



## Appendix G

# Santa Cruz County Municipal and Community-wide Greenhouse Gas Inventories for the Years 2005 and 2009



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## Introduction

There are many gases that contribute to the greenhouse effect, including Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), Nitrogen Dioxide (NO<sub>2</sub>) and others. Information on the three major greenhouse gases is provided in the following table, which includes the sources of these gases and their global warming potential (GWP).

Top Three Greenhouse Gases			
Gas	Chemical Formula	Human Activity	Global Warming Potential (CO <sub>2</sub> e)
Carbon Dioxide	CO <sub>2</sub>	Fossil Fuel Combustion	1
Methane	CH <sub>4</sub>	Fossil Fuel, Combustion, Anaerobic Decomposition of Organic Waste (Landfills, Wastewater), Fuel Handling	21
Nitrous Oxide	N <sub>2</sub> O	Fossil Fuel Combustion, Wastewater Treatment	310

Source: County of Santa Cruz, 2013.

Emissions of CO<sub>2</sub> are the largest contributor, with minor contributions from CH<sub>4</sub>, NO<sub>2</sub>, and others. Some of these gases are more powerful modifiers of the atmosphere than others. For example, CH<sub>4</sub> is 21 times more powerful than CO<sub>2</sub> as a greenhouse gas, and NO<sub>2</sub> is 310 times more powerful than CO<sub>2</sub> as a GHG. The emissions inventory combines emissions from different greenhouse gases and converts the emissions to equivalent amounts of CO<sub>2</sub> for final reporting purposes. The term CO<sub>2</sub>e (carbon dioxide equivalent) will be used throughout this report as the standard measurement for greenhouse gas accounting.

Emissions are calculated using **activity data** and **emissions factors**. Examples of activity data include electricity consumption in kilowatt hours (kWh), natural gas consumption in therms of natural gas, fuel consumed in gallons, and vehicle miles traveled (VMT). An emissions factor is the quantity of greenhouse gas emissions per unit of activity, such as kilograms (kg) of CO<sub>2</sub> per kWh, or kg CO<sub>2</sub> per gallon of fuel, or per mile driven. Use of electricity is associated with emissions at the power generating sources largely located outside the County. These are called indirect emissions. Direct emissions result from burning natural gas in our homes and businesses, and fuel use and miles driven in our cars. Emissions are reported in units of metric tons of CO<sub>2</sub>e (MT CO<sub>2</sub>e) using standard conversion factors in the calculations (e.g. 1,000 kg equals 1 metric ton). Emissions factors used in the calculations are listed in the following table:

Emissions Factors (kgCO <sub>2</sub> e)			
Activity	2005	2009	Percent Change
Electricity	0.2237 kg/kWh	0.2626 kg/kWh	15%
Natural Gas	5.3166 kg/Therm	5.3166 kg/Therm	0%
Gasoline	8.78 kg/gallon	8.78 kg/gallon	0%
Diesel	10.21 kg/gallon	10.21 kg/gallon	0%
Vehicle Class	kg/mile	kg/mile	Varies by vehicle class

Source: County of Santa Cruz, 2013.

The electricity emissions factor changes depending on the type of fuel used to generate electricity at each source (natural gas, nuclear, coal, hydro, etc.) and the source's level of contribution to the overall power supply in a given year. Because the PG&E "power mix" varies from year to year, the electricity emissions factor



changes accordingly. The increase in the emissions factor in 2009 indicates the PG&E power mix was more dependent on fossil fuel sources of electricity compared to 2005. It is important to keep this in mind when analyzing the emissions inventory because a higher emissions factor will increase total emissions even if electricity use does not increase, or even if electricity use goes down.

The various emissions factors for fuels (natural gas, gasoline, and diesel) remain constant from year to year because the carbon content of specific fossil fuel types does not change.

Emissions by vehicle class are determined using a computer model developed by the California Air Resources Board. The model (EMFAC2007) draws from a variety of datasets, such as DMV data, to calculate emission factors by accounting for the emissions characteristics of the current population of registered vehicles in each vehicle class in Santa Cruz County. Vehicle classes range from passenger cars to light-, medium-, and heavy-duty trucks, and motorcycles of all fuel types.

For clarity, emissions factors are grouped in the table above and the tables below contain information on activity data and total emissions.

