Overview of US EPA Inventory Data

CO_2 Urban Synthesis and Analysis ("CO_2-USA") Workshop

Salt Lake City

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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: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
  - 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

National GHG Inventory

GHG Inventory Basics:

- Most inventory work is based on common IPCC framework
- For the most part it involves a bottom-up approach –

Emissions = Activity Data × Emission Factor

» National GHG Inventories

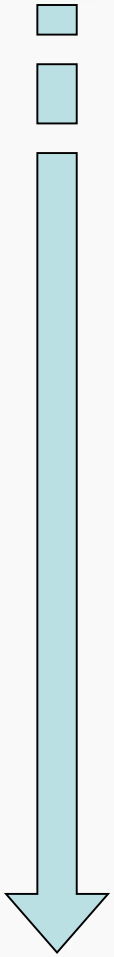
» State Level Inventories

» Corporate GHG Protocols

» GHG Registries

» Life Cycle GHG Accounting

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)

"Higher Tiers"

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

U.S. Greenhouse Gas Inventory: General, Basic Methodologies

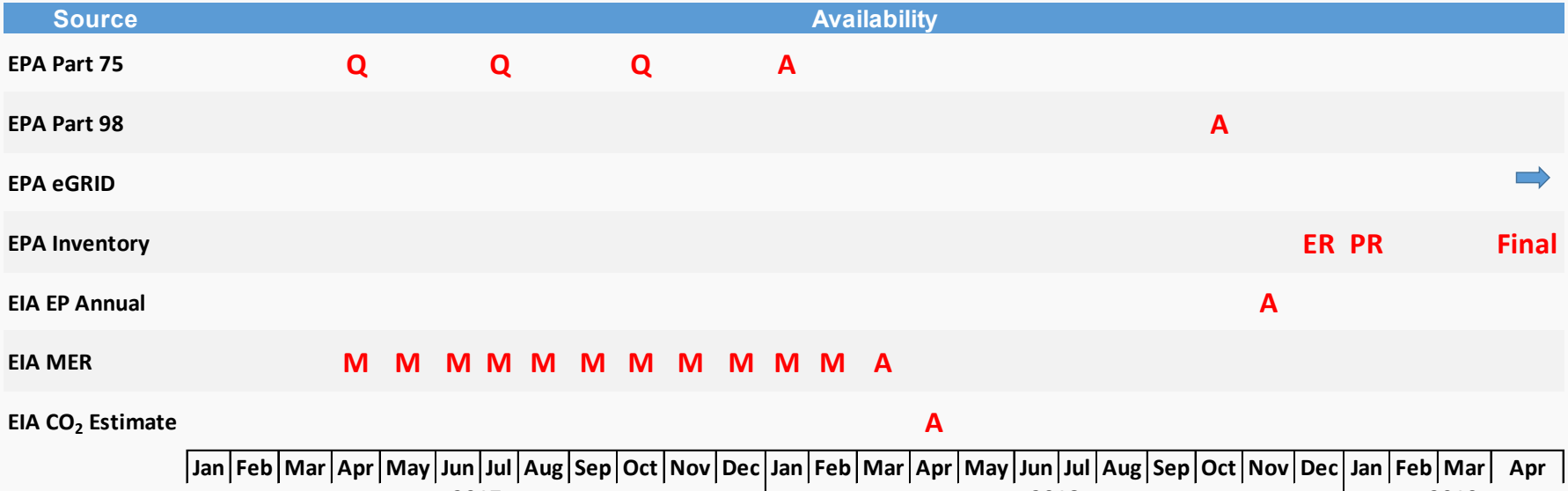
- Activity data is generally from national level statistics
  - e.g., CO_2 from Fossil Fuel Combustion: based on fuel consumed
    - Fuel consumption collected and aggregated to national level by EIA (based on surveys and EIA definitions of sectors)
  - e.g., CO_2 from Iron & Steel Production: based 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_2O 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
  - CO_2 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 CO_2 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



U.S. GHG Reporting Program

Background:

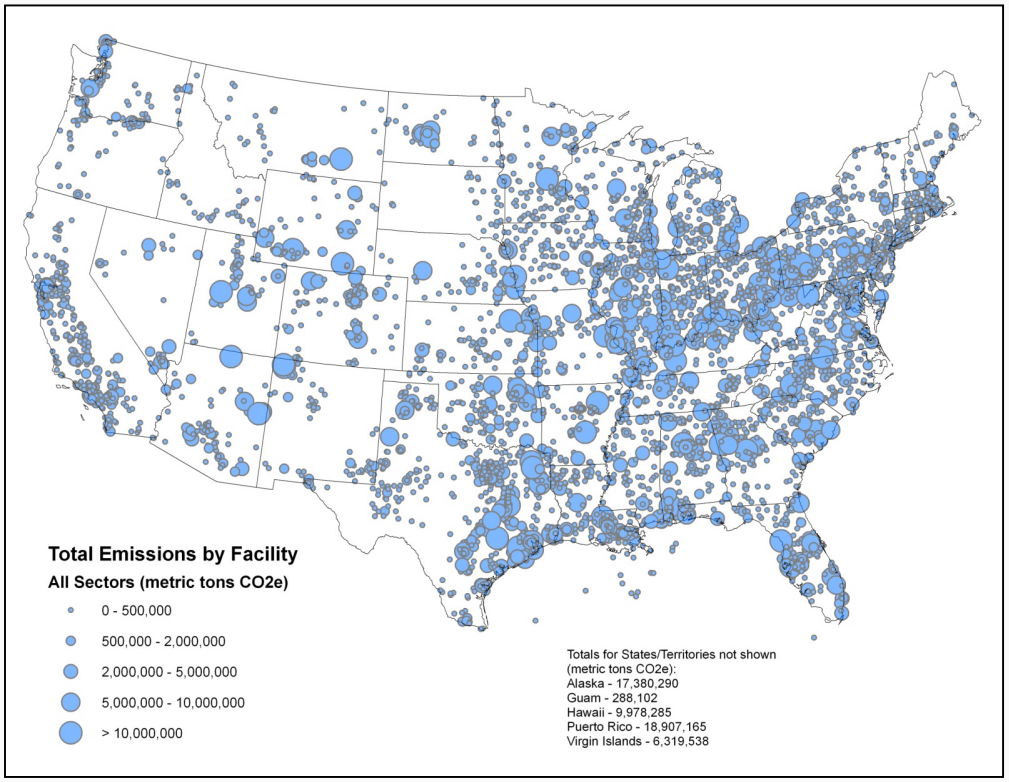
- Annual reporting of GHGs by 41 source categories, accounting for about 85-90% of U.S. GHG emissions
  - 33 types of direct emitters
  - 6 types of suppliers of fuel and industrial GHG
  - Facilities that inject CO_2 underground for geologic sequestration, enhanced oil recovery, or any other purpose
- 25,000 metric tons CO_2 equivalent (CO_2e) 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)

