Inventory of U.S. GHG Emissions and Sinks: Natural Gas and Petroleum Systems

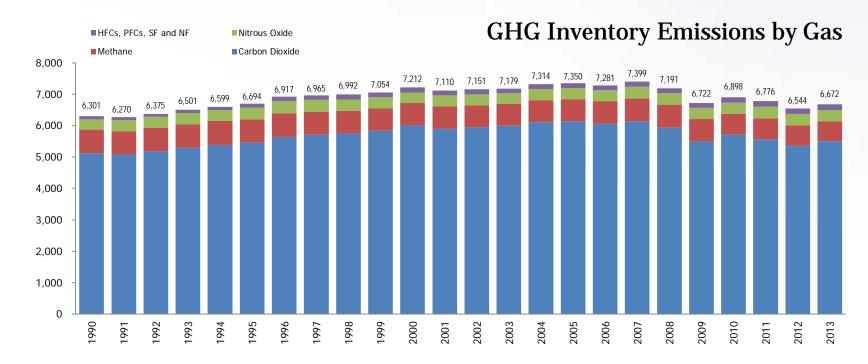Melissa Weitz
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U.S. GHG Inventory Background

- Official U.S. estimate of anthropogenic 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, NF_3
  - Reported in kt of each gas, and as global warming potential (GWP)-weighted CO_2e emissions
- Record of emissions trends over time (1990-most recent)
- Each year, Inventory undergoes expert review, public review, and UNFCCC review

2015 GHG Inventory Results Overview

- US GHG emissions increased 2% from 2012 to 2013
  - Increase of 6% from 1990, decrease of 9% from 2005
- CO_2 from fuel combustion dominates emissions and trends
  - Major contributor to increase in emissions was increased energy consumption across all sectors in the U.S. economy in 2013

GHG Inventory Emissions by Gas

Legend:
- HFCs, PFCs, SF and NF
- Methane
- Nitrous Oxide
- Carbon Dioxide

Y-axis: MMT CO_2 Eq. (0 to 8,000)

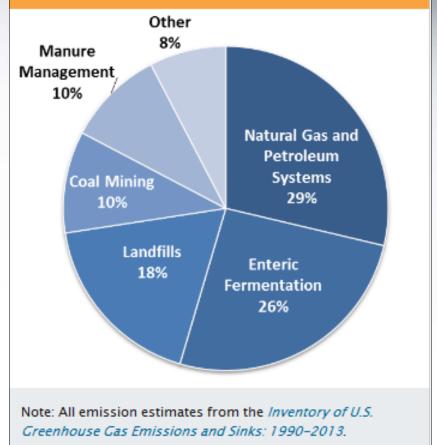| Year	Total
1990	6,301
1991	6,270
1992	6,375
1993	6,501
1994	6,599
1995	6,694
1996	6,917
1997	6,965
1998	6,992
1999	7,054
2000	7,212
2001	7,110
2002	7,151
2003	7,179
2004	7,314
2005	7,350
2006	7,281
2007	7,399
2008	7,191
2009	6,722
2010	6,898
2011	6,776
2012	6,544
2013	6,672

Methane in the GHGI

Methane is a potent greenhouse gas with a global warming potential more than 25 times greater than that of carbon dioxide.

Methane is the second most prevalent greenhouse gas emitted in the United States from human activities, and nearly 30 percent of those emissions come from oil production and the production, transmission and distribution of natural gas.
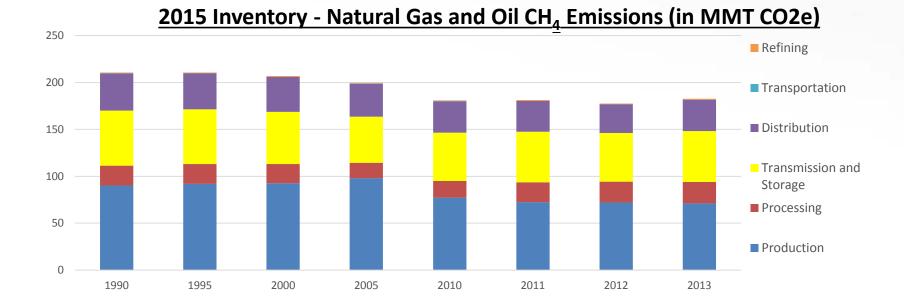
"Other" includes wastewater treatment, rice cultivation, stationary combustion, abandoned underground coal mines, forest fires, and other small sources.

