Climate Pollution Reduction Grants: GHG Inventory & Projections 101 for States

June 1, 2023

Welcome

Housekeeping Notes:

- Mics are automatically muted for all registrants and all cameras should be turned off.
- Links to additional resources will be provided in the Chat during the presentations.
- Please enter all questions in the Q&A tab at the TOP of the screen. Questions will be answered during the Q&A session (*Reserved for Grantees*).
- We encourage you to answer the poll questions which will pop-up periodically throughout the training (*Reserved for Grantees*).
- Slides will be shared after the training.
- A recording will be posted to the website for those who were unable to attend.

Disclaimer

CPRG Inventory and Projections 101 Training

- CPRG GHG Inventory and Projections Requirements for States

- GHG Inventory 101
  - What is an Inventory
  - What to Include
  - Estimation Methods
  - Selecting Base Years

- Tools and Resources
  - US GHG Inventory by State
  - State GHG Inventory & Projection Tool
  - US non-CO_2 GHG Projections by State
  - Sector Specific Tools
  - Other Data and Resources

CPRG Requirements

CPRG Requirements – GHG Inventory

Priority Climate Action Plan (PCAP) Due: March 1, 2024	Comprehensive Climate Action Plan (CCAP) Due: 2 years from award (summer-fall 2025)	Status Report Due: 4 years from award (2027)
Simplified inventory. Using existing data, including a previously published state inventory, or data from EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State, US GHG Reporting Program, or National Emissions Inventory is acceptable.	A comprehensive inventory must include all GHG emissions and sinks by emission source and sink category following commonly accepted protocols for the following sectors: industry, electricity generation and/or use, transportation, commercial and residential buildings, agriculture, natural and working lands, and waste and materials management.	As part of its Status Report, state and metropolitan area planning grant recipients are encouraged to provide an update of the comprehensive GHG inventory included in their CCAP

EPA is not requiring a specific start year, or base year; inventory years or time series start year should be chosen based on availability of underlying data and to support development of GHG targets.

FITTING THE TOOLS TOGETHER

Start With
- US GHGI by State
- Existing Inventory

Sufficient for PCAP

Next, Customize and Enhance
- State Inventory Tool
- Other Tools

Targeted/In-Depth Analysis
- MOVES
- WARM
- Etc.

Reported Data
- US Greenhouse Gas Reporting Program
- State Programs
- National Emissions Inventory

CPRG Requirements – GHG Emissions Projections

Priority Climate Action Plan (PCAP) Due: March 1, 2024	Comprehensive Climate Action Plan (CCAP) Due: 2 years from award (summer-fall 2025)	Status Report Due: 4 years from award (2027)
Not Required	Near-term (e.g., 2030-2035) and long-term (e.g., 2050) projections of GHG emissions are required to be included in the CCAP. This element includes projections of GHG emissions (and sinks, if feasible) in the absence of plan measures (e.g., a "business-as-usual" projection), and a projection of GHG emissions under a scenario where the plan is fully implemented. The inclusion of sector-based projections is strongly recommended (e.g., establishing a separate GHG emissions projection for transportation, electricity generation, commercial and residential buildings, industry, agriculture, and waste and materials management). Grant recipients with existing GHG projections may use those projections, but are encouraged to update, modify, or expand those projections for the CCAP as appropriate.	Strongly encouraged to update their projected GHG emissions for the Status Report, if new information warrants it

GHG Inventory 101

What is a GHG Inventory?

- A greenhouse gas inventory is a historical accounting of the amount of greenhouse gases emitted to, or removed from, the atmosphere over a specific historical period of time (e.g., one year) from all various activities across the economy

- A state-level GHG inventory documents the activities that cause GHG emissions and removals within the state

- GHGs are emitted and sequestered from a variety of categories, and the magnitude of emissions and/or sinks for each category varies state, depending on economic and other state circumstances

What Should be Included

- Comprehensive or economy-wide [anthropogenic] estimates *[PCAP may be streamlined]*
- Cover primary GHGs (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3)
- Developing a time-series can be useful for tracking trends and progress toward goals
- Common organizational approaches to apportioning emissions and sinks
  - **Inventory Sector** (UNFCCC/IPCC) – uses internationally accepted reporting sectors including Energy (includes transportation, buildings, industry, etc), and non-energy sectors, i.e., Industrial Process and Product Use, Agriculture, Land Use and Forestry Sectors, and Waste sectors
  - **Economic Sector** –uses economic end-use sector e.g., Transportation, Electric Power, Industry, Agriculture, Commercial, Residential
  - **Alternate Accounting –** includes approaches needed for state policies, legislation e.g., consumption-based accounting of electricity emissions
- Report in CO_2 equivalent units to facilitate comparison of gases and aggregation of emissions and sinks
  - EPA GHG data uses 100-year GWPs from IPCC Fifth Assessment Report (AR5) per international reporting standards

