Community Greenhouse Gas Inventory Methodology for Bay Area Local Governments

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 form 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 re 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.

Activity Level Data x Emissions Factor = Emissions Generated from Activity

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.

Emissions Sources that are Included

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

<table>
<tr><th></th><th>Sector</th><th>Data / Emission Source</th><th></th><th>Sector</th><th>Data / Emission Source</th></tr>
<tr><td rowspan="7">Built Environment</td><td rowspan="2">Residential</td><td>Electricity Consumption</td><td rowspan="5">Mobile Emissions</td><td rowspan="5">On-Road Transportation</td><td rowspan="3">Vehicles on Local Roads</td></tr>
<tr><td>Natural Gas Consumption</td></tr>
<tr><td rowspan="2">Commercial</td><td>Electricity Consumption</td></tr>
<tr><td>Natural Gas Consumption</td><td rowspan="2">Vehicles on State Highways</td></tr>
<tr><td rowspan="3">Industrial</td><td>Electricity Consumption</td></tr>
<tr><td rowspan="2">Natural Gas Consumption</td><td rowspan="2">Waste</td><td rowspan="2">Community Generated Waste</td><td>Total Landfill Waste</td></tr>
<tr><td>Total Organic Alternative Daily Cover</td></tr>
</table>

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.)

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.

2005 Emission Factors:

Emission Source	GHG	Emission Factor	Emission Factor Source

PG&E Delivered Electricity	CO_2e	0.492859 lbs/ kwh	The certified 2005 CO2e emission factor for delivered electricity was given to ICLEI by Xantha Bruso at PG&E.
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	

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, SF_6. 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.

Methodology

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

- 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.

  Percentage of Road Segment in Jurisdiction x VMT for Road Segment = VMT for Road Segment in Jurisdiction

  These VMT figures were then aggregated by jurisdiction.

- CO_2 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).

- CH_4 and N_2O emissions were calculated from VMT using the CH_4 and N_2O emissions coefficients below.

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, SF_6. This data may be prohibitively difficult to obtain.
- Off road non-point source emissions

Waste Sector

What is included in this data?

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:

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. In line with the Local Government Operations Protocol, a 75% methane recovery factor is applied.

Data Sources:

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

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

Appendix A-Global Warming Potentials and CO2e

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

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.

Compounded annual growth rate = ((2020 statistic/2005 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 emissions = (compounded annual growth rate+1)^15*2005 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 Forecast[3]," 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

<u>On-Road Vehicle Miles Traveled</u>

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 2020[4]. This is the compounded annual growth rate that ICLEI uses to estimate emission growth in the transportation sector for the Pleasanton forecast.

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[3] http://www.energy.ca.gov/2007publications/CEC-200-2007-015/CEC-200-2007-015-SF2.PDF

[4] 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.

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.