

Appendix C: Methodology – ICLEI



Community Greenhouse Gas Inventory Methodology for Bay Area Local Governments

Prepared as part of Bay Area Air Quality Management District – ICLEI Workshop Napa County on November 18, 2008

Community-Scale Inventory: Introduction

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 scope (see definition below) and sector—residential, commercial, industrial, transportation/mobile emissions, and waste. When completed, the community inventory will include the quantities of electricity and fuels used in the residential, commercial, industrial, and transportation/mobile emissions 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. *See sector detail for data sources, methodologies, and emissions coefficients.*

Purposes of an Emissions Inventory

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. Therefore, the primary values of an emissions inventory are:

- To determine the major sources of emissions within your jurisdiction as a basis for effective emissions reduction policy,
- To create a base year to set emissions reduction targets, and
- To enable the demonstration of progress over time through re-inventorying across years.

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.

Inventories as Estimates

This emissions inventory represents a useful tool for creating a quantitative understanding of emissions from your jurisdiction, for creating a basis for effective policies to reduce emissions, and for creating a baseline to compare against future inventories. This said, this inventory represents a best estimate based upon current understanding and data and does not represent a complete and unchanging picture of emissions in your jurisdiction. It is important to communicate this fact to policymakers, staff and community members throughout the inventory process.

Inventories will evolve for two reasons. First, in many of the sectors of the inventory, the science, models, and data infrastructure behind available data are continually evolving. For this reason, available data and emissions factors are continually being refined and made more accurate. In addition, national community-scale emissions inventory standards have yet to be officially established, and methods used for inventories now may not be those adopted in a final Protocol (expected completion Fall 2009). It is therefore important to understand and communicate that this and all inventories represent an estimate based upon best available data and methodologies, and are subject to change over time.

Community-Scale Inventory: Contents and General Data Needs

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.

$$\text{Activity Level Data} \times \text{Emissions Factor} = \text{Emissions Generated from Activity}$$

ICLEI recommends converting all GHG emissions into carbon dioxide equivalent units, or CO₂e, 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.

Emissions Sources that are Included

The community-wide analysis includes the following data sources and sectors:

	Sector	Data / Emission Source		Sector	Data / Emission Source
Built Environment	Residential	Electricity Consumption	Mobile Emissions	On-Road Transportation	Vehicles on Local Roads
		Natural Gas Consumption			Vehicles on State Highways
	Commercial	Electricity Consumption		Off Road Non-Point Sources	Lawn and Garden Equipment
		Natural Gas Consumption			Construction Equipment
	Industrial	Electricity Consumption			Industrial Equipment
		Natural Gas Consumption		Light Commercial Equipment	
		Estimated Direct Access Natural Gas Consumption	Waste	Landfill Methane	Methane (CH ₄) emissions from landfills
		Estimated Direct Access Electricity Consumption		Community Generated Waste	Total Landfill Waste
					Total Organic Alternative Daily Cover

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 or lack necessary data to calculate* –The science is still evolving in many sectors, and data may not be available-e.g. Non-combustion industrial emissions sources, emissions from composting activities.
- *Largely located outside the jurisdiction’s boundaries* – such as intercity transportation fuel (i.e. air, rail, marine and intercity highway traffic).

Community-Scale Inventory: Reporting Emissions

Scopes

The scopes framework is designed to categorize emissions according to source location and the ability of local governments to affect their emissions. ***Scopes must be reported separately, as adding scopes may result in double counting.*** If your jurisdiction chooses to report one “roll-up” number for all emissions *in addition to reporting separately by Scope*, it is important to account for double counting by removing overlapping emissions (if possible), and clearly state exactly what emissions sources were aggregated to create the roll up number whenever mentioning it. In this inventory, the only source of possible double counting is in the waste sector, where community generated waste may be disposed of in a landfill within the jurisdiction, leading to Scope 1 and Scope 2 emissions. Depending upon the source of waste in a landfill, it may be very difficult to separate out emissions resulting from waste generated within the community versus emissions from waste generated outside of the community. For this reason, ICLEI strongly recommends reporting emissions by Scope for the Napa County inventories.

