ICLEI
Local Governments for Sustainability

Community Greenhouse Gas Inventory Methodology for Bay Area Local Governments

Prepared as part of Bay Area Air Quality Management District – ICLEI Workshop in San Mateo County on September 7, 2007

Community-Scale Inventory

The community-scale inventory estimates the quantity of greenhouse gas (GHG) emissions for which the community as a whole is responsible for a specific analysis year. The community inventory is organized by sector—residential, commercial, industrial, transportation, and waste. When completed, the community inventory will include the quantities of electricity and fuels used in the residential, commercial, industrial, and transportation sectors, along with the amount of waste produced and landfilled in the analysis year, as well as the quantity of GHG emissions produced by each of these sectors. The data needed is typically available from **electric and gas utilities, planning and transportation agencies and solid waste management departments.**

Each local community has unique characteristics (e.g., population, housing types, transportation networks, industries, electricity fuel mix) that make its GHG inventory different from other cities or counties. The primary value of an emissions inventory is to enable the demonstration of progress over time. For this Community Inventory Workshop, all participating local governments will use data provided by common sources. However, each local government may choose to supplement this analysis with additional data sources of greenhouse gas emissions to analyze on their own.

Emissions Sources that are Included

The community-wide analysis includes emissions from residential, commercial, and industrial sources, as well as transportation and waste management. All electricity and fuel use should be included as well as all waste generated from these sectors. Community-scale emissions analyses should utilize the geographic boundaries of the community.

Emissions Sources that are Excluded

Local governments should endeavor to include all possible emissions sources in their community-scale inventories. However, local governments will often choose to exclude emissions sources that meet the following criteria:

- *Small and unimportant* – Emissions sources can be excluded from the analysis (e.g. are "de minimis") if, when combined, the excluded emissions total less than 5% of the total of the emissions from the Community or Government Inventory.[1]
- *Prohibitively difficult to track with accuracy* – such as lawn care equipment, off-highway construction equipment, methane from wastewater and sewage sludge, non-combustion industrial emissions sources.
- *Largely located outside the jurisdiction's boundaries* – such as intercity transportation fuel (i.e. air, rail, marine and intercity highway traffic).

[1] Note: an inventory should include at least 95% of the emissions released by the government and community as a whole. Therefore, if a large number of small emissions sources occur within the jurisdiction, they cannot all be ignored.

Finally, emissions from very large energy intensive industrial facilities (paper and steel mills, industrial chemical plants, petrochemical plants and refineries, metal smelters, large cement making operations) should be represented within the context of the community-scale emissions inventory results in an appropriate fashion, as (1) their emissions may be well documented in other inventory programs, (2) the purpose of a local government analysis is to account for the emissions the jurisdiction has the ability to influence, and (3) their inclusion could skew the results to the point of prohibiting the facilitation of intercity comparisons.

Base vs. Additional Emissions Sources

Base Emissions Sources are effectively required for reporting of community-scale emissions inventories. Any future comparative reporting of emissions across jurisdictions should include comparison of energy/fuel demand and emissions produced exclusively by these base emissions sources. Guidance on estimating emissions from these sources will be included in the ICLEI Local Government Emissions Analysis Protocol.

Additional Emissions Sources should also be calculated and included to the extent possible. Guidance on estimating emissions from these sources will also be included in the Local Government Emissions Analysis Protocol. However, it is recognized that in some communities data on some of these emissions sources will be unavailable or inappropriate to include within a community-scale emissions analysis. Thus any future comparative reporting should also enable appropriate comparison of total emissions with sufficient transparency of source components included.

Scopes

Scope 1 emissions sources within the context of community-scale emissions analyses include all direct emissions generated during the analysis period within the community boundaries.

Scope 2 emissions sources within the context of community-scale emissions analyses include all emissions generated during the analysis period outside the community's geographic boundaries but due to activity occurring inside the boundaries (e.g., emissions from power plants associated with electricity consumption).

Information Items within the context of community-scale emissions analyses include additional potentially policy-relevant emissions data that does not fit within the above scope definitions. In some cases this might include lifecycle emissions estimates associated with up-stream manufacture or transport of fuels or materials.