Estimation Methods

- Several approaches, and choice depends on availability of data and nature of source/sink determines method to ensure transparent, representative emissions, for example:
  - Emissions Factor (EF) *activity data (AD)
    - e.g., emissions = (emissions/unit of fuel consumption)* fuel consumption
  - Aggregation of facility level or site-specific emissions data
    - e.g., use of annual GHGRP data for MSW landfills, Coal Mining
  - Emissions modeling
    - useful for characterizing complex systems with multiple variable and time dependencies (e.g., Agricultural Soil Management, use of ODS substitutes, harvested wood products, etc.)
- Based on internationally-accepted methodological framework (e.g., Intergovernmental Panel on Climate Change (IPCC) guidelines)

Selecting a Base Year

- CPRG Guidance does not specify a base year to use

- Considerations
    - Does your state have goals or targets that specify a base year?
    - Do significant programs and policies that reduce emissions include base years?
    - Are there anomalies present in the base year (uncharacteristically high or low emissions)?
    - Will a base year provide needed information to evaluate GHG measures?
    - Will the base year be compatible with base years being used elsewhere?
    - Is the data available?

    Choose a base year that is realistic and meets your specific needs

Tools and Resources

Inventory of U.S. GHG Emissions and Sinks by State

- Annual publication of state-level GHG data, fully disaggregating national Inventory across the 50 states for all gases, sectors/categories
  - Consistent with the national Inventory in terms of emission and removal totals across the time series, from 1990 to the most recent inventory year (e.g., this year it will extend to 2021)
    - Letter peer review completed in Fall 2021
  - Updated on annual basis, published after national inventory (e.g., 3rd publication via EPA GHG Data Explorer planned for late summer each year, i.e., August 2023)
    - 30-day annual state expert review (July 2023)
    - Publish responses to feedback (Fall 2023)
  - See https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals
- Data caveats
  - This dataset should not be viewed as official data of any state government, and we provide information on how to access up-to-date official data from states where it exists
  - Fact sheets on data differences - Comparing EPA state-level GHG data with official state Inventories (i.e., scope, accounting approaches, time series, etc.) and Relationship to EPA's State Inventory Tool (SIT))

Inventory of U.S. Greenhouse Gas Emissions and Sinks by State (cont.)

In order to be consistent with the Inventory of U.S. Greenhouse Gas Emissions and Sinks (national) report, state-level estimates:

- Adhere to international standards, including the Intergovernmental Panel on Climate Changes (IPCC) Guidelines and United Nations Framework Convention on Climate Change (UNFCCC) transparency reporting system

- Are based on the same methodologies as the national *Inventory* and reflect the latest methodological improvements in the national *Inventory*, including the use of Greenhouse Gas Reporting Program (GHGRP) data.

- Cover all anthropogenic sources and sinks, and all seven gases (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3)

- Cover the complete time series consistent with the national Inventory, starting with 1990 through the latest national Inventory year (i.e., 2021)

- Estimates were compiled to avoid double counting or gaps in emissions coverage between States. This ensures that State totals, when summed, will equal totals in the national *Inventory*. This is important for those looking for consistent, comparable, and complete state data for analyses and other purposes where double counting or omissions would be problematic

Differences Between EPA Data and Existing State Data

- Definition/organization of sectors (e.g., states including some Industrial Process sources in Energy sector)

- Different methods/data than those used by EPA

- Differences in accounting approaches (e.g., due to state legislation/goals)
  - Consumption-based accounting approaches (i.e., inclusion of "Scope 3" emissions that occur outside state's geographic boundaries)
  - Varying approaches to estimating transportation, including cross-border aviation and marine emissions
  - Treatment of biogenic CO_2

- Time series

- Use of Global Warming Potentials (GWPs) other than 100-year GWP from IPCC Fifth Assessment Report (AR5) used by EPA per international reporting standards (i.e., UNFCCC)

- Fact sheet on potential differences with existing state GHG data available @ https://www.epa.gov/system/files/documents/2022-03/fact-sheet-differences-epa-and-offical-state-ghgi.pdf