Inventories were prepared for the years 2005 and 2009. 2005 is a commonly accepted baseline year for greenhouse gas inventories for jurisdictions in California because it aligns with guidance from the State and the approach of most local jurisdictions throughout the State. The 2005 inventory is based largely on data for 2005, but some data from other years was used as a proxy when data were not available for 2005. The inventory update was done for the year 2009 because it was the most recent year for which an updated emissions factor was available from PG&E for electricity. Similarly, the 2009 inventory is based largely on data for 2009, but some data from other years was used as a proxy when data were not available for 2009.

The numbers reported in the tables below have been rounded for reporting purposes.

## Santa Cruz County Municipal Greenhouse Gas Inventory

In 2008, the County participated in the International Council for Local Environmental Initiatives (ICLEI)/Sustainable Silicon Valley (SSV) Silicon Valley Climate Protection Partnership program through the Joint Venture Silicon Valley Network to inventory greenhouse gas (GHG) emissions from County operations. As a result of this partnership an inventory of emissions from County government operations for the baseline year of 2005 was completed. The inventory was one of the first inventories to use a new national standard developed and adopted by the California Air Resources Board (CARB) in conjunction with ICLEI, the California Climate Action Registry (CCAR), and The Climate Registry (TCR). This standard, called the Local Government Operations Protocol (LGOP), provides standard accounting principles, boundaries, quantification methods, and procedures for reporting GHG emissions from local government operations. This emissions inventory represents an estimate of emissions using the best available data and calculation methodologies.

The inventory examined the County's GHG impact in the sectors of solid waste, buildings and facilities, vehicle fleet, wastewater treatment, public lighting, employee commute, and water systems. The inventory includes only those activities that the County has direct operational control over.

The County's total calculated emissions were 38,901 MT CO<sub>2</sub>e in 2005, dropping almost 12 percent to 34,267 MT CO<sub>2</sub>e in 2009. This reduction can be attributed largely to a decrease in fugitive methane emissions from the Buena Vista and Ben Lomond landfills, and to a lesser extent apparent reductions in employee commutes and county vehicle fleet use. The largest source of emissions is fugitive methane emissions from the landfills, followed by fuel use by employees commuting, natural gas and electricity to heat and power buildings, fuel use by the vehicle fleet, and other County facilities such as sewage pump stations, public lighting, water delivery related activities.



Government Operations Emissions by Sector			
Sector	MT CO <sub>2</sub> e Emitted		Percent Change from 2005 Baseline
	Year 2005	Year 2009	
Solid Waste Facilities	20,261	18,335	-10%
Employee Commute	6,928	5,370 <sup>(1)</sup>	-22% <sup>(1)</sup>
Buildings and Facilities	5,525	5,847	6%
Vehicle Fleet	5,253	3,673	-30%
Wastewater Treatment Facilities	848	941	11%
Public Lighting	62	69	11%
Water Delivery	24	32	33%
<b>Total</b>	<b>38,901</b>	<b>34,267</b>	<b>-12%</b>

Note:  
 (1) The reduction in emissions from the employee commute is largely due to a reduction in employees between 2005 and 2009  
 Source: County of Santa Cruz, 2013.

**Solid Waste**

Landfills contribute direct emissions of greenhouse gases to the atmosphere in the form of methane gas created by the anaerobic decomposition of buried waste. Both the Buena Vista and Ben Lomond landfills have landfill gas collection systems installed. The landfill gas collected at Ben Lomond is destroyed by a flare. The landfill gas collected at the Buena Vista landfill is used to power a cogeneration facility, and some is destroyed by a flare. Emissions to the atmosphere of GHGs result from methane that escapes the collection system and is not destroyed in a flare or engine generator. The estimate of the amount of methane that escapes the collection system involves a calculation using a number of factors including surface area of the landfill and collection system, the amount of landfill gas collected, the percentage of methane in the landfill gas, the destruction efficiency of methane in the collection system, and the collection efficiency of the system. While there is good accuracy on most of these factors, estimating collection efficiency of a landfill gas collection system is difficult. Based on a review of surface monitoring data collected at the landfill and various studies of collection efficiency in well controlled landfills, a reasonable collection efficiency factor was determined. As further studies are done this collection efficiency factor may change, and the inventory can be adjusted accordingly. The solid waste sector also includes emissions as a result of the use of electricity and natural gas in buildings and facilities associated with landfill operations.