General Data Requirements

Emission factors (also referred to as emission coefficients) and activity level data, typically framed as the amount of energy consumed or waste generated, are needed to calculate emissions resulting from that activity. Emission factors describe the quantity of a pollutant emitted for every unit of activity. For example, the emission factor for electricity purchased from PG&E in 2005 is 0.489 lbs. of CO_2/kwh of electricity delivered. ICLEI recommends converting all GHG emissions into carbon dioxide equivalent units, or CO_2e, per the international convention of using global warming potentials outlined in the IPCC's Second Assessment Report (SAR). However, this convention may change in the future as international consensus shifts to using the values identified in the third assessment report. See Appendix A for more information.

Residential, Commercial and Industrial Sectors

What is included in this data?

- CO_2e for all PG&E electricity that is consumed within your jurisdiction. The CO_2 emission factor has been certified by the California Climate Action Registry (CCAR) and accounts for transmission losses.
- CO_2, CH_4 and N_2O emissions for all natural gas that was delivered within your jurisdiction.

What is not included in this data?

- All electricity purchased through Direct Access (DA) accounts or from a municipal utility. The amount of DA in a given community varies; however, 11.9% of electricity consumption in California was DA in 2005 according to the CPUC. http://www.cpuc.ca.gov/static/energy/electric/electric+markets/direct+access/00thru05.htm. This data will be provided by PG&E in the future, and should then be included in the Base Emission Sources. The emission factor for direct access can be estimated if the amount of electricity is known and the fuel source of the electricity is known. If information is not available in this level of detail, the CACP Software's default emission factor for the CA/NV region can be used.
- Fuel sources not delivered by PG&E. For example, wood, charcoal, propane, kerosene, diesel, heavy fuel oil, etc.
- PFCs, HFCs, SF_6. This data may be prohibitively difficult to obtain.

Emission Factors and Calculation Methodology:

Emission Source	GHG	Emission Factor	Emission Factor Source
PG&E Electricity*	CO_2	0.489155 lbs/kwh	The certified CO_2 emission factor for delivered electricity is publicly available at http://www.climateregistry.org/CarrotDocs/19/2005/2005_PUP_Report_V2_Rev1_PGE_rev2_Dec_1.xls
	CO_2e	0.492859 lbs/kwh	PG&E
Default Direct Access Electricity*	CO_2	343.3 short tons/GWh	ICLEI/Tellus Institute (2005 Region 13 - Western Systems Coordinating Council/CNV Average Grid Electricity Coefficients)
	CH_4	0.035 short tons/GWh	
	N_20	0.027 short tons/GWh	
Natural Gas	CO_2	53.05 kg/MMBtu	PG&E/CCAR. Emission factors are derived from: California Energy Commission, Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999 (November 2002); and Energy Information Administration, Emissions of Greenhouse Gases in the United States 2000 (2001), Table B1, page 140.
	CH_4	0.0059 kg/MMBtu	CCAR. Emission factors are derived from: U.S. EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2000" (2002), Table C-2, page C-2. EPA obtained original emission factors from the Intergovernmental Panel on Climate Change, Revised IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual (1996), Tables 1-15 through 1-19, pages 1.53-1.57.
	N_20	0.001 kg/MMbtu	

*These emission factors only apply for the year 2005.

Data Sources:

Electricity and Natural Gas Consumption: Pacific Gas and Electricity (PG&E)

Contact: Jasmin Ansar, Manager, Environmental Policy, PG&E, JxA2@pge.com, (415) 973-4570

Emission Factors: See above.

Transportation Sector

What is included in this data?

- All non-highway VMT is included in city data. County data also includes state highways.

What is not included in this data?

- State highway VMT within each city. ICLEI has requested maintained mileage data from Caltrans to apportion the state highway VMT within the county to each city. Each city's share of the state highway data should then be included in the Base Emission Sources. Pass-through highway VMT that originates and terminates outside of the jurisdiction's boundary should be included as an additional emission source.
- Vehicle emissions related to sea ports and air ports.
- Rail transit emissions. However, BART's electricity consumption is embedded in the community electricity data.
- This methodology will not reflect the use of any fuels besides gasoline and diesel.
- PFCs, HFCs, SF_6. This data may be prohibitively difficult to obtain.

