Overview of US EPA Inventory Data

CO$_2$ Urban Synthesis and Analysis ("CO$_2$-USA") Workshop
Salt Lake City
October 25, 2018
Overview

- EPA National GHG Inventory
  - Overview
  - Methodologies
- Other sources of GHG data
- Potential linkages to NEI data
U.S. Greenhouse Gas Inventory: Background

• As part of commitments under the UNFCCC, the U.S. Government annually publishes a national inventory of emissions and removals of greenhouse gases due to human activities
  – Focus is on anthropogenic emissions – greenhouse gas emissions and removals that are a direct result of human activities or are the result of natural processes that have been affected by human activities

• Gases include: CO₂, CH₄, N₂O, HFCs, PFCs, SF₆
  – Weighted using “Global Warming Potential”

• U.S. GHG emissions are calculated using IPCC’s internationally-accepted methods and appropriate U.S. statistics and data for national-level GHG estimates
  – Allows for high quality inventories that are transparent, accurate, complete, consistent and comparable across countries (TACCC)
  – IPCC approach allows for a common framework for comparing data from different countries, and a basis for peer review
  – IPCC Guidelines are the foundation of reporting under the UNFCCC and the Kyoto Protocol
GHG Inventory Basics:

- Most inventory work is based on common IPCC framework
- For the most part it involves a bottom-up approach –
  \[ \text{Emissions} = \text{Activity Data} \times \text{Emission Factor} \]
IPCC Methodologies: Tiered Approach

- Tier 1 – designed to use readily available national or international activity data statistics and apply default emission factors
- Tier 2 – use activity data and apply country specific factors, may require additional parameters
- Tier 3 – country specific method and data (e.g. data-intensive modeling, or aggregation of bottom-up facility-level data)

Data availability and significance of emissions may often determine choice of Tier

“Higher Tiers”
Activity data is generally from national level statistics
  - e.g., CO$_2$ from Fossil Fuel Combustion: based on fuel consumed
    • Fuel consumption collected and aggregated to national level by EIA (based on surveys and EIA definitions of sectors)
  - e.g., CO$_2$ from Iron & Steel Production: based on national production statistics
    • Coal and coke consumption from EIA; coke consumed for pig iron production and scrap steel consumption from AISI; iron ore consumption in sinter production from USGS

Emission factors can be mix of IPCC default and country-specific
  - e.g., CO$_2$ from Fossil Fuel Combustion: based on fuel-specific carbon content analyses conducted by EIA (coal, petroleum, natural gas)
    • Non-CO$_2$ from IPCC
  - e.g., CO$_2$ from Iron & Steel Production: based on mix of factors
    • Pig iron and crude steel carbon contents from IPCC
    • Electric arc furnace carbon anodes from DOE

Also involves some source-specific modeling that is based on disaggregated data
  - e.g., Enteric Fermentation: based on model of livestock populations by animal type and age group applied to CH$_4$ conversion factors
  - e.g., Agricultural Soil Management: based on model that uses fertilizer consumption data combined with N$_2$O emission factors for fertilizer use on agricultural soils
U.S. Greenhouse Gas Inventory: Compilation Process

• Climate change is different from other air quality impacts and that has implications for how inventories are constructed
  – Climate change is global and greenhouse gases are well mixed in the atmosphere and transboundary

• Unlike EPA’s criteria pollutant inventory (i.e., NEI), GHG emissions are not collected from States to construct national GHG inventory
  – Not part of air quality designations
  – Not all states compile GHG inventories and few are updated annually
  – Transport modeling is less important for determining impacts
  – CO₂ emission estimation methods are mostly based on mass balances of fuels used
  – National inventories can serve requirements of international community without being spatially disaggregated

• Interagency effort led by EPA
  – Data and input provided by DOE, USDA, DOT, DOD, USGS, the State Department, and others

• In order to provide complete coverage, often aggregated national statistics are used
  – Example: Total fuel use in U.S. economy provided by DOE’s Energy Information Administration, which is utilized to estimate total U.S. GHG emissions from fuel combustion
  – By definition anthropogenic
  – Carbon balances make the approach accurate
  – We have a great system for tracking fossil fuel flows
Other GHG Emissions Data

- There is some overlap with the National GHG Inventory and other sources of GHG emissions that provide more disaggregated data
  - There are several sources of electricity sector emissions
    - EIA produces energy sector CO₂ emission inventory each year
    - Acid Rain Program Part 75 collects data on power plant GHG emissions
    - GHGRP program Part 98 also has data on fuel combustion GHG emissions for large emitters
  - There are also different sources of industrial sector emission estimates
    - We have annual GHGRP data broken out by industrial sector
    - EIA has MECS data for the same sub-sectors collected every ~4 years
- There are also differences in timing for when the data sources are available

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U.S. GHG Reporting Program

Background:

- Annual reporting of GHGs by 41 source categories, accounting for about 85-90% of U.S. GHG emissions
  - 33 types of direct emitters
  - 6 types of suppliers of fuel and industrial GHG
  - Facilities that inject CO₂ underground for geologic sequestration, enhanced oil recovery, or any other purpose
- 25,000 metric tons CO₂ equivalent (CO₂e) or more per year reporting threshold for most sources
- Mix of continuous, periodic measurements, and sampling as well as calculations based on fuel use and emission factors