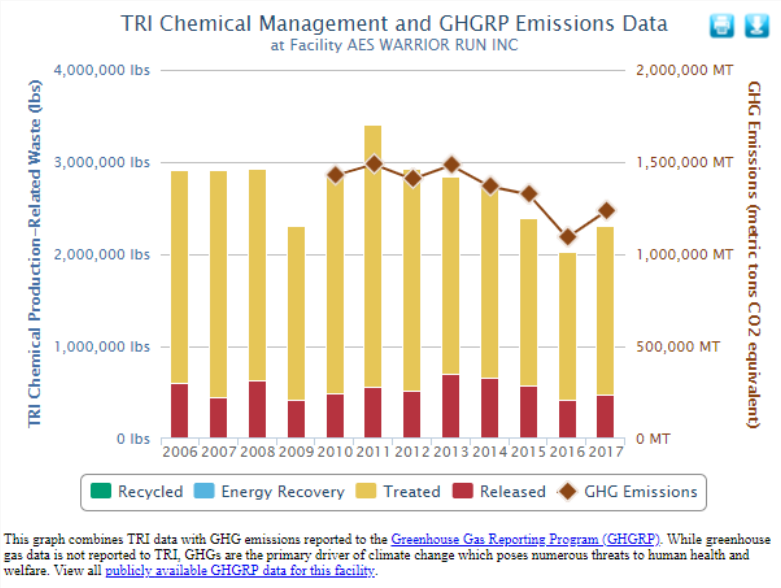
U.S. GHG Reporting Program

- 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)



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 (SO_2) 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 (O_3) 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 SO_2 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

TABLE 7.1
LINK BETWEEN THE IPCC CATEGORIES AND THE CORRESPONDING METHODOLOGY CHAPTERS IN EMEP/CORINAIR GUIDEBOOK [1]

Reporting category				Source Sector	EMEP/CORINAIR Inventory Guidebook Chapter	NO_x	CO	NM-VOC	SO_x
IPCC category		CRF	NFR			Relevance of emissions from the category (see codes above the table)			
1 ENERGY									
1A1 Energy Industries	1A1a	1A1a	1A1a	Main Activity Electricity and Heat Production	B111 and B112	A	A	A	A
	1A1b	1A1b	1A1b	Petroleum Refining	B132 and B136	A	A	A	A
	1A1c	1A1c	1A1c	Manufacture of Solid Fuels and Other Energy Industries	B142, B146 and B152	A	A	A	A
1A2 Manufacturing Industries and Construction	1A2a	1A2a	1A2a	Iron and Steel	B111, B112, B323, B324, B325, B331, B332, B333	A	A	A	A
	1A2b	1A2b	1A2b	Non-ferrous Metals	B336, B337, B338, B339, B3310, B3322, B3323	A	A	A	A
	1A2c	1A2c	1A2c	Chemicals	B111 and B112	A	A	A	A
	1A2d	1A2d	1A2d	Pulp, Paper and Print	B3321	A	A	A	A
	1A2e	1A2e	1A2e	Food Processing, Beverages and Tobacco	B111 and B112	A	A	A	A
	1A2f	1A2f	1A2f	Non-Metallic Minerals	B3311, B3312, B3313, B3314, B3318, B3319, B3320, B3323	A	A	A	A
	1A2g			Transport Equipment	B111 and B112	A	A	A	A
	1A2h			Machinery	B111 and B112	A	A	A	A
	1A2i			Mining and Quarrying	B111 and B112	A	A	A	A
	1A2j			Wood and Wood Products	B111 and B112	A	A	A	A
	1A2k			Construction	B111 and B112	A	A	A	A
	1A2l			Textile and Leather	B111 and B112	A	A	A	A
	1A2m			Non-specified Industry	B111 and B112	A	A	A	A

Calculation Overlap

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

- Mobile source emission example:

Non-CO_2 GHG Emissions

- Determine vehicle miles traveled (VMT) by vehicle type, fuel type, and model year
- Allocate VMT data to control technology type
- Determine CH_4 and N_2O 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

$$E_{i,j} = \sum k \, (N_{j,k} \times M_{j,k} \times EF_{i,j,k})$$

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
- $EF_{i,j,k}$ = technology-specific emission factor of pollutant i for vehicle category j and technology k

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-CO_2 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: GHGInventory@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