



U.S. EPA GHG Emission Data: Natural Gas and Petroleum Systems

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Outline



- EPA GHG emissions data programs
- Inventory of U.S. GHG Emissions and Sinks
- Updating GHG Inventory estimates
- Key considerations for policy-relevant measurement studies

GHG Reporting Program vs. GHG Inventory



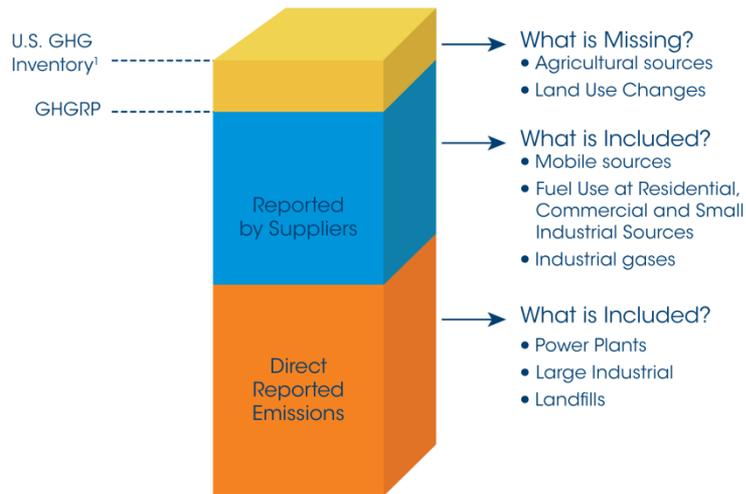
	U.S. GHG Inventory (UN Requirement)	GHG Reporting Program (Facility Reporting by Regulation)
Scale	<ul style="list-style-type: none"> National 	<ul style="list-style-type: none"> Facility
Coverage	<ul style="list-style-type: none"> All U.S. anthropogenic emissions <ul style="list-style-type: none"> Energy Industrial Processes Agriculture and Land Use Waste 	<ul style="list-style-type: none"> ~55% US direct anthropogenic emissions ~30% US indirect anthropogenic emissions (e.g., fuel & chemical suppliers) Over 8,000 facilities Facilities > 25,000 metric tons CO₂ equivalent per year Excludes agriculture
GHGs	<ul style="list-style-type: none"> CO₂, CH₄, N₂O, Fluorinated GHGs 	<ul style="list-style-type: none"> CO₂, CH₄, N₂O, Fluorinated GHGs
Methods	<ul style="list-style-type: none"> IPCC higher “tier” Mix of measurement-based emission factors, models, and GHGRP data 	<ul style="list-style-type: none"> Mix of measurement (continuous, periodic measurements, and sampling), and engineering calculations & emission factors
Time series	<ul style="list-style-type: none"> 1990 – present 	<ul style="list-style-type: none"> Annually, since 2010

EPA GHG Emissions Data Programs



- 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

GHGRP Covers the Majority of U.S. GHG Emissions



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 <u>reported</u> emissions by state		✓



