems
  - In 2017 GHGI, CO<sub>2</sub> from onshore production flaring for both Natural Gas and Petroleum is included in Natural Gas.
  - GHGRP data would allow for an estimate for CO<sub>2</sub> specifically from associated gas flaring, shifting CO<sub>2</sub> from flaring from natural gas to petroleum systems
    - 2015 GHGRP reported total of CO<sub>2</sub> from associated gas venting and flaring is around 10 MMT CO<sub>2</sub>; scaling up to national level based on oil well counts would result in a significantly higher estimate
  - Scaling up tank-related CO<sub>2</sub> emissions to the national level using the same method as used for CH<sub>4</sub> calculations would likely result in an increase in emissions from that category
- EPA is seeking stakeholder feedback on use of GHGRP data to update its CO<sub>2</sub> estimates

# Uncertainty Analysis



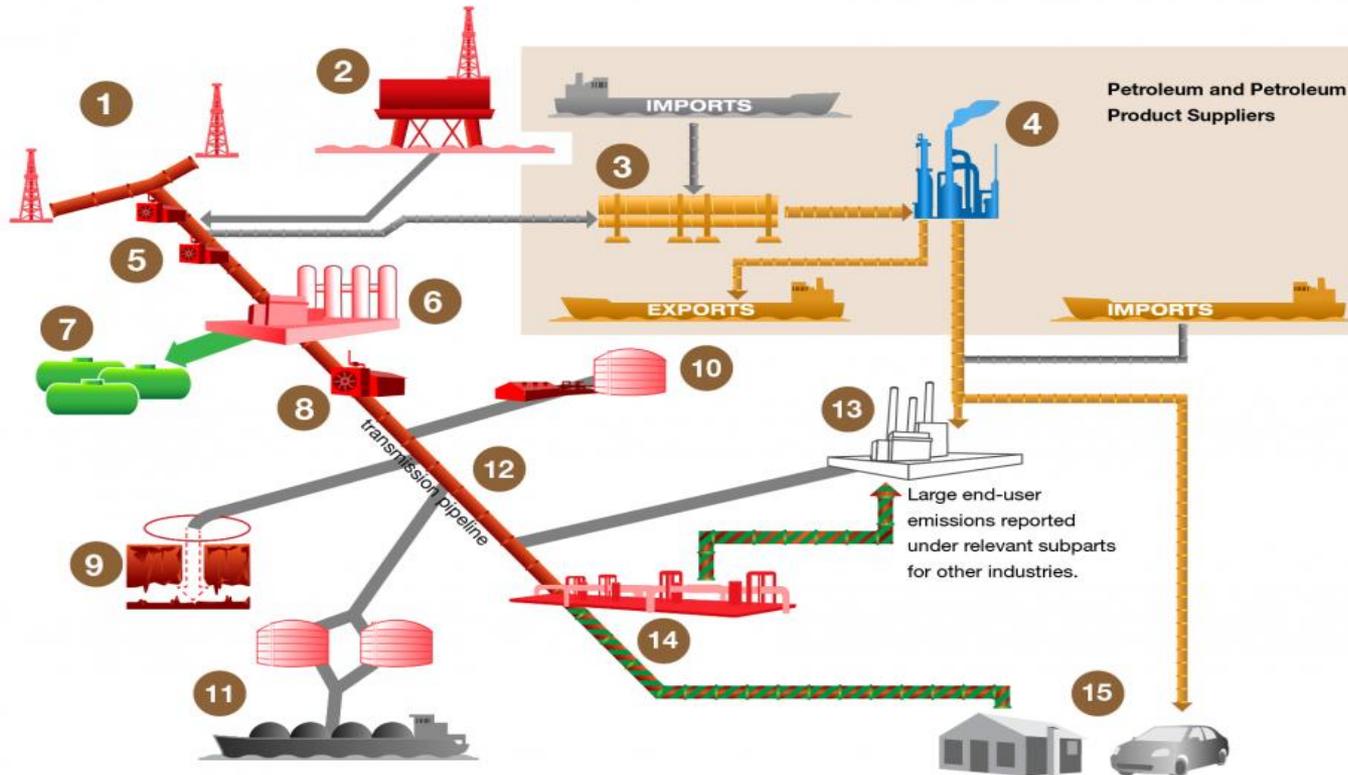
- Uncertainty analysis for natural gas and petroleum systems last updated in 2011 GHGI
- Many of the methods used in the Inventory have changed to reflect improved data and changes in industry practices and equipment.
- New studies and other data sources offer improved understanding of uncertainty of some emission source estimates
- Draft update to the uncertainty analysis reflects the new information and seeks stakeholder feedback on the draft analysis for the 2018 GHGI