EPA GHG Data: U.S. GHG Inventory (GHG Inventory) and GHG Reporting Program (GHGRP)

- Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHG Inventory), the U.S. official GHG Inventory submission to UNFCCC, tracks total annual U.S. emissions across all sectors of the economy, using mostly national-level data
- GHGRP collects detailed emissions data from large greenhouse gas emitting facilities in the United States, as directed by the Clean Air Act
  - GHGRP covers most, but not all, U.S. GHG sources and sinks (i.e., GHGRP does not include agriculture, land use, and small sources)

GHGRP Covers the Majority of U.S. GHG Emissions

Task	Inventory of U.S. GHG Emission and Sinks	Greenhouse Gas Reporting Program (GHGRP)
Find total U.S. emissions and sinks	✔	
Review trend data for the past 20+ years	✔	
Browse a map to find the largest emitters in your area		✔
Compare facility emissions across an industrial sector		✔
Find state-level data	Totals for sources/sinks ✔	Reported ✔

Use of GHGRP data in EPA State GHGI Data

- GHGRP collects detailed emissions data from large greenhouse gas emitting facilities in the United States, as directed by the Clean Air Act
  - GHGRP covers most, but not all, U.S. GHG sources and sinks (i.e., GHGRP does not include agriculture, land use, and small sources)
  - Transparent, verified data reported starting in 2010 and 2011 through 2022
  - Need to consider definitions, reporting thresholds, etc.
- Annual data is used across several Inventory sectors (e.g., energy, industrial process/product use, and waste) and facilitates a range of improvements
  - Source of emissions data, but also annual activity data (e.g., clinker production)
    - Some sector estimates previously depended on decades-old data (as only available data set)
  - Improved total estimates (i.e., direct use of aggregated emissions)
    - e.g., for national GHGI, using MSW Landfills directly reported net emissions from GHGRP, updated annually
  - Derivation of state, technology, and/or process-specific emission and/or other activity factors (e.g., petrochemicals and industrial gas subsectors)
  - Better understanding of industry trends and emission reduction efforts (e.g., use of lower-emitting technologies at oil and gas wells, landfills, nitric acid, aluminum production)
    - Emissions in rapidly changing sectors could not otherwise be reflected
  - QA/QC (comparing estimates, comparing activity data)

Access EPA State-Level GHG Data

GHG Data Explorer

View and download state data for 1990-2020 and trend/pie charts by inventory or economic sector and/or gas (1990-2021 data is coming)

Link:

https://cfpub.epa.gov/ghgdata/inventoryexplorer/

Supplemental State Data Tables and Methodology Report
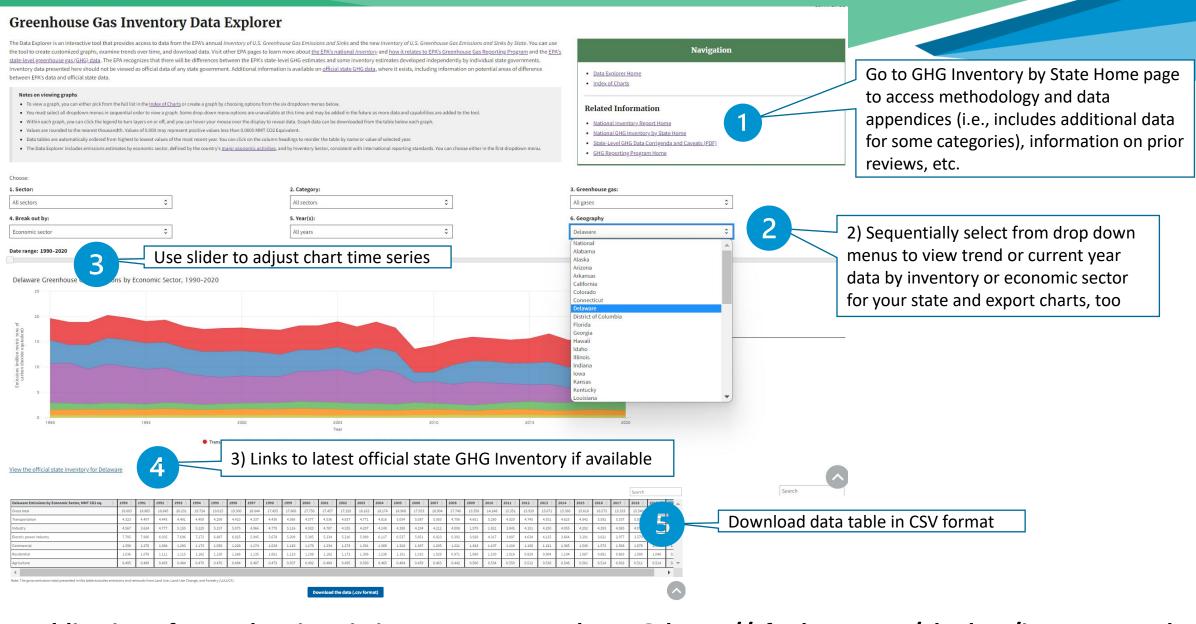
Download excel-based state GHG data table, summarizing emissions and sinks and details on disaggregation methods