Inventory of U.S. Greenhouse Gas Emissions and Sinks

U.S. Greenhouse Gas Emissions Inventory

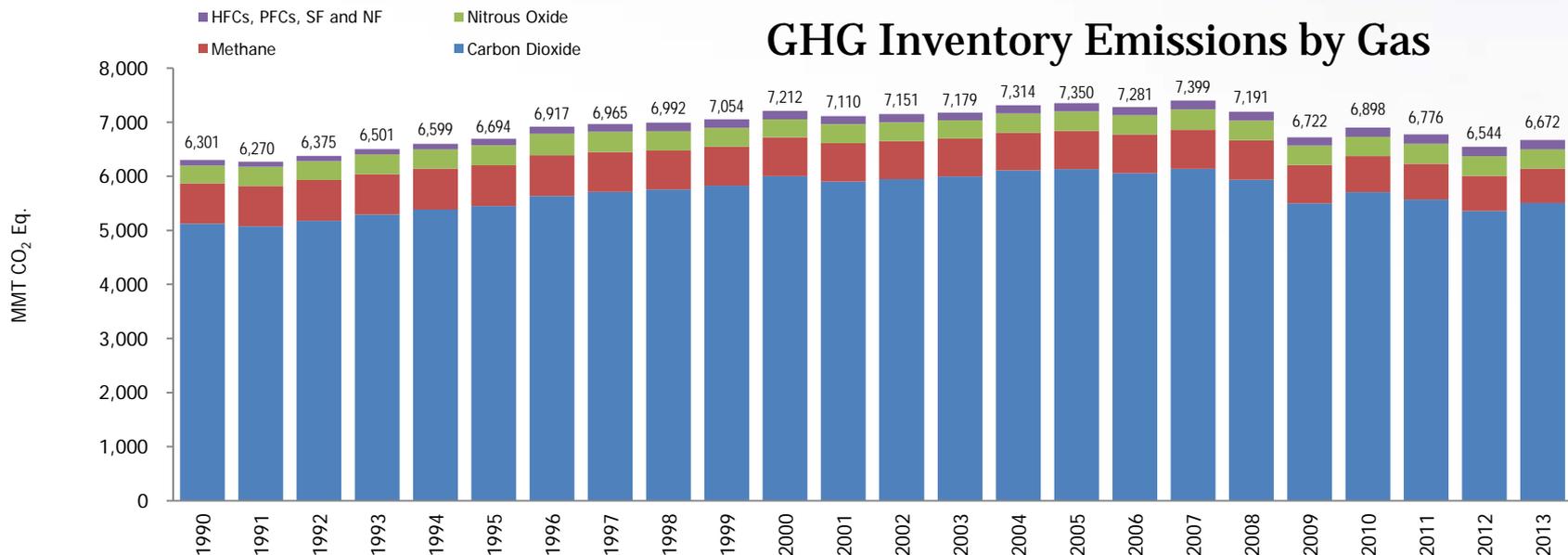


- Official U.S. estimate of greenhouse gas emissions for reporting to United Nations Framework Convention on Climate Change (UNFCCC)
 - Annual national-level inventory submissions to the UNFCCC since 1994
- EPA leads Inventory development, working with several agencies
 - e.g. input data on forestry from USFS, data on energy from EIA
- Sectors Covered
 - Energy, Industrial Processes, Agriculture, Land-Use Change and Forestry, and Waste
- Gases Covered
 - CO₂, CH₄, N₂O, HFCs, PFCs, SF₆
 - Reported in Gg of each gas, and as global warming potential (GWP)-weighted CO₂e emissions
- Record of emissions trends over time
- Each year, Inventory undergoes expert review, public review, and UNFCCC review