# Abandoned Wells



- Abandoned wells not currently included in GHGI
- Several available studies with data on abandoned wells (Townsend-Small et al. 2016; Kang et al. 2016; Brandt et al. 2014)
- EPA considering including an estimate in future GHGI
- Preliminary estimates, based on Townsend-Small et al. (2016) and Brandt et al. (2014), and the split between oil and gas wells in the total producing wells population
  - 2.6 to 3.4 MMT CO<sub>2</sub> Eq. for abandoned oil wells
  - 0.9 to 1.2 MMT CO<sub>2</sub> Eq. for abandoned gas wells
- EPA is seeking emission factors and national activity data available to calculate these emissions

# GHGRP and the Oil & Gas Industry



## Production & Processing

1. Onshore Petroleum & Natural Gas Production
2. Offshore Petroleum & Natural Gas Production
3. Total Crude Oil to Refineries
4. Petroleum Refining
5. Gathering and Boosting  
\*Data collection will begin in RY16
6. Gas Processing Plant  
\*May contain NGL Fractionation equipment
7. Natural Gas Liquids (NGL) Supply

## Natural Gas Transmission & Storage

8. Transmission Compressor Stations
9. Underground Storage
10. Liquefied Natural Gas (LNG) Storage
11. LNG Import-Export Equipment
12. Natural Gas Transmission Pipeline  
\*Data collection will begin in RY16

## Distribution

13. Large End Users
14. Natural Gas Distribution
15. Natural Gas & Petroleum Supply to Small End Users

<span style="color: red;">■</span>	Subpart W: Emissions from petroleum & natural gas systems
<span style="color: blue;">■</span>	Subpart Y: Emissions from petroleum refineries
<span style="color: orange;">■</span>	Subpart MM: CO <sub>2</sub> associated with supplies of petroleum products
<span style="color: green;">■</span>	Subpart NN: CO <sub>2</sub> associated with supplies of natural gas & natural gas liquids
<span style="color: grey;">■</span>	Not reported under GHGRP



- Beginning with Reporting Year 2016, new data collection for:
  - Oil well completions and workovers with hydraulic fracturing
  - Well identification reporting for onshore petroleum and natural gas production
  - Gathering and boosting systems
  - Blowdowns of natural gas transmission pipelines
- Where can I find more information?
  - Federal Register: 80 FR 64262 (October 22, 2015)



- Many sources in GHGI are calculated using GHGRP data
- GHGRP data incorporated in GHGI in several ways
  - e.g., for some sources, year-specific GHGRP information on equipment type
  - e.g., for some sources, 2015 GHG data for emission factors in 2011-2015
- EPA is seeking feedback on alternate approaches for use of GHGRP data in GHGI
  - Regional versus national
  - Year-specific emission factors versus average emission factors or rolling average emission factors

# GHGI Improvements: Research Needs



- Tank malfunction and control efficiency data
- Data for facilities not reporting to GHGRP
- Associated gas venting and flaring 1990-2010
- Refineries and natural gas power plant leaks
- Unassigned high emitters
- Anomalous leak events