- Gas
- Inventory (UNFCCC/IPCC) sector
- Economic sector, and
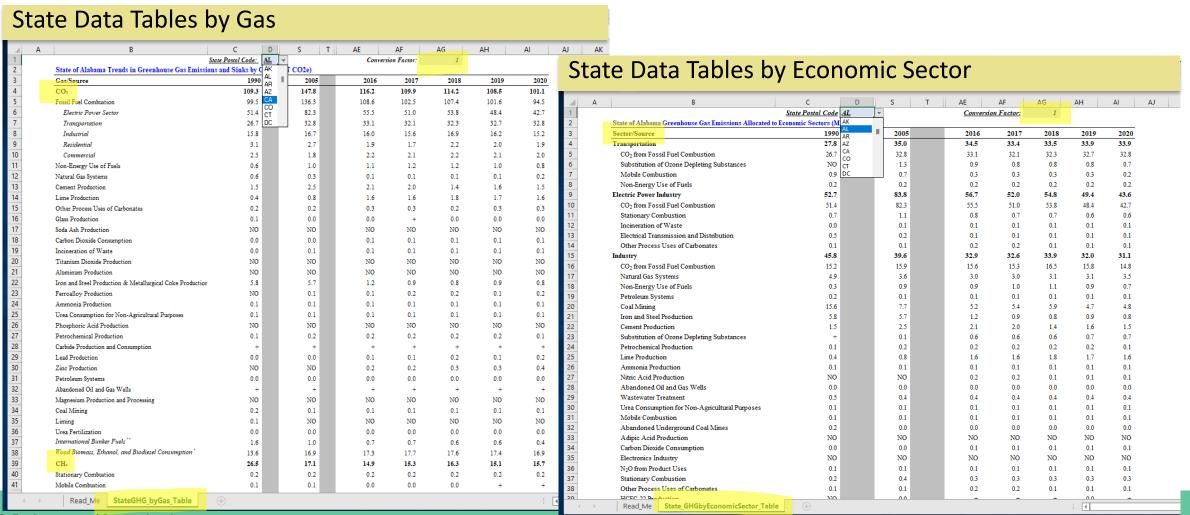- More detail on the land use, land use change and forestry sector

Link:

https://www.epa.gov/ghgemissions/methodology-report-inventory-us-greenhouse-gas-emissions-and-sinks-state-1990-2020

Greenhouse Gas Inventory Data Explorer

The Data Explorer is an interactive tool that provides access to data from the EPA's annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks* and the new *Inventory of U.S. Greenhouse Gas Emissions and Sinks by State*. You can use the tool to create customized graphs, examine trends over time, and download data. Visit other EPA pages to learn more about the EPA's national *Inventory* and how it relates to EPA's Greenhouse Gas Reporting Program and the EPA's state-level greenhouse gas (GHG) data. The EPA recognizes that there will be differences between the EPA's state-level GHG estimates and some inventory estimates developed independently by individual state governments. Inventory data presented here should not be viewed as official data of any state government. Additional information is available on official state GHG data, where it exists, including information on potential areas of difference between EPA's data and official state data.

Notes on viewing graphs
- To view a graph, you can either pick from the full list in the Index of Charts or create a graph by choosing options from the six dropdown menus below.
- You must select all dropdown menus in sequential order to view a graph. Some drop-down menu options are unavailable at this time and may be added in the future as more data and capabilities are added to the tool.
- Within each graph, you can click the legend to turn layers on or off, and you can hover your mouse over the display to reveal data. Graph data can be downloaded from the table below each graph.
- Values are rounded to the nearest thousandth. Values of 0.000 may represent positive values less than 0.0005 MMT CO2 Equivalent.
- Data tables are automatically ordered from highest to lowest values of the most recent year. You can click on the column headings to reorder the table by name or value of selected year.
- The Data Explorer includes emissions estimates by economic sector, defined by the country's major economic activities, and by Inventory Sector, consistent with international reporting standards. You can choose either in the first dropdown menu.

