

*This text accompanies the release of the CAIT Climate Data Explorer - U.S. State GHG Emissions Data Collection. It is accurate as of 30 July, 2015.*

## CAIT Climate Data Explorer-US State GHG Emissions Documentation

Adapted from Appendix A of *Charting the Midwest: An Inventory and Analysis of Greenhouse Gas Emissions in America's Heartland* by Larsen et al. (2007) and updated July, 2015. Available online at <http://pdf.wri.org/charting-the-midwest.pdf>.

CAIT Climate Data Explorer-US State GHG Emissions (CAIT-US), includes economy-wide emissions of the six major greenhouse gases (GHGs) from most major sources and sinks (see discussions below). Table 1 shows which gases are included in each sector.

Table 1. CAIT-US Sector and Gas Coverage				
SECTOR	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	F-GASES
<b>Energy Sectors</b>				
Electricity Generation	X	X	X	
Residential	X	X	X	
Commercial	X	X	X	
Industrial	X	X	X	
Transportation	X	X	X	
Fugitive Emissions	X	X		
Industrial Processes	X			X
Agriculture		X	X	
Waste	X	X	X	

The economic sectors included in CAIT-US are the same as those sectors covered in guidance documents of the Intergovernmental Panel on Climate Change (IPCC), such as the 2006 IPCC Guidelines for National Greenhouse Gas Inventories ([IPCC, 2006](#)), and the U.S. Inventory of Greenhouse Gas Emissions and Sinks ([EPA, 2015](#)), although they are not directly comparable with those prescribed by international reporting frameworks. In addition to those sectors identified in Table 1, two additional sources of emissions are included in CAIT-US:

**International Bunker Fuels.** These emissions come from fuel use during international transportation--for instance, air travel or shipping to and from other countries. Attribution of these emissions is controversial because it is unclear whether to attribute them to the country of origin or the destination country. This issue is even more difficult at the U.S. state level. Total



U.S. emissions attributable to international bunkers in the CAIT-US data set are approximately 0.42 million metric tons of CO<sub>2</sub> equivalent (in 2011).

**Land-Use Change and Forestry (LUCF).** This category is comprised of changes in GHG levels due to afforestation, deforestation, reforestation, forest management, and similar activities. Carbon dioxide is released into the atmosphere as forests are cleared or burned, and is sequestered through forest growth. Therefore, this category may constitute a net source of GHGs if released carbon dioxide exceeds sequestered carbon dioxide or a net sink if sequestered carbon dioxide exceeds released carbon dioxide. There are substantial data and methodological uncertainties regarding the calculation of carbon dioxide emissions or sequestration from LUCF at the state level, making it difficult to identify trends in this sector with any reliability or to make assurances that emissions are greater or less than zero.

CAIT-US GHG data are derived from the State Inventory Tool (SIT) of the U.S. Environmental Protection Agency's (EPA's) Emissions Inventory Improvement Program (EIIP). The EIIP provides guidance and methodologies to states that are developing their own emission inventories. To facilitate state GHG inventory initiatives, the EIIP has developed a set of Excel-based source modules--the SIT--to accompany its latest technical reports. The SIT includes "default" state activity data from a variety of sources, mostly federal agencies, for each U.S. state and the District of Columbia (Table 2). A state may supplement or replace the default (EPA-supplied) data if it has its own sources that it considers more reliable. For more information regarding EPA state inventory guidance, please see <http://www.epa.gov/statelocalclimate/resources/tool.html>.

SECTOR	SOURCE
Electricity Generation, Residential, Commercial, Industrial, Transportation, International Bunkers	Energy Information Administration (EIA); Federal Highway Administration (FHWA); U.S. Environmental Protection Agency (EPA)
Fugitive Emissions	U.S. Environmental Protection Agency (EPA); Energy Information Administration (EIA); Mineral Management Services (MMS)
Industrial Processes	U.S. Geological Survey (USGS); Energy Information Administration (EIA)
Agriculture	U.S. Department of Agriculture (USDA); <i>Commercial Fertilizers</i> report, Fertilizer Institute
Waste	U.S. Environmental Protection Agency (EPA)
Land-Use Change and Forestry	U.S. Environmental Protection Agency (EPA); U.S. Geological Survey (USGS)

WRI uses a simple process to produce its CAIT-US inventory: for each source module, state default data are selected, emissions are calculated using emissions factors and calculation methodologies included in the source modules, and the results are extracted and compiled. The same process is used for each state and the District of Columbia. In CAIT-US, national emission totals for the United States are a simple sum of total emissions for each state and the District of Columbia. For the sake of comparability, the source data for CAIT-US do not incorporate any state-supplied activity data; in all instances, WRI utilizes only the default data embedded in the SIT.