The solid waste sector contributed about half of the County’s emissions in 2005 and 2009. The estimate of emissions of methane gas from the Buena Vista and Ben Lomond landfills decreased between 2005 and 2009 by almost 10 percent. This decrease could be attributable to improvements in the landfill gas collection systems and/or a reduction in methane gas generation by decomposing garbage. Emissions of GHGs as a result of escape of landfill gas from the landfills and the use of electricity and natural gas are summarized in the following tables:

Landfill Gas			
Year	Methane Emissions (MT CH <sub>4</sub> )		Emissions (MT CO <sub>2</sub> e)
	Buena Vista	Ben Lomond	
2005	907	51	20,124
2009	827	42	18,245

Source: County of Santa Cruz, 2013.



Landfill Electricity				
Year	Consumption (kWh)		Emissions (MT CO <sub>2</sub> e)	
	Buena Vista	Ben Lomond		
2005	433,357	125,765		125
2009	229,224	84,316		82

Source: County of Santa Cruz, 2013.

Landfill Natural Gas				
Year	Consumption (Therms)		Emissions (MT CO <sub>2</sub> e)	
	Buena Vista	Ben Lomond		
2005	2,200	0		12
2009	1,507	0		8

Source: County of Santa Cruz, 2013.

Landfill Summary (MT CO <sub>2</sub> e)				
Year	Methane Emissions	Emissions from Electricity Use	Emissions from Natural Gas Use	Total Landfill Emissions
2005	20,124	125	12	<b>20,261</b>
2009	18,245	82	8	<b>18,335</b>

County of Santa Cruz, 2013.

*Employee Commute*

The employee commute sector contributed about one sixth of the County’s GHG emissions in 2005 and 2009. This sector realized a decreased in GHG emissions of about 22 percent. The reduction in emissions from the employee commute is largely due to a reduction in employees between 2005 and 2009

An estimate of overall vehicle miles traveled (VMT) was based on a County employee commute survey conducted in 2008. This information was used as a proxy for this sector in the overall 2005 emissions inventory. Survey questions were designed to obtain information on the type of vehicle and commute distance (VMT). VMT were converted to fuel consumption using estimates of fuel efficiency for each vehicle type. Fuel consumption estimates from the 2008 employee commute survey were multiplied by emissions factors for transport fuels to obtain total emissions.

2008 Employee Commute			
Fuel Type	Vehicle Miles Traveled	Fuel Consumption (gallons)	Emissions (MT CO <sub>2</sub> e)
Gasoline		142,403	6,902
Diesel		453	26
<b>Total</b>	<b>14,240,655</b>		<b>6,928</b>

Source: County of Santa Cruz, 2013.



A subsequent estimate of overall VMT was based on a second County employee commute survey conducted in 2011. This information was used as a proxy for this sector in the overall 2009 emissions inventory. The survey questions were designed to obtain information on the type of vehicle and commute distance (VMT). The 2011 survey was simplified compared to the 2008 survey by limiting the number of questions. As a result the response rate was increased from about 22 percent in 2008 to about 39 percent in 2011.

The information on VMT and vehicle type from the 2011 employee commute survey was multiplied by an emission factor for each vehicle type to estimate GHG emissions. Categories of vehicle types used in the 2008 survey and the 2011 survey are not comparable due to inconsistent categorization.

2011 Employee Commute		
Vehicle Type	Vehicle Miles Traveled	Emissions (MT CO <sub>2</sub> e)
Passenger Car	7,463,112	3,071
Light Duty Truck	2,928,609	1,490
Medium Duty Truck	524,522	365
Heavy Duty Truck	453,365	428
Motorcycle	138,966	17
<b>Total</b>	<b>11,508,574</b>	<b>5,370</b>

Source: County of Santa Cruz, 2013.

*Buildings and Facilities*

The buildings and facilities sector contributed about one sixth of the County's emissions in 2005 and 2009. This sector realized an almost six percent increase in GHG emissions between 2005 and 2009. The increase could have been caused by a combination of factors. While there was an increase in natural gas use, there was a significant decrease in the use of electricity, which is likely the result of County efforts to conserve energy and increase energy efficiency in buildings and facilities. However, the decrease in electricity use did not result in a proportional reduction in GHG emissions because the decreased energy use was partially offset by an increase in the Pacific Gas & Electric (PG&E) emission factor.