# Role of Measurement Studies in Improving Inventories

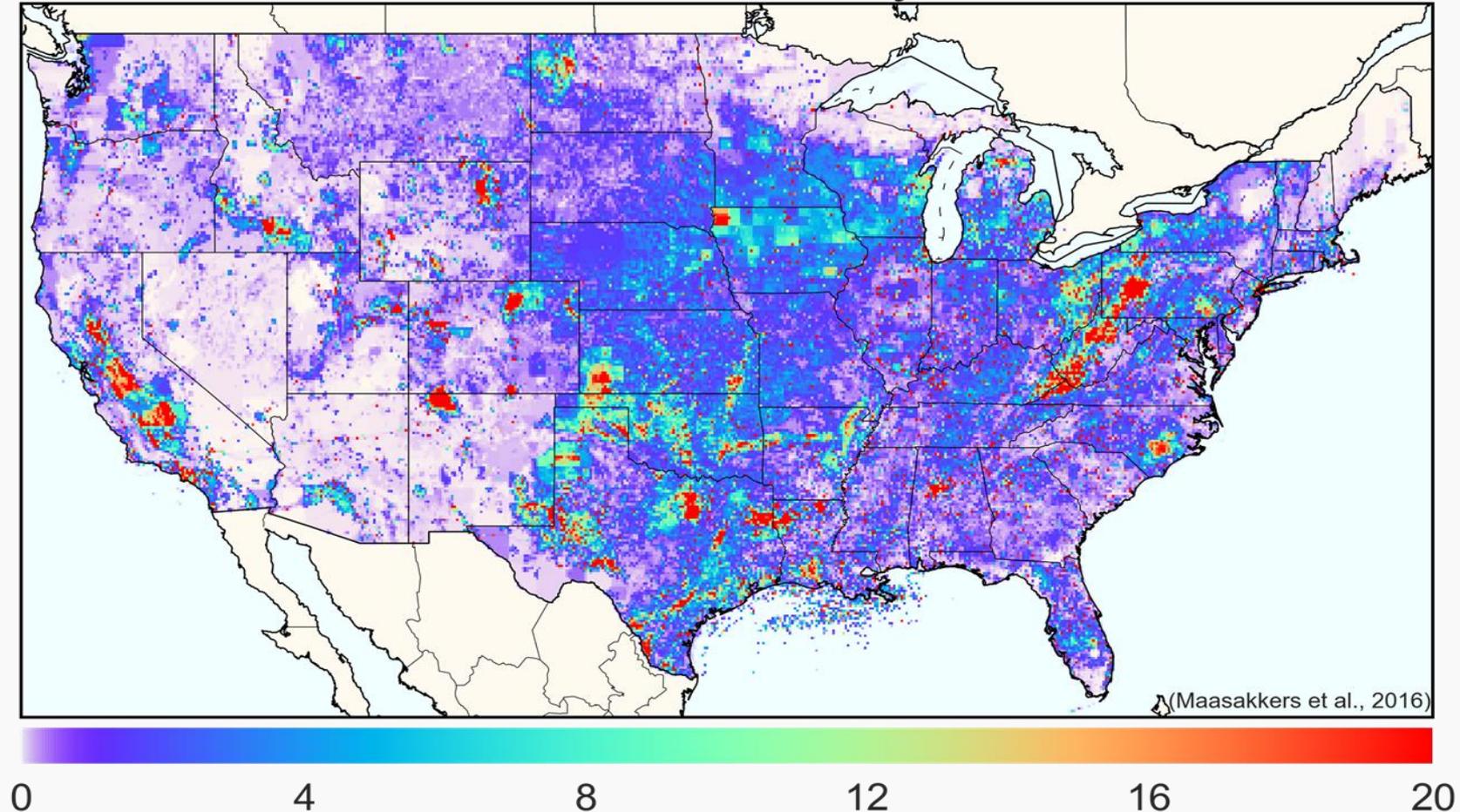


Type of Study	Relevance to GHGI	Key Considerations
Measurement of specific activities, processes and equipment (~bottom up)	Direct improvement to GHGI <ul style="list-style-type: none"><li>• Updates to activity data and emission factors in production (GHGRP)</li><li>• Updates to processing (GHGRP)</li></ul>	<ul style="list-style-type: none"><li>• Providing information on<ul style="list-style-type: none"><li>-Activities taking place at the time of measurements</li><li>--General operating conditions versus high emitting events or malfunctions</li><li>--Controlled versus uncontrolled</li><li>--Representativeness at national / regional levels</li></ul></li></ul>
Inverse modeling (~top down)	General indication of over- or under-estimates <ul style="list-style-type: none"><li>• General support for update (e.g. studies showing high emissions in production areas)</li><li>• Highlights additional questions related to updates (e.g., distribution update, McKain study)</li></ul>	<ul style="list-style-type: none"><li>• Using the appropriate Inventory comparison</li><li>• Seasonal/regional variations</li><li>• Documentation of assumptions and uncertainties</li><li>• Attribution is a challenge</li><li>• Limited ability to pinpoint which data inputs need to be improved</li></ul>