Navigation
- Data Explorer Home
- Index of Charts

Related Information
- National Inventory Report Home
- National GHG Inventory by State
- State-Level GHG Data Corrigenda and Caveats (PDF)
- GHG Reporting Program Home

Choose:

1. Sector: All sectors
2. Category: All sectors
3. Greenhouse gas: All gases
4. Break out by: Economic sector
5. Year(s): All years
6. Geography: Delaware

(1) Go to GHG Inventory by State Home page to access methodology and data appendices (i.e., includes additional data for some categories), information on prior reviews, etc.

(2) 2) Sequentially select from drop down menus to view trend or current year data by inventory or economic sector for your state and export charts, too

(3) Use slider to adjust chart time series

(4) 3) Links to latest official state GHG Inventory if available

(5) Download data table in CSV format

View the official state inventory for Delaware

Download the data (.csv format)

Publication of state data in existing GHGI Data Explorer @ https://cfpub.epa.gov/ghgdata/inventoryexplorer/

Quick View of Data Tables

State Data Tables by Gas

State Data Tables by Economic Sector

U.S. Environmental Protection Agency

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Areas for Improving State GHG Inventories
Inventories should be a "living" analysis

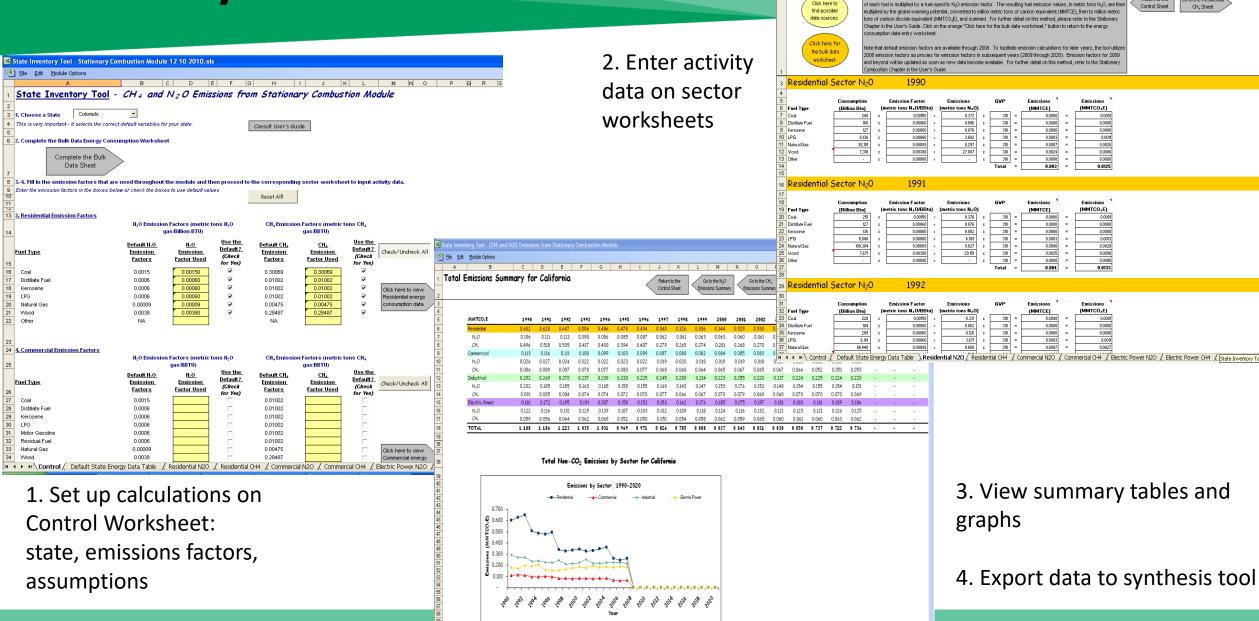| Transparency	Accuracy (managing uncertainties)	Consistency	Completeness	Comparability
• Ensure stakeholders and public can understand how the estimates were compiled	• Incorporate updated or new data (e.g., reported data from GHGRP or other similar programs) • Reflect new methods based on latest science (e.g., 2019 Refinement to 2006 IPCC GL)	• Track emissions and sinks using consistent methods/data over reported time series to reflect real trends (e.g., going back to start year)	• Cover all anthropogenic sources and sinks for which methods are available (i.e., incorporating new sources to improve completeness of the estimates)	• Ensuring estimates are organized/ classified so that they are comparable with data from other states

- Focus resources on significant or "key" sources and sinks that influence current GHG levels and trends overtime

- Improvements can also consider inventory management systems to facilitate regular publication of inventories over time (e.g., documentation, archiving, improvement tracking, etc.)