Applicability to Urban Inventories:

- Sectors covered
  - Emissions reported by gas, facility, subpart, and unit (typically)
    - Subpart C—General Stationary Fuel Combustion Sources
    - Subpart D—Electricity Generation
    - Subpart W—Petroleum and Natural Gas Systems
    - Subpart FF—Underground Coal Mines
    - Subpart HH—Municipal Solid Waste Landfills
    - Subpart II—Industrial Wastewater Treatment
- Ability to track changes over time
  - Emissions reported annually starting in 2010
  - Reported data includes, facility information, calculation method, tests methods used to determine equation inputs (e.g., carbon content), process characteristics (e.g., equipment capacities, # of process units)
U.S. GHG Reporting Program

- Geographic coverage
  - Reporting at the facility and unit level which could be used in developing urban inventories
  - Links with other datasets of facility emissions reporting

- Power Plant Crosswalk (XLS)
  Used to cross-walk EPA GHGRP Facility ID’s to Facility ID’s in other data sets (ORIS codes)

- TRI Chemical Management and GHGRP Emissions Data
  at Facility AES WARRIOR RUN INC

- Total Emissions by Facility
  All Sectors (metric tons CO2e)
  - 0 - 500,000
  - 500,000 - 2,000,000
  - 2,000,000 - 5,000,000
  - 5,000,000 - 10,000,000
  - > 10,000,000

- This graph combines TRI data with GHG emissions reported to the Greenhouse Gas Reporting Program (GHGRP). While greenhouse gas data is not reported to TRI, GHGs are the primary driver of climate change which poses serious threats to human health and welfare. View all publicly available GHGRP data for this facility.
GHG Precursors

• Although they are not included in global warming potential-weighted greenhouse gas emission totals, emissions of carbon monoxide (CO), oxides of nitrogen (NOx), non-methane volatile organic compounds (NMVOCs), and sulphur dioxide (SO₂) are reported in the National GHG Inventory
  – Carbon monoxide (CO), Nitrogen oxides (NOx) and NMVOC in the presence of sunlight contribute to the formation of the greenhouse gas ozone (O₃) in the troposphere and are therefore often called ‘ozone precursors’

• The methodologies for ambient air quality emission inventories have been elaborated in detail elsewhere, and the methodologies for CO, NOx, NMVOCs, and SO₂ emissions are referenced rather than included in the IPCC GHG Guidelines
  – E.g., EPA’s Compilation of Air Pollutant Emission Factors, AP-42

• For reporting in the GHG Inventory, emission estimates for these pollutants are obtained from data published on the National Emission Inventory (NEI) Air Pollutant Emission Trends
Coverage of Pollutant Categories

- Many of the same sources of GHG emissions also result in criteria pollutant emissions
  - Combustion sources
  - Industrial sources
- There are some sources of criteria pollutants that are less represented in GHG inventories
  - Source emissions like solvent use
Non-CO₂ GHG Emissions

- Determine vehicle miles traveled (VMT) by vehicle type, fuel type, and model year.
- Allocate VMT data to control technology type.
- Determine CH₄ and N₂O emission factors by vehicle, fuel, and control technology type.
- Multiply total VMT by vehicle, fuel, and control technology type by the emission factors.

Criteria Pollutant Emissions

\[ E_{i,j} = \sum_k (N_{j,k} \times M_{j,k} \times E_{F_{i,j,k}}) \]

where,
- \( E_{i,j} \) = emission of pollutant i, for vehicle of category j.
- \( N_{j,k} \) = number of vehicles in nation’s fleet of category j and technology k.
- \( M_{j,k} \) = average annual distance driven per vehicle of category j and technology k.
- \( E_{F_{i,j,k}} \) = technology-specific emission factor of pollutant i for vehicle category j and technology k.

Lower tier methods used to calculate GHG emissions are similar to the methods used to calculate other pollutant emissions.

- Mobile source emission example:
US NEI Calculations

- NEI emissions are often based on higher (i.e., Tier 3 type) approaches
- For example, for on-road gasoline and diesel vehicles, EPA’s emissions models (MOVES) directly calculate emissions
- Includes detailed emissions calculations:
  - Accounting for high emitters
  - Deterioration of PM emissions (i.e., increase in PM mass) with higher mileage
  - Gasoline OC and BC emissions increase dramatically at lower ambient temperatures. To calculate this increase for gasoline vehicles, an hourly grid-cell temperature adjustment was done as part of emissions processing at the county level for each of over 3,200 counties.

- The US Inventory approach for calculating non-CO₂ emissions uses an approach and activity data that could be used for calculating default criteria pollutant emissions
- However, more detailed approaches exist (e.g., MOVES) and are often used to get data directly on criteria pollutant emissions
Conclusions

• The National GHG Inventory has high quality data on overall national level GHG emissions
• There is also sub-national and sector specific GHG emissions data available (e.g., GHGRP)
• Both have links with inventories of other emissions
• There are synergies in conducting GHG inventories and inventories of other emissions
• However, difficulties occur due to the type of data and methods used
Questions:

Contact Us: GHGIventory@epa.gov

Upcoming annual reviews of next GHG Inventory report:
- Expert Review (Fall 2018 – out now)
- Public Review (Winter 2019)

If you have experience/expertise, please send note indicating your name, title, organization, and interest areas to email above