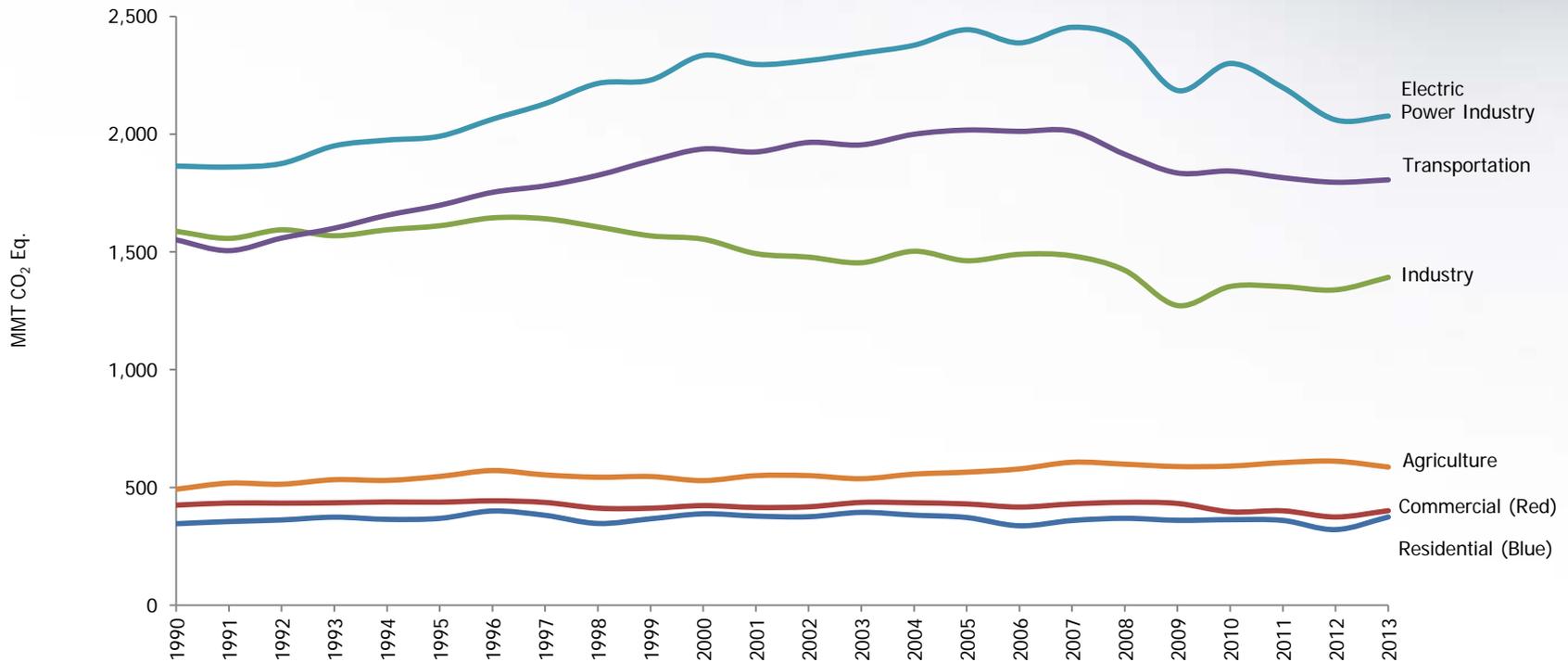
2015 GHG Inventory Results Overview



- US GHG emissions increased 2% from 2012 to 2013
 - Increase of 6% from 1990, decrease of 9% from 2005
- CO₂ from fuel combustion dominate emissions and trends
 - Major contributor to increase in emissions was increased energy consumption across all sectors in the U.S. economy, and increases in the carbon intensity for electricity generation due to increased reliance on coal generation in 2013



2015 Inventory by Economic Sector

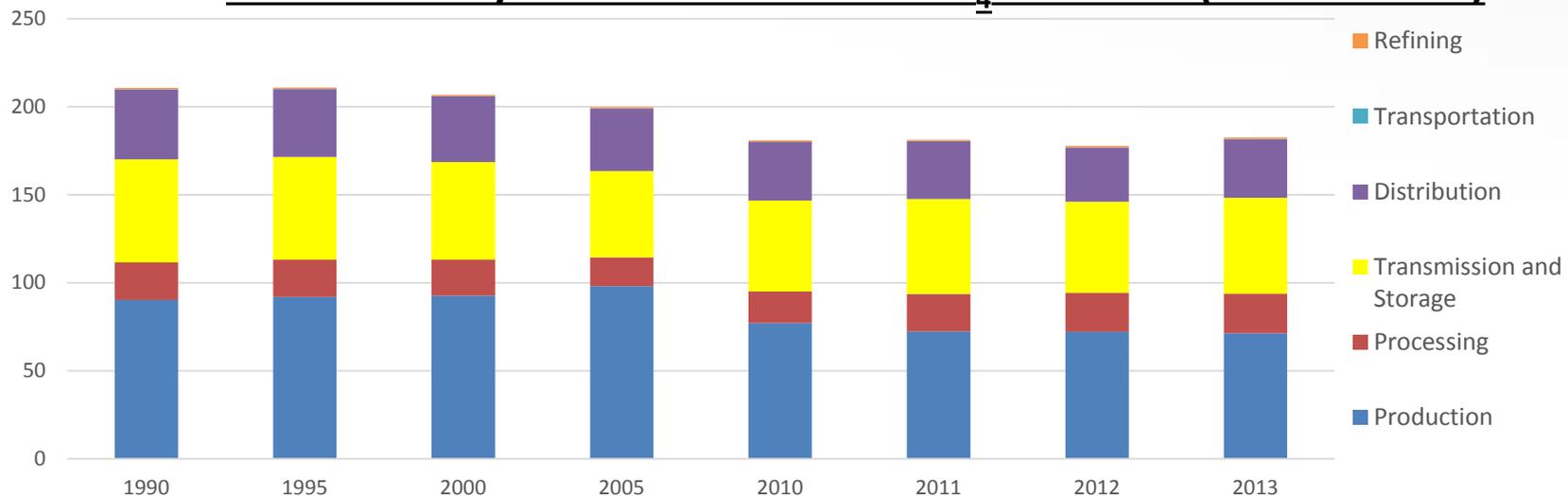


Oil and Gas Emission Estimates in the US GHG Inventory



- Oil and gas CH₄ account for 3% of total U.S. GHG emissions, and 29% of U.S. CH₄ emissions
- 183 Tg CO₂e total CH₄ emissions from oil and gas systems
 - 71 MMT CO₂e from oil and gas production segments
 - 23 MMT CO₂e from processing segment
 - 55 MMT CO₂e from transmission and storage segment
 - 33 MMT CO₂e from distribution segment
- Emissions decreased 28 Tg CO₂e, or 13%, from 1990-2013
- EPA continues to update estimates to reflect best available information

