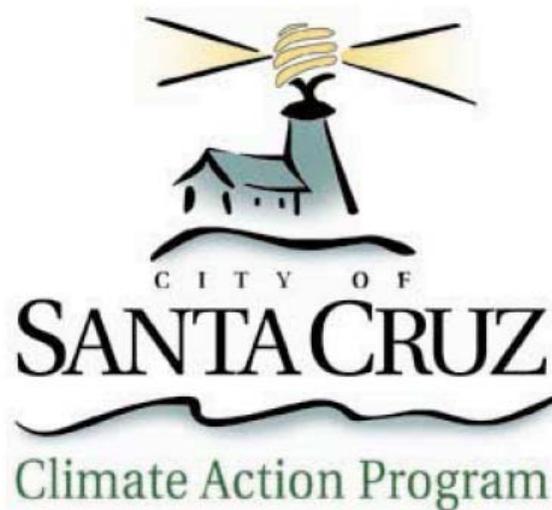


City of Santa Cruz

Inventory of Municipal and Community Greenhouse Gas Emissions

*1996, 2000, and 2005 Revisions
&
Draft 2008 Inventory Update*

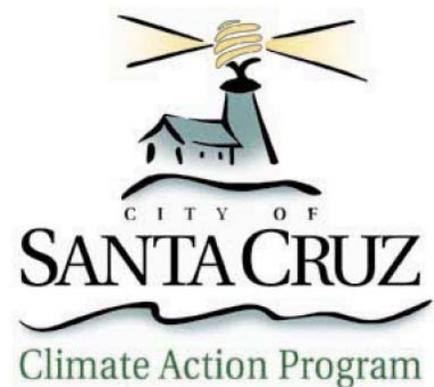


Charlie Lewis & Ross Clark

Climate Action Program
February 2010

Table of Contents

Acknowledgments	2
Santa Cruz Responds to Global Climate Change	3
Greenhouse Gas Emissions Inventory Procedure	4 – 6
Overview of Revisions to 1996, 2000, and 2005 Inventories	6 – 11
2008 Municipal Emissions Inventory	11 – 18
2008 Community-Wide Emissions Inventory	18 – 21
Conclusions	22



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Special thanks to Liz Camarie and Alexis Bradford.

“Warming of the climate system is unequivocal...”

– Intergovernmental Panel on Climate Change, 4th Assessment Report

1 Santa Cruz Responds to Global Climate Change

1.1 Santa Cruz; Precedent to Act

For over two decades, the City of Santa Cruz has taken steps to reduce and respond to Global Warming. In February 2007, the city council adopted a set of General Plan goals and policies on climate change; including reducing community-wide greenhouse gas emissions thirty percent by 2020, reducing eighty percent by 2050 (compared to 1990 levels), and for all new buildings to be emissions neutral by 2030. (tinyurl.com/SCpolicies)

1.2 Climate Action Compact

On October 1st 2007, officials of the County of Santa Cruz, the City of Santa Cruz and the University of California Santa Cruz signed a collective agreement recognizing climate change as a global issue with achievable local solutions. Called the *Climate Action Compact*, the members pledged to support public, private and nonprofit partnerships and investments to reach quantifiable reductions in their institutions' greenhouse gas (GHG) emissions. Since the signing of the Climate Action Compact, several cooperative projects have been implemented and four more are currently being approved.

1.2 Climate Action Program

As part of the City's commitment to the Climate Action Compact, the Climate Action Program and the Climate Action Coordinator and Intern positions were created in the months leading up to the agreement. The Climate Action Program staff works closely with the international organization ICLEI – Local Governments for Sustainability (ICLEI) as one of the 400 members representing the United States in the Cities for Climate Protection campaign, an internationally recognized program that provides the tools and framework needed to help communities track and reduce their GHG emissions.