# Gridding of CH<sub>4</sub> in GHGI



## Gridded EPA Inventory for 2012



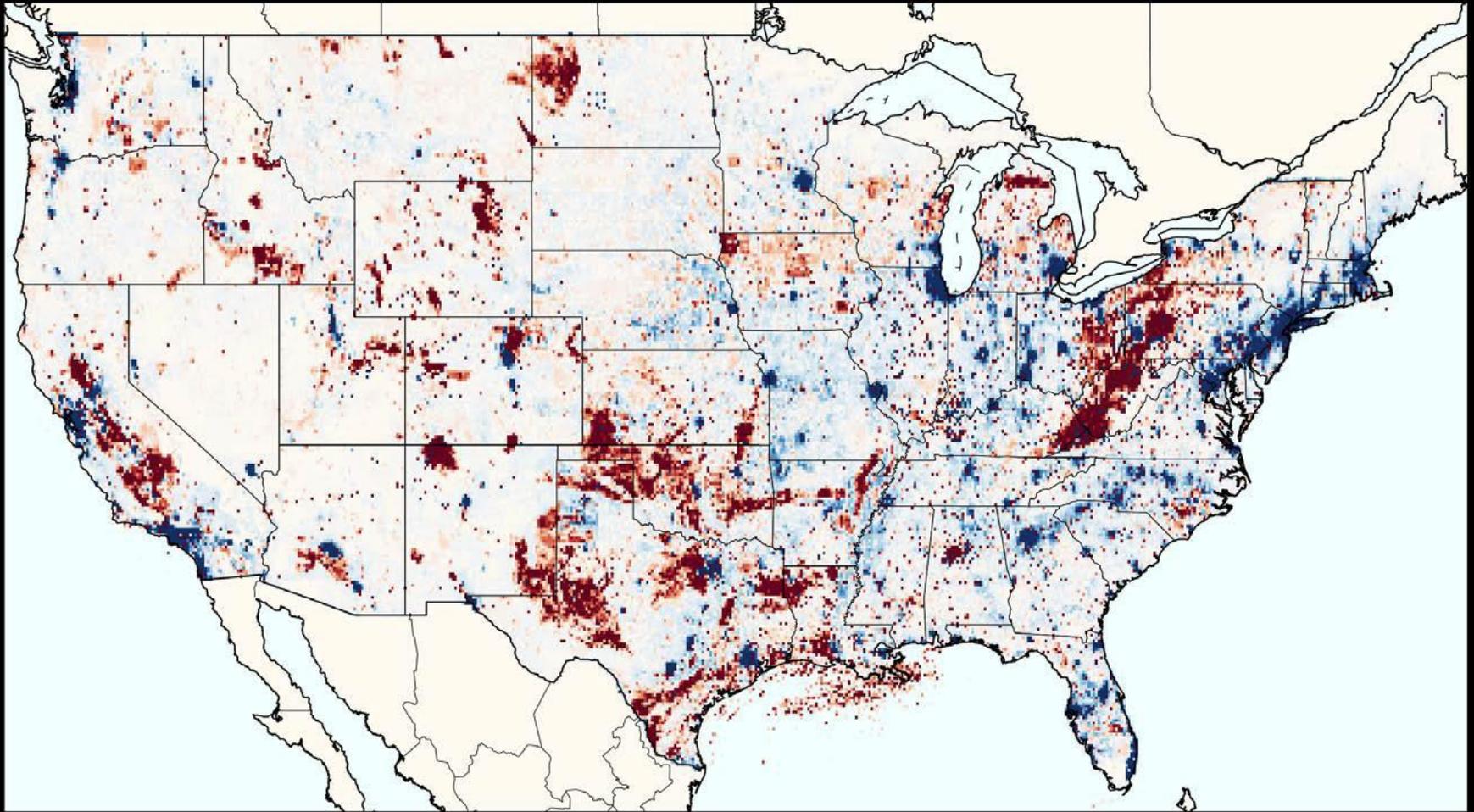
Methane emissions ( $\text{Mg a}^{-1} \text{ km}^{-2}$ )

Includes all methane emissions included in the National Greenhouse Gas Inventory.

# Difference Gridded CH<sub>4</sub> in GHGI - EDGAR



Difference EPA - EDGAR v4.2





- Stakeholder Process: <https://www.epa.gov/ghgemissions/stakeholder-process-natural-gas-and-petroleum-systems-1990-2016-inventory>
- GHG Inventory: <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>
- Additional detail on natural gas and petroleum systems in the GHG Inventory: <https://www.epa.gov/ghgemissions/natural-gas-and-petroleum-systems>
- Relationship of GHGRP and GHG Inventory: <https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory-greenhouse-gas-emissions-and-sinks>
- Petroleum and Natural Gas Systems in GHGRP (Subpart W) data summary: <https://www.epa.gov/ghgreporting/ghgrp-petroleum-and-natural-gas-systems-sector-industrial-profile>
- Envirofacts: <https://www.epa.gov/enviro/greenhouse-gas-customized-search>