2015 Inventory - Natural Gas and Oil CH₄ 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 CH ₄ per C/W)	Emissions (tons CH ₄)
HF C&W that vent	1,677	36.8	61,737
HF C&W that flare	835	4.9	4,100
HF C&W with RECs	3,156	3.2	10,229
HF C&W with RECs+flare	2,117	4.9	10,326
Total	7,775	N/A	86,392



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: 2012 Emissions from pneumatic devices in transmission sector (2014 Inventory)

Activity Data (# of pneumatics)	Emission Factor (Scf/device)	Calculated Potential (MMTCO ₂ e)	Reductions (MMTCO ₂ e)	Emissions (MMTCO ₂ e)
70,827	x 162,197	= 4.7	- 0.3	= 4.4

Increasing Stakeholder Interest in CH₄



- Interest in EPA estimates
 - Many changes in natural gas industry practices in recent years
 - e.g. hydraulic fracturing; control technologies
 - General interest in role of short-lived climate forcers
 - Fuel-switching implications
 - e.g. power and transport sectors
- Increased EPA engagement with stakeholders
 - Expert and public review processes of the GHG Inventory
 - Stakeholder workshops and webinars
 - External studies
- Stakeholder data and information has led to recent improvements in GHG Inventory estimates

Recent Updates to GHG Inventory for Oil and Gas



Inventory Year	Update to GHG Inventory Natural Gas Systems Estimate
Inventories through 2010	<ul style="list-style-type: none">• GHG estimates for all activities were based on a 1996 GRI/EPA study (1992 data)
2011/2012 Inventories	<ul style="list-style-type: none">• Updated estimates of liquids unloading using engineering calculations• Included hydraulically fractured (HF) gas well completions/workovers
2013 Inventory	<ul style="list-style-type: none">• Further improvements to liquids unloading estimates using API/ANGA study• Updated HF gas well completions/workovers estimates
2014 Inventory	<ul style="list-style-type: none">• Update to approach for estimating emissions from HF gas well completions/workovers to use GHGRP data
2015 Inventory	<ul style="list-style-type: none">• 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



