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

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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
  - CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, NF₃
  - Reported in kt of each gas, and as global warming potential (GWP)-weighted CO₂e 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

- MMT CO$_2$ Eq.
- HFCs, PFCs, SF and NF
- Nitrous Oxide
- Methane
- Carbon Dioxide

<table>
<thead>
<tr>
<th>Year</th>
<th>HFCs, PFCs, SF and NF</th>
<th>Nitrous Oxide</th>
<th>Methane</th>
<th>Carbon Dioxide</th>
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</thead>
<tbody>
<tr>
<td>1990</td>
<td>6,301</td>
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<tr>
<td>1991</td>
<td>6,270</td>
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<tr>
<td>2010</td>
<td>6,898</td>
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<tr>
<td>2011</td>
<td>6,776</td>
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<tr>
<td>2012</td>
<td>6,544</td>
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<tr>
<td>2013</td>
<td>6,672</td>
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</tbody>
</table>
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.

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$_2$e total CH$_4$ emissions from oil and gas systems
  - 71 MMT CO$_2$e from oil and gas production segments
  - 23 MMT CO$_2$e from processing segment
  - 55 MMT CO$_2$e from transmission and storage segment
  - 33 MMT CO$_2$e from distribution segment
- Emissions decreased 28 MMT CO$_2$e, or 13%, from 1990-2013

2015 Inventory - Natural Gas and Oil CH$_4$ Emissions (in MMT CO$_2$e)
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

<table>
<thead>
<tr>
<th>Activity Data</th>
<th>Emission Factor, tons CH4 per C/W</th>
<th>Emissions, tons CH4, (MMT CO2e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF C&amp;W that vent</td>
<td>1,677</td>
<td>36.8</td>
</tr>
<tr>
<td>HF C&amp;W that flare</td>
<td>835</td>
<td>4.9</td>
</tr>
<tr>
<td>HF C&amp;W with RECs</td>
<td>3,156</td>
<td>3.2</td>
</tr>
<tr>
<td>HF C&amp;W with RECs+flare</td>
<td>2,117</td>
<td>4.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,775</strong></td>
<td><strong>N/A</strong></td>
</tr>
</tbody>
</table>
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 CH₄ emissions

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

<table>
<thead>
<tr>
<th>Activity Data (# of pneumatics)</th>
<th>Emission Factor (Scf/device)</th>
<th>Calculated Potential (MMTCO₂e)</th>
<th>Reductions (MMTCO₂e)</th>
<th>Emissions (MMTCO₂e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70,756</td>
<td>x 162,197</td>
<td>= 5.5</td>
<td>- 0.4</td>
<td>= 5.1</td>
</tr>
</tbody>
</table>
# Recent Updates to GHG Inventory for Oil and Gas

<table>
<thead>
<tr>
<th>Inventory Year</th>
<th>Update to GHG Inventory Natural Gas Systems Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventories through 2010</td>
<td>• GHG estimates for all activities were based on a 1996 GRI/EPA study (1992 data)</td>
</tr>
</tbody>
</table>
| 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