The framework consists of five milestones:

1. Conduct a baseline emissions inventory and forecast
2. Adopt an emissions reduction target for the forecast year
3. Develop a Local Climate Action Plan
4. Implement the policies and measures in the Local Climate Action Plan
5. Monitor and verify results

The Climate Action Program staff has already completed a baseline inventory and has set a reduction goal of a 30% below 1996 levels by 2020, and 80% below by 2050. The Climate Action Plan is currently under development and should be made public by spring 2010.

2 Greenhouse Gas Emissions Inventory Procedure

2.1 Assembly Bill 32: Global Warming Solutions Act

On September 27th 2006, Governor Arnold Schwarzenegger signed Assembly Bill 32 (Nuñez and Paveley) which requires the state of California to take major steps to reduce the emission of greenhouse gases (GHG) into the atmosphere. AB32 was California's answer to the complete lack of climate legislation to come out of Washington and moved the State to the forefront of the climate change movement. AB32 requires some of the most aggressive reduction goals in the world, reducing emissions by 30% below 1990 levels by 2020 and 80% by 2050. (tinyurl.com/AirBoard)

AB32 requires municipalities to report their emissions every five years and establish programs to reduce emissions. The city of Santa Cruz has chosen to complete a 2008 emissions inventory in order to hone the inventory process in response to new State guidance, to establish a reproducible methodology for future inventories, to supplement the draft Climate Action Plan and to track changes in emissions more accurately.

2.2 ICLEI – Local Governments for Sustainability

ICLEI – Local Governments for Sustainability is an international organization that assists local governments in reaching their goals of sustainability and climate change mitigation. The City of Santa Cruz joined ICLEI in 2001 and has been utilizing the available resources to assist in data collection and analysis, all of which are necessary to accurately calculate GHG emissions. Such resources include useful excel databases that help organize energy use data or calculate emissions savings available from hundreds of different projects, upgrades and programs. (icleiusa.org)

2.3 Local Government Operations Protocol

The Local Government Operations Protocol was produced through the partnerships of many organizations including ICLEI USA, the California Air Resources Board, the California Climate Action Registry as well as many other local municipalities and serves as a guideline in proper data collection and analysis. The LGOP contains methodologies on how to calculate all scopes of emissions of the six main GHGs: carbon dioxide, sulfur hexafluoride, nitrous oxide, methane, hydrofluorocarbons and perfluorocarbons. (tinyurl.com/lgoprotocol)

2.4 Clean Air Climate Protection Software

To assist local governments in their GHG inventories, ICLEI created the Clean Air Climate Protection (CACP) software. The program uses fuel specific emissions factors to translate raw energy use (kWh of electricity, therms of natural gas, gallons of gasoline or diesel etc.) into GHG emissions. CACP calculates the emission of nine different GHGs, deemed most harmful to the climate by the International Council on

Climate Change, and aggregates them in terms of carbon dioxide equivalent, or CO₂e. The emissions coefficients and gases tracked by the CACP software are consistent with national and international inventory standards established by the Intergovernmental Panel on Climate Change. Although the software provides the City with a sophisticated and useful tool, calculating emissions from energy use with precision remains difficult. The software depends upon numerous assumptions and is limited by the quantity and quality of available data. With this in mind, it is useful to think of any specific number generated by CACP as an approximation of reality, rather than an exact value. This update establishes a level of accuracy and consistency among inventory years necessary to quantify the results of changing energy use patterns.

2.5 Emissions Scopes

Scopes of emissions are used in order to evaluate how easily a municipality can reduce the emissions from various sources. The list and figure below define the different scopes and how they apply to the City of Santa Cruz.