U.S. Methane Emissions, By Source

- Other 8%
- Manure Management 10%
- Coal Mining 10%
- Landfills 18%
- Natural Gas and Petroleum Systems 29%
- Enteric Fermentation 26%

Note: All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2013.*

Oil and Gas Emission Estimates in the US GHG Inventory

- Oil and gas CH_4 accounts for 3% of total U.S. GHG emissions, and 29% of U.S. CH_4 emissions
- 183 MMT CO_2e total CH_4 emissions from oil and gas systems
  - 71 MMT CO_2e from oil and gas production segments
  - 23 MMT CO_2e from processing segment
  - 55 MMT CO_2e from transmission and storage segment
  - 33 MMT CO_2e from distribution segment
- Emissions decreased 28 MMT CO_2e, or 13%, from 1990-2013

2015 Inventory - Natural Gas and Oil CH_4 Emissions (in MMT CO2e)

Calculation of National Emissions

- Calculation: regional versus national
  - Natural Gas production: regional estimates compiled to national
  - All other segments calculated at national level
- Methods
  - Net calculation approaches
  - Potential methane and subtraction of Gas STAR reductions
- Emission factor data sources
  - GHGRP
  - GRI/EPA
  - Others

Calculation: Net Factor Approach

- Approach uses activity data and emission factors distinct for control type categories

Calculation of National Emissions
Step 1. Compile activity data on controls
Step 2. Calculate Net Emissions-Apply net emission factors to the corresponding control categories

Example: Calculation of CH4 from HF Gas well completions and workovers

	Activity Data	Emission Factor, tons CH4 per C/W	Emissions, tons CH4, (MMT CO2e)
HF C&W that vent	1,677	36.8	61,737 (1.5)
HF C&W that flare	835	4.9	4,100 (0.1)
HF C&W with RECs	3,156	3.2	10,229 (0.3)
HF C&W with RECs+flare	2,117	4.9	10,326 (0.3)
Total	7,775	N/A	86,392 (2.2)

Calculation: Potential Factor Approach

- Approach uses GRI/EPA study with detailed equipment counts, emissions measurements and development of emission factors, updates with recent survey data

Calculation of National Emissions

Step 1. Calculate Potential Methane

- Collect activity data on production and equipment in use and apply emission factors (i.e., scf gas per unit or activity)

Step 2. Compile Reductions Data

- Calculate the amount of the methane that is not emitted, using data on voluntary action and state regulations

Step 3. Calculate Net Emissions

- Deduct methane that is not emitted from the total methane potential estimates to develop net CH_4 emissions

Example: 2013 Emissions from pneumatic controllers in transmission sector (2015 Inventory)

Activity Data (# of pneumatics)	Emission Factor (Scf/device)	Calculated Potential (MMTCO$_2$e)	Reductions (MMTCO$_2$e)	Emissions (MMTCO$_2$e)
70,756	x 162,197	= 5.5	- 0.4	= 5.1

Recent Updates to GHG Inventory for Oil and Gas
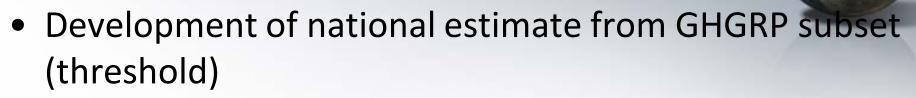
Inventory Year	Update to GHG Inventory Natural Gas Systems Estimate
Inventories through 2010	• GHG estimates for all activities were based on a 1996 GRI/EPA study (1992 data)
2011/2012 Inventories	• Updated estimates of liquids unloading using engineering calculations • Included hydraulically fractured (HF) gas well completions/workovers
2013 Inventory	• Further improvements to liquids unloading estimates using API/ANGA study • Updated HF gas well completions/workovers estimates
2014 Inventory	• Update to approach for estimating emissions from HF gas well completions/workovers to use GHGRP data
2015 Inventory	• **Improved data source for well counts** • **Updated data for offshore oil and gas platforms** • **Updated GHGRP data for HF gas well completions/workovers** • **Use of GHGRP data for refineries** • **Reallocating Gas STAR pneumatic controller reductions**

General Criteria for Evaluating New Data for GHG Inventory

- Representativeness (national, regional, production-level, emissions-level)
- Data on controls, practices, and other relevant information
- Availability of relevant activity data
- Ability to develop emission factors and activity data for the time series
- Robust and transparent sampling approach, measurement method, and key background data

Consideration for Use of GHGRP data in Inventories

- Development of national estimate from GHGRP subset (threshold)
  - Source with no threshold (e.g. petroleum refineries)
  - Use of input data to assess coverage (e.g. well counts comparison to national well counts), and adjust national activity data estimate
- Activity data availability (2015 GHGRP data release)
- Methods GHGRP versus GHGI
- Exit ramp

Time Series Consideration

- Some new studies show very different emissions and activity data from original GHG Inventory data source

- Incorporating new data requires information/assumptions of activities from 1990-2014 to properly apply to emission factors and activity data

  - E.g., does significantly lower GHG in recent studies mean that a source has had emissions reductions or is the new data point different because it is an improved measurement?

- Reviewing data sources for information on when/if changes occurred over time series

Process for Revisions to 2016 GHGI

- Review of new data

- Presentation of revisions under consideration

- Request for stakeholder feedback on key questions and approaches to extend estimate across the time series

- Review of stakeholder feedback and any new data

- Incorporate stakeholder feedback into draft revisions