## GHG Data Uncertainties, Omissions, and Caveats

Opting to use the SIT and only EPA-supplied default activity data and emission factors to produce the CAIT-US data set provides a well-established, homogeneous methodology for compiling GHG data for each U.S. state and the District of Columbia and facilitates comparisons across states and sectors. However, in some cases this procedure produces emission estimates that have significant uncertainties due to the availability of underlying activity data, the activity data itself, and methodologies. The compilation of CAIT-US data also excludes several emission sources. All of these factors may cause the emissions values presented in this dataset to differ from totals reported elsewhere, such as independent or state-produced inventories.

### DATA UNCERTAINTIES

In brief, uncertainties in reported GHG emission values result from the underlying activity data, emission factors, and methodologies. The following discussion, although not exhaustive, provides examples of the uncertainties that arise in the CAIT-US data due to its reliance on the EPA-supplied activity data, emissions factors, and calculation methodologies for state GHG emissions of the SIT.

**Activity data and emission factors.** The SIT makes use of EPA-supplied activity data and emission factors to calculate total sectoral emissions. Activity data include data sets such as total fossil fuel combustion, number of vehicles, number of cattle, and total population. Largely supplied from federal agencies (see Table 2), these data become less precise at the state level and additionally contain their own inherent uncertainties. Although up-to-date, emission factors (e.g., the carbon content of fossil fuels) utilized by the SIT, in some instances, can introduce additional uncertainties. For example, the appropriate emission factor for coal depends on which coal type (e.g., bituminous, sub-bituminous) is used. This can vary significantly between and within states or even between individual power plants. To calculate emissions from coal-fired electricity generation, the SIT draws on coefficients from the Energy Information Administration (EIA), but since the SIT uses only one emission factor for coal per state per year, emission totals are likely to be inexact.

**Methodologies.** The calculation protocols for emissions from individual sectors or subsectors can also introduce uncertainties into CAIT-US emissions data. Some examples include the following:

- \* In the calculation of emissions from municipal landfills, the SIT methodology assumes the waste composition of all landfills is the same; in reality, the composition of landfills is likely to vary across locations (EIIP, 2014).
- \* To calculate emissions from agricultural soils, the SIT uses a Tier 1 methodology ([IPCC, 2006](#)) with emission factors. This contrasts with the modeling approach employed by EPA to calculate national more accurate at the federal level.
- \* Part of the estimates of animal stock populations are based on a single date (January 1), rather than accounting for stock fluctuations throughout the year.

For perspective, according to the U.S. Inventory of Greenhouse Gas Emissions and Sinks, quantitative estimates of uncertainty for different GHG sources at the national level can vary significantly: for example, -2 and 5 percent (low and high uncertainty estimate bounds) for CO<sub>2</sub> from fossil fuel combustion; -4 and 35 percent for CH<sub>4</sub> emissions from coal mining; and -16 and 24 percent for N<sub>2</sub>O emissions from manure management ([EPA, 2015](#)). State-level emission estimates in CAIT-US are likely to have even greater uncertainty for reasons explained above. However, in general, sources which are the largest emitters of GHGs tend to have the least amount of uncertainty associated with them, which reduces the overall uncertainty associated with estimates of a state's total emissions. A more comprehensive explanation of uncertainties for all emission sources that arise at any level is available in both the EIIP documentation that accompanies the SIT and the U.S. Inventory of Greenhouse Gas Emissions and Sinks ([EPA, 2015](#)).

## DATA OMISSIONS

GHG emission sources included in the SIT generally follow the U.S. Inventory of Greenhouse Gas Emissions and Sinks ([EPA, 2015](#)). However, to ensure optimal comparability between state inventory data within CAIT-US, sectors (SIT modules) in which default activity data are largely absent have been purposely excluded when calculating state emission totals. Instances where end-use data are missing entirely are noted below.

\* *Fugitive Emissions.* Methane emissions from natural gas transmission and distribution, and oil refining and transportation are not included because of a lack of activity data. These industries represent an estimated 2 percent of national GHG emissions ([EPA, 2015](#)).