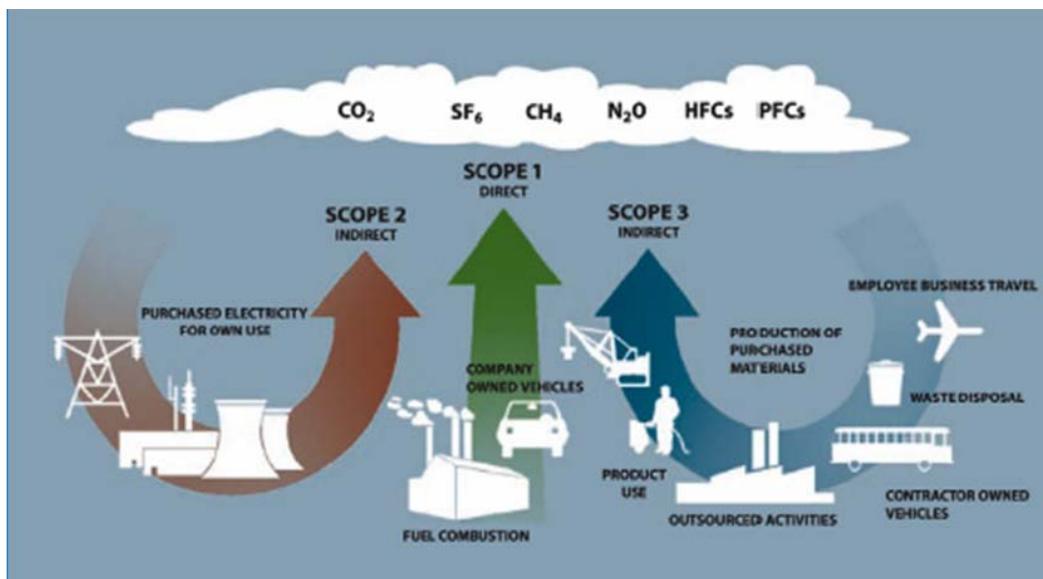


Figure 1 Source: WRI/WBCSD GHG Protocol Corporate Accounting and Reporting Standard (Revised Edition), Chapter 4.

Scope 1: All direct GHG emissions (with the exception of biogenic CO₂ emissions, those from the combustion of digester gas from the Wastewater Treatment Facility (WWTF)).

- This applies to natural gas burned to generate electricity at the WWTF, natural gas burned to heat buildings and water, gasoline and diesel used in City owned cars and trucks and fugitive methane emissions from the City owned landfill.

- The Climate Action Staff is currently working with operations managers on establishing the framework necessary for tracking future and historic refrigerant leaks from mobile and stationary air-conditioning units.

Scope 2: Indirect GHG emissions associated with the use of purchased electricity.

- This includes electricity purchased from Pacific Gas & Electric.

Scope 3: All other indirect emissions not covered in Scope 2, such as upstream and downstream emissions, emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity (e.g., employee commuting and business travel), outsourced contract activities, etc.

- The City of Santa Cruz is reporting only one of the many Scope 3 emissions due to unavailability of data and staff resources. The emissions included are those that will occur in the future when the waste that entered the landfill in the reporting year digests into methane.
- Other Scope 3 emissions that the City has not yet established mechanism to quantify include employee commutes and job related air travel.

Tracking emissions by scope is useful when setting out a plan of attack for reducing emissions. Scope 1 emissions are created onsite and are easily modified, reduced or changed since the City controls the purchase and combustion of the fossil fuels responsible for emissions. Scope 2 emissions come from offsite making it difficult for the City to reduce the emissions, but energy efficiency measures and investments in renewable generation are mechanisms that can reduce electricity use and ultimately generate less Scope 2 emissions. Scope 3 emissions are not only difficult to reduce due to their upstream sources, but tracking the emissions alone can prove to be a monumental task.

3 Overview of Revisions to 1996, 2000, and 2005 Inventories

The calculation of GHG emissions inventories is an evolving science¹. Therefore, all emissions inventories must be considered an estimate using the best available data, methodologies and protocols. Since the original release of the 2005 GHG Emissions Inventory in August 2008, improved methodologies and protocols, along with more data made available from updates to the City's various data storage and reporting processes, have helped establish a stronger framework for inventories. Revisions to prior years' GHG inventories are important for the City to compare emissions over time and properly evaluate reductions in emissions within the community.