Activity data in this sector is from PG&E records of electricity and natural gas usage in 2005 and 2009 for all facilities under direct operational control of the County of Santa Cruz. This includes buildings, parks, sanitary sewer collection system, small scale wastewater treatment facilities, traffic lights and other public lighting, and water facilities (Davenport treatment plant, irrigation and storm water control system).

2005 Major Buildings and Facilities			
Facility	Electricity Use (kWh)	Natural Gas Use (therms)	Emissions (MT CO <sub>2</sub> e)
Detention Centers*	1,496,087	291,958	1,887
Government Center	3,863,400	56,278	1,164
Emeline Complex	2,717,152	76,537	1,015
Simpkins Swim Center*	50,880	161,195	868
Animal Services	307,479	9,087	117
Minor Facilities	1,195,941	23,834	394
Stationary Refrigerants	N/A	N/A	80
<b>Total</b>	<b>9,630,939</b>	<b>618,889</b>	<b>5,525</b>

Source: County of Santa Cruz, 2013.



2009 Major Buildings and Facilities			
Facility	Electricity Use (kWh)	Natural Gas Use (therms)	Emissions (MT CO <sub>2</sub> e)
Detention Centers*	1,345,925	312,910	2,012
Government Center	3,364,951	48,234	1,134
Emeline Complex	2,812,506	94,834	1,237
Simpkins Swim Center*	31,280	162,326	870
Animal Services	271,950	21,342	184
Minor Facilities	848,319	20,632	331
Stationary Refrigerants	N/A	N/A	80
<b>Total</b>	<b>8,674,931</b>	<b>660,278</b>	<b>5,847</b>

Source: County of Santa Cruz, 2013.

*Vehicle Fleet*

This sector contributed about one sixth of the County's GHG emissions. Between 2005 and 2009 emissions in this sector dropped about 30 percent. All of the decrease was caused by a decrease in fuel use in the Public Works Department, while most other department's fuel use stayed the same or increased slightly.

The County has two vehicle fleets, the fleet managed by the General Services Department, and the fleet managed by the Public Works Department. Each department purchases and manages fuel separately. Detailed fuel use data was provided by these two departments for 2005 and 2010. The data was conditioned to separate out fuel use by department. Some vehicles in the General Services fleet purchase fuel from Public Works, and vice versa, which added complexity to the process of assigning absolute fuel use to each department.

2005 Fleet Emissions by Department				
Function	Gasoline Use (gal)	Diesel Use (gal.)	CNG Use (gal.)	Emissions (MT CO <sub>2</sub> e)
Public Works	166,342	219,505		3,702
Sheriff	85,513		225	752
General Services	11,744		835	109
Health Services Agency	12,773		146	113
Parks	17,745		737	161
District Attorney	7,965			70
Human Services Dept.	9,779			86
Probation	6,128		434	57
Agriculture Commission	8,643			76
Planning	6,894			61
Animal Services	5,745			50
Minor Functions <sup>(1)</sup>	1,874			16
<b>Totals</b>	<b>341,143</b>		<b>2,377</b>	<b>5,253</b>

Note:  
 (1) Minor Functions include Agricultural Extension, Assessor, Department of Child Support Services, Elections, Information Services, Office of Emergency Services, Recorder, Radio Shop  
 Source: County of Santa Cruz, 2013.





2010 Fleet Emissions by Department				
Function	Gasoline Use (gal)	Diesel Use (gal.)	CNG Use (gal.)	Emissions (MT CO <sub>2</sub> e)
Public Works	78,651	122,582		1,942
Sheriff	102,243		54	898
General Services	18,403		411	164
Health Services Agency	14,780		176	131
Parks	15,046		681	137
District Attorney	8,421			74
Human Services Dept.	7,781			68
Probation	7,669		171	69
Agriculture Commission	7,902			69
Planning	5,470			48
Animal Services	4,982			44
Minor Functions <sup>(1)</sup>	3,252			29
<b>Totals</b>	<b>274,600</b>	<b>122,582</b>	<b>1,493</b>	<b>3,673</b>

Note:  
 (1) Minor Functions include Agricultural Extension, Assessor, Department of Child Support Services, Elections, Information Services, Office of Emergency Services, Recorder, Radio Shop  
 Source: County of Santa Cruz, 2013.