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. For the purposes of this inventory, Scope one emissions include point source emissions such as natural gas and diesel consumption in homes and businesses, and methane released from decomposing waste in landfills within the jurisdiction. It also includes emissions from vehicles and other non-point sources within the local government 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. In this inventory, Scope two sources are limited to the electricity consumed in homes and businesses within local government boundaries.

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.

Scope 3 emissions sources 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 this inventory, emissions resulting from community-generated waste sent to landfills is considered a scope three emission (pending adoption of the Community-Scale Emissions Protocol).

Forecasting Emissions

ICLEI encourages forecasting emission to a projected target year (most often 2020) to create a more accurate picture of the emission reductions necessary to meet your jurisdiction's targets. Because of population increase, as well as growth in the jobs and transportation sectors, emissions will experience a background change not related to policy changes made by the local government. When creating an emissions reduction target, it is therefore important to consider not only emissions in the base year, but projected emissions in the target year, as these will need to be accounted for as well.

To assist in the forecast, ICLEI has included a forecasting tool as part of the master data summary file that was created for your jurisdiction. ICLEI has included Household, Population, and Job forecasts from ABAG's policy-based *Projections 2005* for you to use in your jurisdictions forecast if so chosen. Many local governments have conducted their own forecasts as part of General Plan or other processes and may wish to use this information instead. See more details on the methodology of the forecast tool in Appendix B.

Built Environment: Residential, Commercial and Industrial Sectors

Data Sources

- Utility electricity and natural gas consumption for 2005 was provided by Corie Cheeseman at PG&E. Data is reported at an aggregate level for each sector – Residential, Commercial and Industrial (Commercial and Industrial are often bundled together for reasons stated below.)
- Countywide Direct Access electricity consumption (purchased directly from the power generator, not through PG&E) for Napa County was obtained from Andrea Gough at the California Energy Commission.

Methodology

- Utility (PG&E) electricity and natural gas consumption was converted to emissions using PG&E emissions factors below.
- Industrial customers are subject to State PUC confidentiality laws (15/15 rule) if they consume a certain proportion of the electricity within the local government. For this reason, all Napa County jurisdictions had at least a portion of the industrial consumption reported in the commercial sector and any reported emissions from the industrial sector constitute only a subset of actual industrial emissions.
- The Direct Access (DA) data used for these emissions inventories (provided by the CEC-- see above) are aggregated at the countywide level. Direct Access electricity consumption at the municipal level was estimated by assigning the countywide ratio of DA electricity to

PG&E electricity to all cities and towns. This ratio, applied to known PG&E electricity at the municipal level, generates the DA consumption estimate. The DA estimate is then converted to CO_{2e} emissions using emissions factors below.

2005 Emission Factors:

Emission Source	GHG	Emission Factor	Emission Factor Source
PG&E Delivered Electricity	CO _{2e}	0.492859 lbs/kwh	The certified 2005 CO _{2e} emission factor for delivered electricity was given to ICLEI by Xantha Bruso at 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 ₂ O	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 ₂ O	0.001 kg/ MMBtu	

What is not included in this data?

- Fuel sources not delivered by PG&E. For example, wood, charcoal, propane, kerosene, diesel, heavy fuel oil, etc. In California, this largely results in an exclusion of industrial process emissions.
- PFCs, HFCs, SF₆. This data may be prohibitively difficult to obtain.