3.1 Protocol Changes

The Local Government Operations Protocol (LGOP), developed in partnership by the California Air Resources Board (CARB), the California Climate Action Registry, ICLEI – Local Governments for Sustainability (ICLEI) and The Climate Registry, was

released in September 2008 to provide a comprehensive protocol for the quantification and reporting of municipal GHG emissions inventories. In response to the LGOP, ICLEI released a series of excel database tools to its members to effectively organize data and calculate emissions not covered by the CACP software. Such emissions never covered by CACP are Scope 1 fugitive emissions from landfills and wastewater treatment plants.

A community emissions protocol has yet to be released. Therefore, the City continues to use the CACP software and ICLEI guidance to complete community emissions inventories. Once community protocols are complete, current emissions should be easily modified to meet new standards. The Climate Action Program staff anticipates the building energy use emissions will be equal using the two methods, but transportation emissions may change. Using the regional and city specific data resources available, we anticipate that the new methods should be easily adopted and adjustments made.

3.2 Third Party Validation

The California Climate Action Registry has worked with the State of California to register GHG reductions of businesses and municipalities and provide validation of completed inventories. Currently, the City of Santa Cruz has not registered its emissions inventory for several reasons. First, there is an annual cost to being a member of the registry, which until continued funding of the Climate Action Program is established is not a financial priority. The Registry also provides third party validation services that may be valuable, however, the City is investigating other peer review options for this and prior inventories. The third value of registering is that future carbon offset exchanges will require third party validation prior to the sale of any offsets or carbon credits. At present the City does not have a policy on how to participate in offset programs and, if carbon reductions were commoditized by the state, whether City carbon reductions should be sold to others parties to support their reduction goals. Future sales of carbon offsets could be justified for those reductions above and beyond those necessary for the city to meet its GHG reduction goals, and may be a value to supporting additional local actions.

3.3 Data Availability

City fleet databases have recently been updated with programs that allow for customized reporting that can compile records by vehicle make, model year and fuel type. This increased accuracy in reporting allows for more accurate emissions calculations in CACP. The CARB has initiated new reporting requirements for certain municipal operations, such as the Wastewater Treatment Facility (WWTF) and landfill, to quantify their onsite power and fugitive emissions (from sewage and waste decomposition) which has made detailed information available to the Climate Action Program.

3.3 Honed Methodologies

Previous estimates of emissions associated with community transportation have been remodeled within this report because the 2005 emissions were based on a two point linear extrapolation of the 1996 and 2000 inventories and the methods which were used to calculate the 1996 and 2000 emissions cannot be found in City records. While the accuracy of the new transportation emissions model cannot be exactly determined, the new model can be easily reproduced in future years to ensure that the transportation emissions calculated will always be comparable and will reflect changes in driving habits of the community. The 2005 report neglected to include the emissions benefits of all diesel vehicles in the City fleet using B20 biodiesel (20% of the fuel is from biogenic sources and 80% is from fossil-based diesel). This has been corrected and included in this updated version.

3.4 Baseline 1996 Municipal Inventory Revision

The baseline for municipal emissions is 10,211 Tonnes CO_{2e} as a result of the use of 148,257 GigaJoules of fossil-based energy.

1996 has been chosen by the City of Santa Cruz as the baseline emissions year from which all reductions will be evaluated. The newly revised inventory for 1996 is 3.66% lower than reported in August 2008 and the majority of the decrease from 10,599 Tonnes CO_{2e} to 10,211 Tonnes CO_{2e} is due to better vehicle classification data provided by the City's Operations Manager. In the original inventory, vehicle type was assigned using many assumptions, whereas these new data were tagged to the