*Wastewater Treatment Facilities*

The Santa Cruz County Sanitation District (District) operates the system of pump stations and other facilities to collect and transport sewage from unincorporated areas of the County to the waste water treatment facility in the City of Santa Cruz. Operation of District facilities creates emissions from the use of electricity and natural gas. This sector does not include emission from the wastewater treatment facility in the City of Santa Cruz. Additionally, this sector includes emission from the operation of five small package treatment plants (Trestle Beach, Sand Dollar, Place De Mer, Canon Del Sol, Boulder Creek), one community leach field (Place de Mer), and a wastewater treatment lagoon (Davenport). Emissions from this sector increased between 2005 and 2010 by about 11 percent. This increase is attributable to an increase in the use of natural gas by the Santa Cruz County Sanitation District.

Santa Cruz County Sanitation District			
Year	Electricity (kWh)	Natural Gas (therms)	Emissions (MT CO <sub>2</sub> e)
2005	3,100,652	2,690	<b>708</b>
2009	2,981,010	4,953	<b>804</b>

Source: County of Santa Cruz, 2013.



Package Treatment Plant Emissions (MT CO <sub>2</sub> e)		
Facility	2005	2009
Davenport	81	81
Place de Mer	40	40
Boulder Creek	6	6
Sand Dollar	5	5
Canon Del Sol	5	5
Trestle Beach	1	1
Rolling Woods	1	N/A
<b>Total</b>	<b>140</b>	<b>138</b>

Source: County of Santa Cruz, 2013.

Wastewater Treatment Summary (MT CO <sub>2</sub> e)		
Function	2005	2009
Santa Cruz County Sanitation District	708	804
Package Treatment Plants	140	138
<b>Totals</b>	<b>848</b>	<b>942</b>

Source: County of Santa Cruz, 2013.

*Public Lighting*

Emissions from electricity consumption for streetlights, and traffic control devices increased between 2005 and 2009 by about 11 percent. Because the number of these facilities did not change significantly, the increase can be attributed to an increase in the PG&E emission factor. This sector includes public lighting for which the County has direct operation control. The vast majority of streetlights throughout the County are under the control of PG&E.

2005 Public Lighting		
Source	Electricity Use (kWh)	Emissions (MT CO <sub>2</sub> e)
Streetlights	108,086	24
Traffic Signals / Controllers	156,088	35
Other Outdoor Lighting	13,012	3
<b>Total</b>	<b>277,186</b>	<b>62</b>

Source: County of Santa Cruz, 2013.



2009 Public Lighting		
Source	Electricity Use (kWh)	Emissions (MT CO <sub>2</sub> e)
Streetlights	101,078	26
Traffic Signals / Controllers	164,160	43
Other Outdoor Lighting	N/A	N/A
<b>Total</b>	<b>265,238</b>	<b>69</b>
Source: County of Santa Cruz, 2013.		

*Water Systems*

This sector includes storm drain pumps, irrigation pumps, and the Davenport water treatment plant. These were grouped together due to the small size of this sector all related to water delivery. Emissions from this sector increased between 2005 and 2009 by about 33 percent. This can be attributed to a combination of factors including the increase in the PG&E emissions factor and an increase in electricity use for irrigation systems, both resulting from drought conditions.

2005 Water Systems		
Source	Electricity Use (kWh)	Emissions (MT CO <sub>2</sub> e)
Irrigation Pumps	43,582	10
Stormwater Pumps	38,923	9
Davenport Water System	24,010	5
<b>Total</b>	<b>106,515</b>	<b>24</b>
Source: County of Santa Cruz, 2013		

2009 Water Systems		
Source	Electricity Use (kWh)	Emissions (MT CO <sub>2</sub> e)
Irrigation Pumps	56,959	15
Stormwater Pumps	38,775	10
Davenport Water System	27,421	7
<b>Total</b>	<b>123,155</b>	<b>32</b>
Source: County of Santa Cruz, 2013.		