Transportation/Mobile Emissions Sector

Data Sources

- Local Roads 2005 VMT data was obtained from CalTrans, which compiles and published statewide VMT data annually through the Highway Performance Monitoring System.² CalTrans obtains local roads VMT data from regional transportation planning agencies and councils of governments across the state. For the San Francisco Bay Area, CalTrans obtains data from the Metropolitan Transportation Commission (MTC). MTC obtains data on local roads VMT either from the local governments within its jurisdiction or, if that data is unavailable, through a CalTrans model.
- State Highways Vehicle Miles Traveled (VMT) 2005 data was also obtained from CalTrans, with daily VMT by road segment.
- Off Road non-point source emissions were obtained by Walter Wong, California Air Resources Board, wwong@arb.ca.gov

Methodology

- State Highway VMT data by road segment was translated to the jurisdiction level data through a GIS analysis by Jonathan Strunin, Program Officer at ICLEI. Road segments were split into jurisdictions and, where road segments crossed jurisdiction boundaries, the percentage of each road segment in a jurisdiction was calculated. This percentage was then applied to the VMT figure for the road segment.

$$\text{Percentage of Road Segment in Jurisdiction} \times \text{VMT for Road Segment} = \text{VMT for Road Segment in Jurisdiction}$$

These VMT figures were then aggregated by jurisdiction.

- CO₂ emissions were calculated from VMT using regional EMFAC figures including: VMT mix, fuel efficiencies (to convert VMT to fuel consumption), and local emission factors (to convert fuel usage to emissions).
- CH₄ and N₂O emissions were calculated from VMT using the CH₄ and N₂O emissions coefficients below.
- Emissions from off-road non-point sources for Napa County were calculated from the California Air Resources Board OFFROAD2007 model.³ Countywide figures were then split into jurisdictions using 2005 household and job estimates from ABAG *Projections 2005*.

² The 2005 report is available at: <http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/hpmspdf/2005PRD.pdf>.

³ For a detailed description of the OFFROAD2007 model methodology and included emissions sources, see http://www.arb.ca.gov/msei/offroad/pubs/offroad_overview.pdf

2005 Emissions Factors⁴

CH ₄ Rates (grams/mile)		N ₂ O Rates (grams/mile)		VMT Mix		CO ₂ Rates- (grams/gallon)		Fuel Efficiency (miles/gallon)	
Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
0.074	0.033	0.070	0.050	93.4%	6.6%	8,561	10,126	117.6	9.1

What is not included in this data?

- Emissions associated with port or airport operations.
- Rail transit emissions.
- This methodology will not reflect the use of any fuels besides gasoline and diesel.
- PFCs, HFCs, SF₆. This data may be prohibitively difficult to obtain.

Waste Sector

What is included in this data?

- 1) Landfill Emissions
 - Total captured and fugitive 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.

⁴ Emissions Factors Source: Bay Area Air Quality Management District (BAAQMD). CO₂, CH₄ and N₂O emission factors are generated using the EMFAC model. The basis for the estimates are CO₂ 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 (CH₄). 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: Abby Young, Principal Environmental Planner, BAAQMD, ayoung@baaqmd.ca.gov

Emission Factors and Calculation Methodology:

- 1) **Total Emissions Generated:** Landfill Gas Collection figures were provided by the Bay Area Air Quality Management District for the two permitted landfills located within Napa County. Landfill gas recovery (75%), methane destruction efficiency, and other determining factors were provided by the Local Government Operations Protocol (Chapter 9).
- 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/wywd/waste/calculators/Warm_home.html. In line with the Local Government Operations Protocol, a 75% methane recovery factor is applied.

Data Sources:

- 1) **Landfill information and total landfill waste in place:** Bay Area Air Quality Management District (BAAQMD). Contact: Carol Allen, BAAQMD, callen@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=IURIS>

Upper Valley Waste Management Authority

Waste tonnage of municipalities and unincorporated areas that are part of the Upper Valley Waste Management Authority (UVWMA) were estimated by disaggregating the UVWMA annual data (provided by the CIWMB DRS). The percentage that a given UVWMA jurisdiction generated was based upon the number of Upper Valley Disposal and Recycling (UVDS) accounts in each jurisdiction. Data provided by Amy Garden, Napa County Environmental Management, AGARDEN@co.napa.ca.us; and Linda Sereni, Upper Valley Disposal and Recycling, Linda@uvds.com.