EPA's State GHG Inventory Tool

- Interactive Excel tool that quickly calculates default state-level GHG emissions and allows customization of activity data and emissions factors

- Comprised of 12 Excel modules
  - 10 sector modules paralleling the National Inventory by State
  - 1 optional Electricity Consumption module
  - 1 synthesis module that combines all sectors

- Current modules have 1990-2020 data; 2021 data available in December

- Updates coming in late June: build out calculation framework to 2025, move to AR5 GWPs, include additional land use change categories, etc

  https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool

Inventory Tool Flow

2. Enter activity data on sector worksheets

3. View summary tables and graphs

4. Export data to synthesis tool

1. Set up calculations on Control Worksheet:
state, emissions factors, assumptions

EPA's State GHG Projection Tool

- Companion Excel tool that allows simple GHG emissions projections based on historical trends and projected activity

- Currently compiles projections for 2021-2050

- Uses population (Census), animal population (USDA), and energy consumption projections (Annual Energy Outlook) as defaults—users can customize those data

- The tool relies on published analyses (e.g., AEO) which may not reflect recent regulations; the tool does not itself model the impacts of specific actions or policies

Non-CO$_2$ GHG Projections and by State

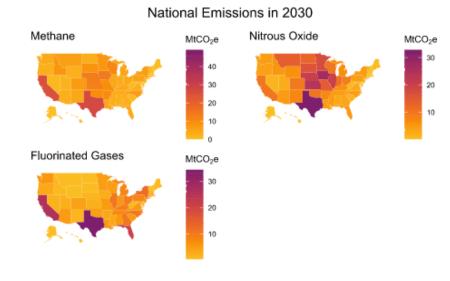EPA Report: U.S. State-level Non-CO$_2$ Greenhouse Gas Mitigation Potential: 2025-2050

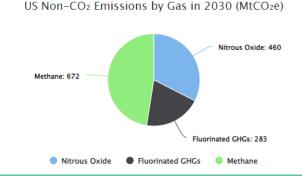- Provides projections of non-CO$_2$ GHG emissions at the state-level through 2050

Report Characteristics	
Projections	**Mitigation**
Through 2050, focus 2030	
U.S. 50 States	
Downscaled U.S. state-level estimates using national-level projections	U.S. state estimates
Business-as-usual (not modeling current policy)	Not a policy/market barrier analysis - Technical emissions reduction potential
Mitigation included from historical data	Known mitigation options and technological change (e.g. cost reductions through learning and deployment)

Sector/Source	CH$_4$	N$_2$O	HFCs	PFCs	SF$_6$	NF$_3$
Energy						
Natural gas and oil systems	•					
Coal mining activities	•					
Stationary and mobile combustion	•	•				
Biomass combustion	•	•				
Industrial Processes						
Adipic acid and nitric acid production		•				
Use of substitutes for ozone-depleting substances[a]			•			
HCFC-22 production			•			
Electric power systems					•	
Metals						
Primary aluminum production				•		
Magnesium manufacturing					•	
Electronics manufacturing			•	•	•	•
Agriculture						
Agricultural soils		•				
Livestock						
Enteric fermentation	•					
Manure management	•					
Rice cultivation	•	•				
Waste						
Landfilling of solid waste	•					
Wastewater	•	•				

Non-CO$_2$ GHG Projections by State: Methods

- Projections generated with a combination of the U.S. state-level GHGI and projected emissions from the U.S. Fourth Biennial Report (BR) submission to the U.N. Framework Convention on Climate Change (UNFCCC).

- Historical emission estimates were incorporated from national reported data from 1990 through 2019 and emissions were projected through 2050.