Table 1: Changes to 1996 Municipal Baseline Inventory

Breakdown of Municipal CO _{2e} Emissions Changes, 1996 Original to 1996 Adjusted		
	Tonnes CO _{2e} Difference	Change as % 1996 Original
1996 Municipal Original Total	10,599	
Reason for Change		
More Accurate Fleet Data	-296	-2.79%
More Accurate PG&E Natural Gas Coefficient	-40	-0.38%
More Accurate Cogen Emissions Coefficients	-52	-0.49%
1996 Municipal Adjusted Total	10,211	-3.66%

vehicle type and quantity of fuel used. Another change in data quality is that all previous inventories used natural gas coefficient based on statewide averages; the new coefficient used for this report is specific to the natural gas provided by PG&E. The 52 Tonne CO_{2e} decrease came from more accurate coefficients for the cogeneration facility. These coefficients, along with natural gas use, were provided with a high degree of accuracy by WWTF management as part of their recently required CARB reports.

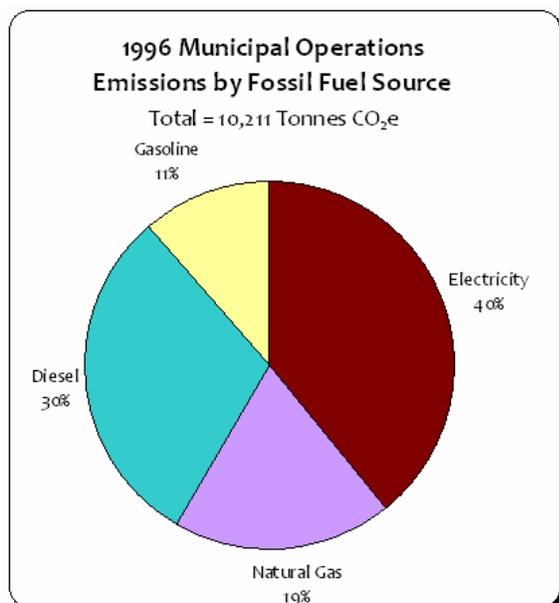


Figure 2: Municipal Emissions by Source

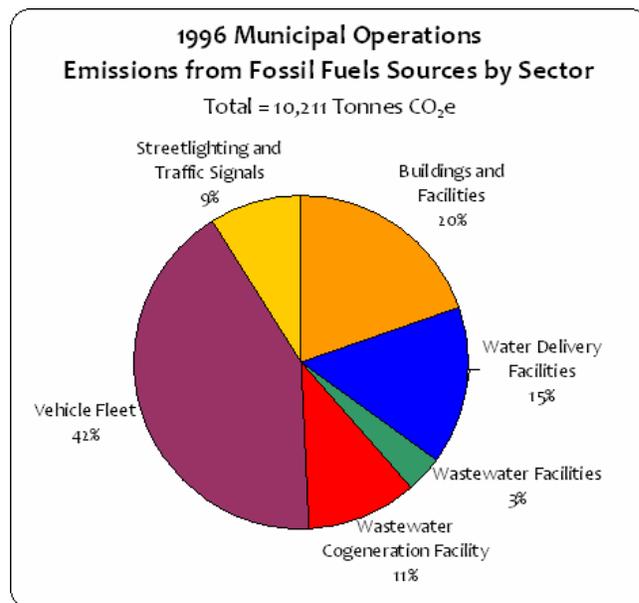


Figure 3: Municipal Emissions by Sector

Figure 2 and 3 above breakup the municipal baseline emissions inventory, from fossil fuels, by source and sector respectively. Emissions by sector include all different sources used by that sector. For example, the 42% of emissions from vehicle fleet includes both gasoline and diesel use whereas the 9% emitted by streetlights and traffic signals only accounts for grid electricity as that is the only energy source used.