Updating GHG Inventory Estimates

- **GHGRP**
- **External study data**

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

GHGRP: Overview

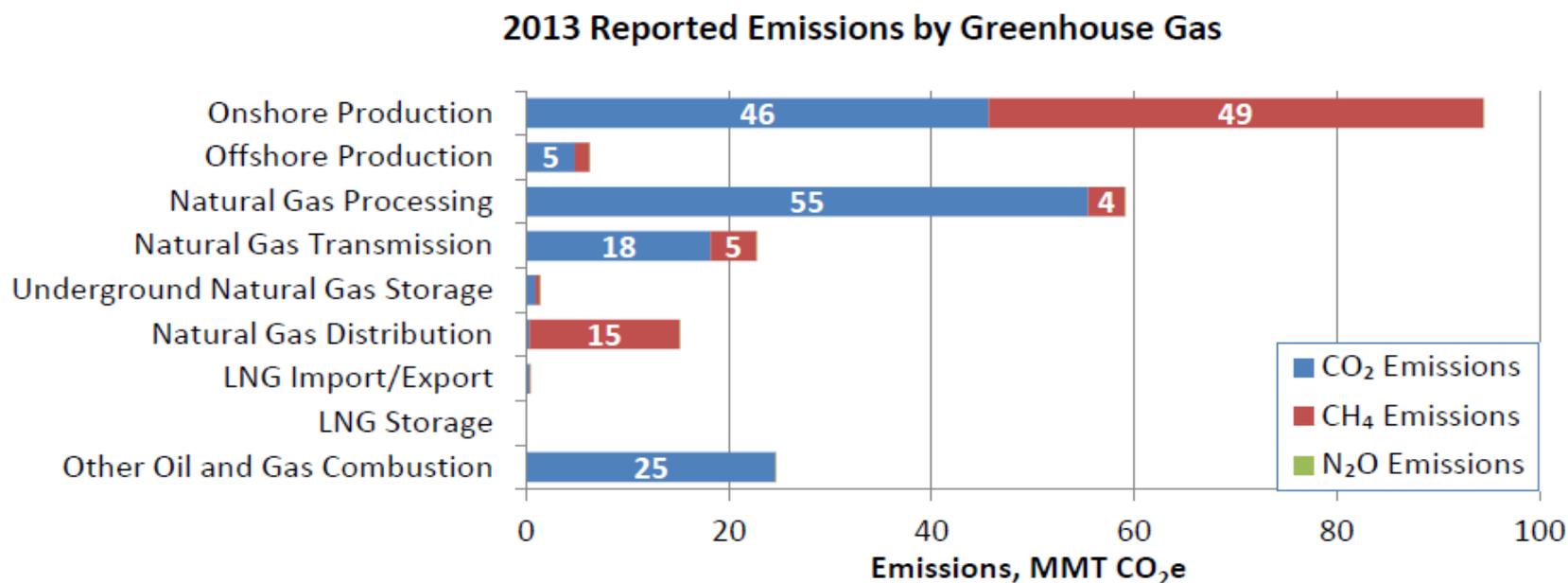


- Launched in response to FY 2008 Consolidated Appropriations Act
- Annual reporting of GHGs by 41 source categories
 - 33 types of direct emitters
 - 6 types of suppliers of fuel and industrial GHGs
 - Facilities that inject CO₂ underground for geologic sequestration, enhanced oil recovery, or any other 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 published 4 years of data for 29 source categories and 3 years of data for 12 source categories
- Facilities use uniform methods prescribed by 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
- Direct reporting to EPA electronically
- EPA verification of GHG data

GHGRP: 2013 Reported Emissions by Greenhouse Gas



- Carbon dioxide (CO₂) emissions accounted for 150 MMT CO₂e and methane (CH₄) emissions accounted for 74 MMT CO₂e
- 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 includes combustion and process emissions
GHGRP data as of 8/18/2014



Consideration for Use of GHGRP data in Inventories



- Threshold
 - Methods to develop national estimate
 - No threshold-petroleum refineries
 - GHGRP activity data versus national activity data
 - Use of input data to assess coverage (e.g. well counts comparison to national well counts)
- Methods
- Exit ramp

Oil and Gas GHGRP data in GHG Inventory



- Use of GHGRP data to update methods
 - Use of GHGRP data to update HF emissions methodology with practice-specific factors instead of potential factor
 - Petroleum refineries-replacement of GHGI estimate
- Future use of GHGRP
 - Activity data available in 2015
- QC of GHGI estimates and identification of areas for review
 - Sources where GHGRP indicates over- or under- estimates
 - E.g., 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
 - Evaluation of regional GHGRP data compared to GHGI regional data
 - Evaluation of GHGRP trends compared to GHGI trend for recent years

General Criteria for Evaluating External Studies



- 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

Methane Measurement Studies



- Several recent studies have measured CH₄ emissions at the national or regional level, with estimates that differ from EPA's emissions estimate
 - Some studies compare to EPA inventory; some to other bottom-up data
- 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 of emissions and 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

Role of Methane Measurement Studies in Improving Inventories



Type of Study	Example	Feedback to inventories
Assessing effectiveness of global efforts to reduce emissions through trends in atmospheric concentrations	IPCC Assessment Reports	<ul style="list-style-type: none">• n/a
Independent verification of inventory estimates through inverse modeling	NOAA verification studies	<ul style="list-style-type: none">• General conclusions about potential over- and under-estimates• Source attribution is a challenge• Limited ability to pinpoint which data inputs need to be improved
Measurement of specific activities, processes and equipment to develop improved emission factors	UT-Austin/EDF studies	<ul style="list-style-type: none">• Direct improvements, if measurements are representative• Sample size and access to facilities can be a challenge

Key Considerations for Policy-Relevant Measurement Studies



- Top down
 - Using the right bottom up Inventory comparison
 - EDGAR is not U.S. GHG Inventory
 - Seasonal/regional variations important
 - Natural sources
 - Clearly communicating assumptions and uncertainties
- Bottom up
 - Providing information on activities taking place at the time of measurement and their national/regional representativeness
 - General operating conditions
 - High-emission venting events
 - Controlled versus uncontrolled

Accessing EPA GHG Data



- U.S. GHG Inventory (National-level data)
 - <http://www.epa.gov/climatechange/ghgemissions/userinventoryreport.html>
- Facility-Level GHGRP Reporting Data
 - <http://www.epa.gov/ghgreporting/>

Greenhouse Gas Emissions Data

Information and data about greenhouse gas emissions are available at the global, national, facility, and individual levels.

Global



Find out more about global greenhouse gas emissions and trends.

[Learn More »](#)

National



Review EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks* report, which contains annual estimates of greenhouse gas emissions and removals associated with human activities, for each year since 1990.

[Learn More »](#)

Facility



Explore facility-level greenhouse gas data collected through EPA's Greenhouse Gas Reporting Program data. You can view emissions from individual facilities or from many facilities organized by sector or state.

[Learn More »](#)

Individual



Use EPA's Individual Greenhouse Gas Emissions Calculator to estimate your carbon footprint.

[Learn More »](#)