- The state-level GHGI proportions were used to downscale the BR national emission projections to display sub-national detail.
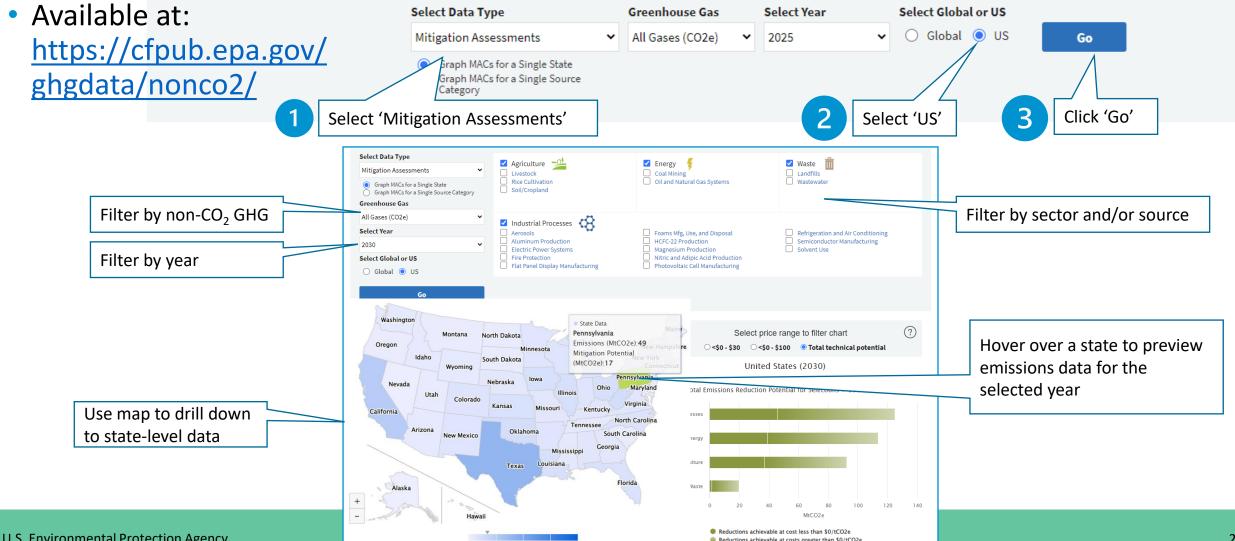

National Emissions in 2030

Methane — MtCO$_2$e

Nitrous Oxide — MtCO$_2$e

Fluorinated Gases — MtCO$_2$e

US Non–CO$_2$ Emissions by Gas in 2030 (MtCO$_2$e)

Nitrous Oxide: 460

Methane: 672

Fluorinated GHGs: 283

Nitrous Oxide   Fluorinated GHGs   Methane

View State-level Non-CO₂ GHG Data

Visit the web summary report

- Available at: https://cfpub.epa.gov/ghgdata/nonco2/

1 Select 'Mitigation Assessments'

2 Select 'US'

3 Click 'Go'

Filter by non-CO₂ GHG

Filter by year

Filter by sector and/or source

Hover over a state to preview emissions data for the selected year

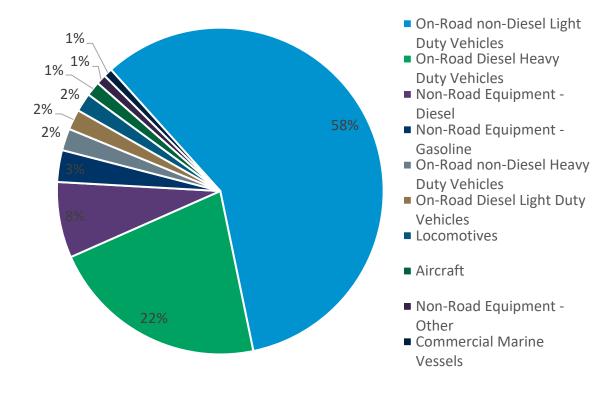Use map to drill down to state-level data

Sector-Specific Emissions Inventories

- Developing a detailed, sector-specific GHG emissions inventory may be useful for developing sector GHG projections.

- Additional detail in sector-based inventories can help identify targeted reduction measures.

- For example, a transportation sector inventory that identifies sub-sector emissions makes it easy to see which sub-sectors to prioritize.