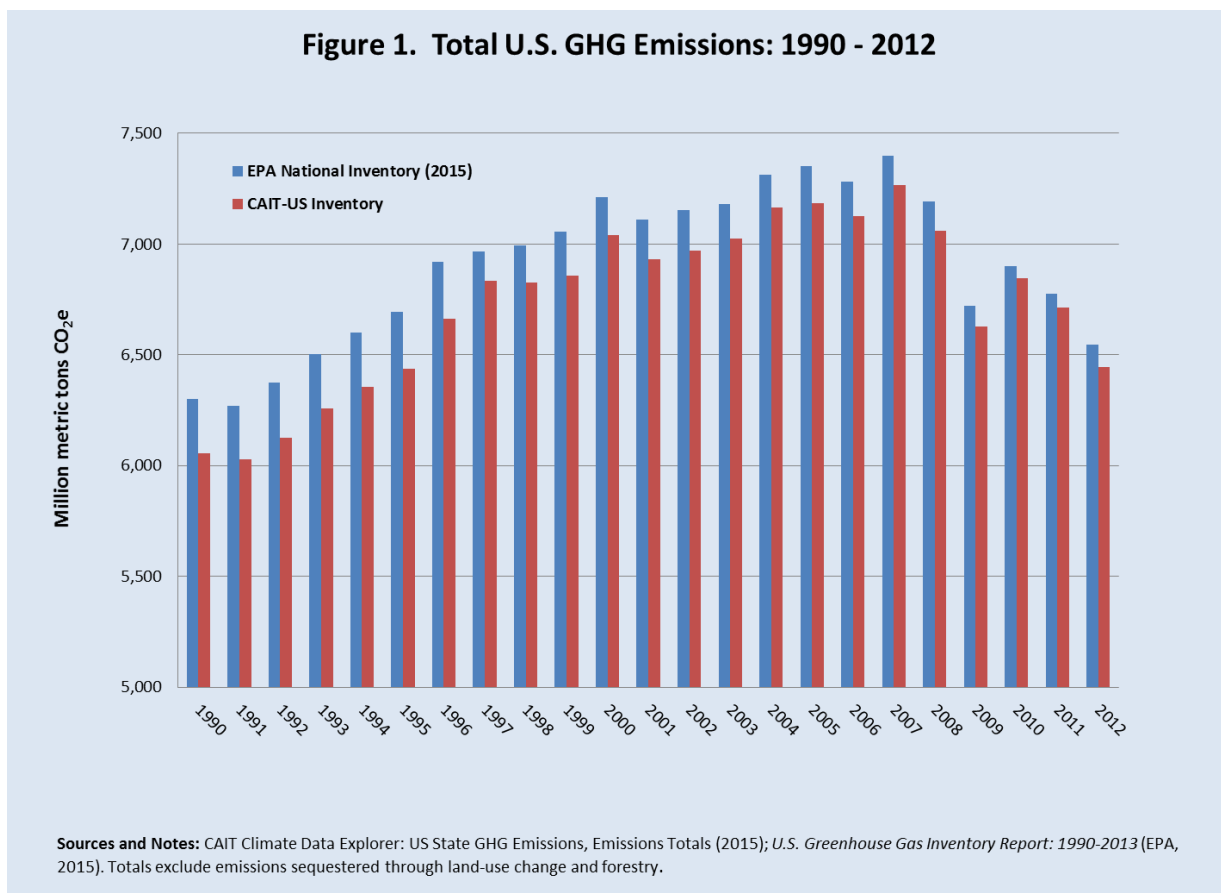
\* *Industrial Processes.* This sector produced approximately 5 percent of total U.S. GHG emissions in 2012 ([EPA, 2015](#)). Emissions from the manufacture of nitric acid, adipic acid, HFCF-22, and magnesium are generally not included because of a lack of data. In addition, default estimates of emissions from limestone and dolomite use are unavailable for 1990-93, and estimates of emissions from iron and steel production--a large percentage of total industrial



processes emissions in several states--are unavailable until 1997. As a result, many states exhibit "step functions" in their total industrial processes data--that is, a lack of complete industrial processes emissions data prior to 1997 causes an artificial increase in these data beginning in that year. *Note: In an effort to avoid presenting misleading comparisons with other sectors, trends in the industrial processes sector should only be assessed from 1997 through 2007.*

\* *Waste.* Methane emissions from industrial wastewater (fruits and vegetables, poultry, and pulp and paper) are not included because of a lack of data.

In addition to the overarching data omissions described above, certain sectors or subsectors within some states have missing or unreported data (i.e., no default value is provided in the SIT). The cumulative effect of purposely excluding the data noted above and/or calculating state emission values while missing data points for particular sectors or years results in an underestimate of total national emissions in CAIT-US relative to the EPA's national inventory (Figure 1). An underestimation of total emissions for any given state inventory is also likely, although this cannot be quantified for any particular state. Nevertheless, because this underestimate may be on the order of several MtCO<sub>2</sub>e, it would alter the absolute emissions, per capita emissions, and trends analysis reported here.



## SUMMARY



The emission estimates produced by the SIT and presented in CAIT-US are, admittedly, imperfect. While using EPA-supplied default estimates and applying uniform calculation methodologies ensures comparability among states, this approach can compromise some of the nuances of state-specific data. Other inventories may incorporate levels of detail that are missing in this analysis. Therefore, states are encouraged to seek out additional data resources, if available, to supplement the analysis provided here.

Although general trends and emission values presented in this report are likely good approximations of emission totals, it is critical that the user bear in mind that for some sectors and/or years, deviations from "true" emission values can occur. However, data sources and inventory calculation methodologies are regularly being updated and improved. As such, subsequent releases of CAIT-US should build upon the inventory tools already in existence, providing greater quantitative accuracy for all included years for both sectors and states.