Emission Factors and Calculation Methodology*:

County	CO_2 Rates (grams/mile)		CH_4 Rates (grams/mile)		N_2O Rates (grams/mile)		VMT Mix		CO_2 Rates- (grams/gallon)		Fuel Usage		Fuel Efficiency (miles/gallon)	
	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
San Mateo	440	1,269	0.058	0.030	0.070	0.050	96.8%	3.2%	8,609	10,216	92.5%	7.5%	19.6	8.1
Santa Clara	462	1,361	0.062	0.027	0.070	0.050	95.9%	4.1%	8,612	10,117	90.4%	9.6%	18.6	7.4
Bay Area AQMD Average	463	1,389	0.063	0.030	0.070	0.050	94.9%	5.1%	8,607	10,091	87.8%	12.2%	18.6	7.3

*The values above only apply for the year 2005

Data Sources:

2005 Vehicle Miles Traveled (VMT) data by City and County: Caltrans. The Highway Performance Monitoring System (HPMS), a division of Caltrans, published the VMT data in "2005 California Public Road Data", available online at http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php. Data is reported in Daily Vehicle Miles Traveled. Annual VMT is calculated by multiplying the DVMT by 365 days, as the DVMT accounts for decreased traffic volumes on the weekends.

Emission Factors, VMT Mix, Fuel Usage and Fuel Efficiency: Bay Area Air Quality Management District (BAAQMD). CO_2, CH_4 and N_2O emission factors are generated using the EMFAC model. The basis for the estimates are CO_2 emission rates (grams/mile), which are based on engine testing at different speeds, and county-wide vehicle registration data obtained from DMV. Estimates are available for years 1970-2040. The model also provides estimates of criteria air pollutants, as well as methane emissions (CH_4). In addition, it produces an estimate of fuel usage, and fuel economy. County variations in emission factors are due to the use of county-specific vehicle usage, vehicle mix, vehicle speed and ambient temperatures. For more information on EMFAC2007, please refer to California Air Resources Board website: http://www.arb.ca.gov/msei/onroad/latest_version.htm
Contact: Ana Sandoval, Principal Environmental Planner, BAAQMD, ASandoval@baaqmd.gov

Waste Sector

What is included in this data?

1) Landfill Waste in Place
   - Total emissions (methane emissions) released from any landfills located in your jurisdiction in the baseline year
2) Lifetime Decomposition Associated with Waste Generated
   - Total emissions (methane emissions) from solid waste generated in your jurisdiction in the baseline year that was sent to landfills regardless of whether they are located within or outside of your jurisdiction's boundaries
   - Total emissions (methane emissions) from the Alternative Daily Cover (ADC) used in the landfills where the waste generated in your jurisdiction is disposed.

What is not included in this data?

- Any GHG emissions from fossil-based products (incineration or decomposition) are not included nor are GHG emissions from organic waste handling and decay because they are considered to be biogenic in origin.

Emission Factors and Calculation Methodology:

1) Total Emissions Generated: Estimate using the EPA Landfill Gas Emissions Model (LandGEM). It can provide the recovered methane (metered landfill gas in flux units scf/m^2). LandGEM is available online: http://www.epa.gov/ttn/catc/products.html
   User's Manual: http://www.epa.gov/ttncatc1/dir1/landgem-v302-guide.pdf
2) Lifetime Decomposition Associated with Waste Generated: The methane emission factors used in the ICLEI CACP Software were derived from the EPA WARM model. For quantification of emissions only methane generation (or gross emissions) is taken into account. More information on the WARM Model is available at: http://epa.gov/climatechange/wycd/waste/calculators/Warm_home.html

Data Sources:

1) Landfill information and total landfill waste in place: Bay Area Air Quality Management District (BAAQMD).
   Contact: Ana Sandoval, Principal Environmental Planner, BAAQMD, ASandoval@baaqmd.gov
2) Waste Tonnage: California Integrated Waste Management Board (CIWMB), California Solid Waste Statistics.
   Waste disposal and alternative daily cover (ADC) tonnage is reported by permitted facility operators and compiled by county/regional agency disposal reporting coordinators and published in the Disposal Reporting System (DRS) for every county/jurisdiction from 1999 to 2005 (as of September 2007).by the California Integrated Waste Management Board. http://www.ciwmb.ca.gov/lgcentral/DRS/Reports/JurDspFa.asp?VW=JURIS

Waste Characterization: CIWMB 2004 Statewide Waste Characterization Study. This state average waste characterization accounts for residential, commercial and self haul waste. http://www.ciwmb.ca.gov/Publications/default.asp?pubid=1097
Residential and Commercial Waste Characterization Studies are provided every five years by county/jurisdiction. The CIWMB does not compile the sector-specific tonnage of waste generated. Therefore, this characterization is only usable if every jurisdiction has the exact tonnage per sector.
http://www.ciwmb.ca.gov/Profiles/Juris/Default.asp

[2] In order to use the landfill gas recovered information reported by the Air District a conversion from flux units to mass units of should be done. Use an average landfill gas density for the Bay Area of 0.0734 lbs/scf and a concentration of Methane in the landfill gas of 50% (BAAQMD).

CIWMB's waste categories correlate with the ICLEI CACP software categories according to the following guidelines:

- Paper Products includes all paper types.
- Plant Debris includes leaves and grass, prunings and trimmings, branches and stumps, and agricultural crop residues.
- Wood and Textiles includes lumber.
- Other category includes all inorganic material types reported: glass, metal, electronics, plastics, non organic C&D, and special/hazardous waste.

Landfill Gas Recovery Rate (or Methane Recovery Factor): *Solid Waste Disposal. Chapter 2. AP 42 Emission factors.* U.S. EPA 1998

Landfills in the San Francisco Bay Area are regulated under the EPA New Source Performance Standard regulations. The local implementation agency is the Bay Area Air Quality Management District. Onsite measurements should be reported to comply with the control emissions (Non Methane Organic Compounds). The recommended landfill gas recovery rate (or methane recovery factor) that landfills should apply for their uncontrolled emissions is provided by the EPA AP 42 Emission Factor Guidelines and it is from 60%-85%. ICLEI recommends using the minimum recommended rate being consistent with the 2006 IPCC Guidelines of acknowledging the uncertainties associated with the measurements.
http://www.epa.gov/ttn/chief/ap42/ch02/index.html

Appendix A

Global Warming Potentials and CO_2e

When reporting GHG emissions and reductions, the individual gases are typically converted to carbon dioxide equivalencies (CO_2e) in order to report a single number that captures the total amount of GHG being released (or avoided).

Carbon dioxide equivalent (CO_2 e) is a commonly used unit that allows amounts of greenhouse gases of different strengths to be added together based on each gas's relative impact on climate change. CO_2 e is expresses in terms of the amount of carbon dioxide it would take to produce the same impact on global climate change. For example, nitrous oxide is 310 times more potent than carbon dioxide as a greenhouse gas. Therefore, one ton of N_2O is equal to 310 tons CO_2e. This conversion factor is known as the gas's "global warming potential." The global warming potential is calculated based on a 100 year time frame, taking into consideration both impact and the length of time the gas remains in the atmosphere (i.e. a more potent greenhouse gas that is removed from the atmosphere in 10 years could have a lower global warming potential than a weaker gas that remains in the atmosphere for 50 years).

Relative Global Warming Potentials from the IPCC's Second (SAR) and Third (TAR) Assessment Reports

Gas	SAR	TAR
Carbon Dioxide	1	1
Methane	21	23
Nitrous Oxide	310	296
HFC-23	11,700	12,000
HFC-125	2,800	3,400
HFC-134a	1,300	1,300
HFC-143a	3,800	4,300
HFC-152a	140	120
HFC-227ea	2,900	3,500
HFC-236fa	6,300	9,400
Perfluoromethane (CF4)	6,500	5,700
Perfluoroethane (C2F6)	9,200	11,900
Sulfur Hexafluoride (SF6)	23,900	22,200