Example Transportation Sector CO_2 Inventory to Target Reduction Measures

Pie chart values:
- 58%
- 22%
- 8%
- 3%
- 2%
- 2%
- 2%
- 1%
- 1%
- 1%

Legend:
- On-Road non-Diesel Light Duty Vehicles
- On-Road Diesel Heavy Duty Vehicles
- Non-Road Equipment - Diesel
- Non-Road Equipment - Gasoline
- On-Road non-Diesel Heavy Duty Vehicles
- On-Road Diesel Light Duty Vehicles
- Locomotives
- Aircraft
- Non-Road Equipment - Other
- Commercial Marine Vessels

MOVES : **Detailed Transportation Sector Modeling**

Motor Vehicle Emission Simulator

- The <u>MO</u>tor <u>V</u>ehicle <u>E</u>mission <u>S</u>imulator (MOVES) is EPA's state-of-the-science emission modeling system that can model GHGs, criteria air pollutants, and air toxics for both onroad vehicles (cars, trucks, buses, etc.) and some nonroad vehicles and equipment (e.g., construction equipment)

  - Some state, local air quality and transportation planning agencies are already familiar with MOVES

- Can be used to develop detailed transportation sector GHG inventories for current and previous years as well as GHG projections for future years through 2060

- MOVES combines the latest data on emission rates for various vehicle/equipment and fuel types, vehicle/equipment populations and activity information, and emissions controls

- MOVES will produce an inventory of vehicle fleet emissions based on this information, once the user defines the desired place, time, and vehicle or equipment types

Resources and Guidance

- EPA's [MOVES website](#) – download MOVES and find documentation
  - Current version is MOVES3
  - MOVES4 available later this year. Stay tuned!
    - Will account for two new major EPA rules - HD2027 and LD GHG 2023-2026.
    - Will include ability to model heavy-duty battery electric and fuel cell vehicles
- EPA's [guidance for using MOVES to estimate state and local inventories of GHG emissions](#)
- EPA's in-depth [technical guidance for using MOVES](#)
- EPA's [MOVES training](#) resources

Other Inventory Resources

- Other sector-specific GHG Inventory Compilation Tools
  - Agriculture and Land Use GHG Inventory Software (can be applied at state level)
  https://www.nrel.colostate.edu/projects/alusoftware/home/

  - Waste Reduction Model (WARM)
  https://www.epa.gov/warm

Upcoming Trainings

All trainings will be 1-1.5 hours from 2-4 pm ET:

- **June 28, 2-3 PM ET**: Interagency Coordination and Meaningful Engagement

- **July 19, 2-3:30 PM ET**: Co-Pollutant Inventory and Future Projections Benefits Analysis

- **Week of July 24**: Quantified GHG Reduction Measures

- **Week of July 31**: EPA Tools used for Evaluation and Quantification of Reduction Measures

- **Week of August 7**: Workforce Planning Analysis

- **Week of August 14**: Low Income/Disadvantaged Communities Benefits Analysis

- **Week of August 28**: Meaningful Engagement: Update and Technical Resources

Climate Innovation Teams (CITs)

- Opportunity for peer-to-peer technical assistance, collaboration, and mentoring, and sharing of case studies, best practices, and lessons learned

- Teams will be created based on workplan elements, EPA tools, key CPRG sectors, and grantee needs

- Led by EPA subject matter experts

- CITs will be launched late summer/early fall via Teams

Annex

What is Relationship of National Emissions Inventory (NEI) to GHGI?

- See https://www.epa.gov/air-emissions-inventories/are-ghgs-national-emissions-inventory-complete

- **Are the GHGs in the National Emissions Inventory Complete?**
  - No, the 2017 National Emissions Inventory (NEI) includes a subset of total national emissions of greenhouse gases (GHGs) for fires, mobile sources, and certain point sources. EPA provides a comprehensive assessment of all anthropogenic emissions and sinks of greenhouse gases in the annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks*.
  - In the 2017 NEI, EPA included point source facility total values for four GHGs (CO_2, CH_4, N_2O, and SF_6) from the Greenhouse Gas Reporting Program (GHGRP) data when GHGRP facilities matched to NEI facilities. 2014 NEI and earlier did not include the GHGRP emissions. State, local, and tribal agencies voluntarily provide GHG emissions for a small number of smaller point sources in addition to those GHGRP sources, but many small point sources do not have GHG emissions in the NEI. GHG completeness in the NEI for fires is limited to emissions (and not sequestration or other carbon stock changes) of CO_2 and CH_4, and for mobile sources, we include estimates for CO_2, CH_4, and N_2O.   The NEI program does not include GHG emissions for nonpoint sources.
  - For more information, the EPA provides an overview of the relationship between the annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks* and the GHGRP.

- Understand differences for mobile sources in NEI TSDs: https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-technical-support-document-tsd