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>

	Unit	CH4 Coefficient by Waste Type				All Other Waste
		Paper Products	Food Waste	Plant Debris	Wood/Textiles	
Methane Emissions	(tonne/tonne of waste disposed)	2.1382629	1.210337	0.685858	0.605168736	0

ICLEI U.S.A.

Appendix A-Global Warming Potentials and CO₂e

When reporting GHG emissions and reductions, the individual gases are typically converted to carbon dioxide equivalencies (CO₂e) in order to report a single number that captures the total amount of GHG being released (or avoided).

Carbon dioxide equivalent (CO₂e) 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. CO₂e is expressed 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 N₂O is equal to 310 tons CO₂e. 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 (CF ₄)	6,500	5,700
Perfluoroethane (C ₂ F ₆)	9,200	11,900
Sulfur Hexafluoride (SF ₆)	23,900	22,200

Appendix B-Forecasting

General Forecast Methodology

ICLEI uses forecast data from various sources (see below) to calculate compounded annual growth rates from each emissions sector. Compounded annual growth rates (from the year 2005 to the year 2020) are calculated from the following formula.

$$\text{Compounded annual growth rate} = ((2020 \text{ statistic}/2005 \text{ population})^{(1/15)})-1$$

Once a compounded annual growth rate has been calculated for the sector, this growth rate is applied to emissions for that sector to calculate emissions for 2020 by the following formula.

$$2020 \text{ emissions} = (\text{compounded annual growth rate}+1)^{15} \times 2005 \text{ emissions}$$

Residential Forecast Methodology

For the residential sector, ICLEI calculates the compounded annual household growth rate between 2005 and 2020, using household projections from ABAG's *Projections 2005*.

Commercial / Industrial Forecast Methodology

Analysis contained within "California Energy Demand 2008-2018: Staff Revised Forecast⁵," a report by the California Energy Commission (CEC), shows that commercial floor space and the number of jobs have closely tracked the growth in energy use in the commercial sector. ICLEI uses job growth projections from ABAG's *Projections 2005* to calculate a compounded annual growth rate.

Transportation Forecast Methodology

On-Road Vehicle Miles Traveled

The recently passed federal Corporate Average Fuel Economy standards and the state of California's pending tailpipe emission standards could significantly reduce the demand for transportation fuel in the State. An analysis of potential fuel savings from these measures at a scale that would be useful for the purpose of a forecast has not been conducted, nor would such an analysis produce a true business-as-usual estimation. Regardless of future changes in the composition of vehicles on the road as a result of state or federal rulemaking, emissions from the transportation sector will continue to be largely determined by growth in vehicle-miles-traveled (VMT). For this reason, ICLEI uses VMT to predict emission from on-road vehicles.

In their report, "Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report," the CEC projects that on-road VMT will increase at an annual rate of 1.509% per year through 2020⁶. This is the compounded annual growth rate that ICLEI uses to estimate emission growth in the transportation sector for the Pleasanton forecast.

⁵ <http://www.energy.ca.gov/2007publications/CEC-200-2007-015/CEC-200-2007-015-SF2.PDF>

⁶ Report available at: <http://www.energy.ca.gov/2007publications/CEC-600-2007-009/CEC-600-2007-009-SF.PDF>. Compounded Annual growth rate for 2005-2020 is calculated from Table 4 on page 12. In light of recent fuel cost increases, the calculation assumes high fuel cost scenario.

Off-Road Non Point Emissions

Lawn and Garden Equipment

Because the number of pieces of lawn and gardening equipment is dependent upon the number of households, ICLEI uses household projections from ABAG's *Projections 2005* to calculate the annual average growth rate of emissions from lawn and garden equipment.

Industrial Equipment, Construction Equipment, and Light Commercial Equipment

The primary determinate for growth in emissions from these off road point sources is the growth of commercial and industrial activity, which can be proxied by using job growth projections from ABAG's *Projections 2005*.

Waste Forecast Methodology

The primary determinate for growth in emissions in the waste sector is population. Therefore, the compounded annual population growth rate for 2005 to 2020 as calculated from ABAG population projections in *Projections 2005*, is used to estimate future emissions in the waste sector.