3.5 2000 Municipal Inventory Revision

The revised 2000 inventory totals decreased from 11,053 Tonnes CO₂e to 10,321 Tonnes CO₂e for the same reasons outline in section 3.4; more accurate correlation

Table 2: Changes to 2000 Municipal Inventory

Breakdown of Municipal CO ₂ e Emissions Changes, 2000 Original to 2000 Adjusted		
	Tonnes CO ₂ e Difference	Change as % 2000 Original
2000 Municipal Original Total	11,053	
Reason for Change		
More Accurate Fleet Data	-81	-0.73%
More Accurate PG&E Natural Gas Coefficient	-42	-0.38%
More Accurate Cogen Emissions Factors/Calculations	-699	-6.32%
2000 Municipal Adjusted Total	10,231	-7.44%

between fleet fuel used and vehicle type, a PG&E specific natural gas emissions coefficient and a digester gas coefficient specific to our WWTF.

City of Santa Cruz 2008 Greenhouse Gas Emissions Report

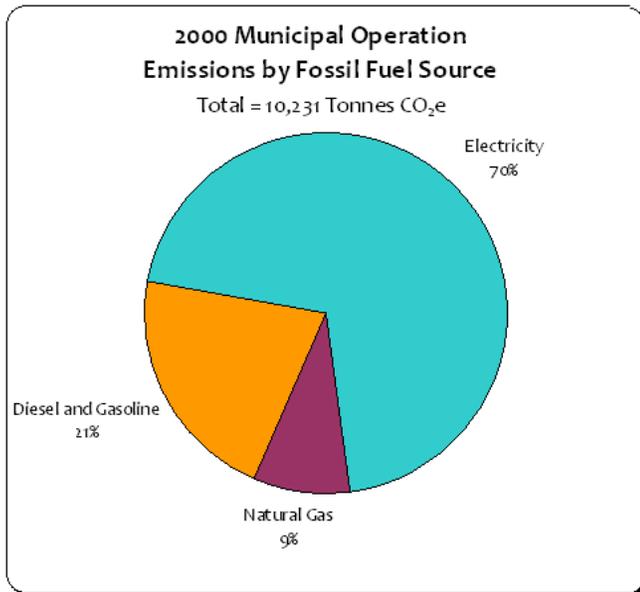


Figure 4: Municipal Emissions by Source

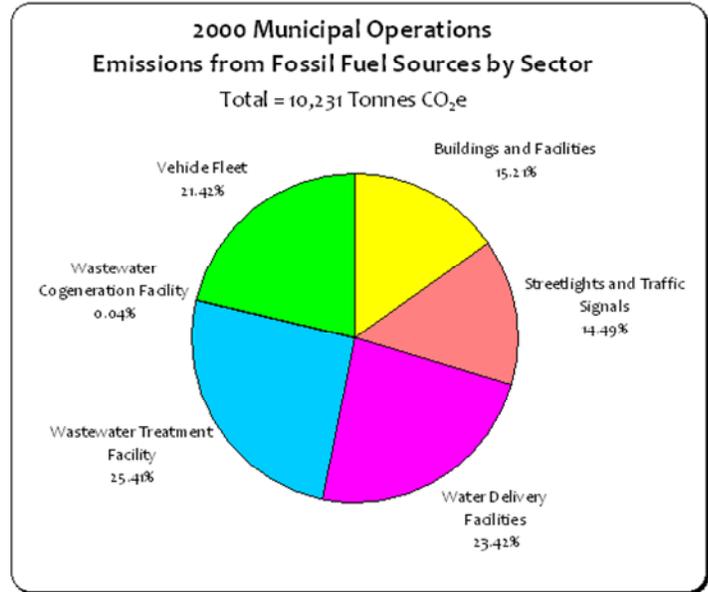


Figure 5: Municipal Emissions by Sector

By looking at figures 4 and 5 above, one notices the large increase in electricity use from 1996 to 2000. This increase in electricity emissions is not correlated to a higher carbon content of PG&E electricity but rather from the decreased use of the cogeneration facility and the corresponding increase in use of purchased electricity. This relation is also evident in the small portion of emissions from natural gas and the nearly nonexistent emissions from the cogeneration facility.

3.6 2005 Municipal Inventory Revision

Table 3: Changes to 2005 Municipal Inventory

Breakdown of Municipal CO ₂ e Emissions Changes, 2005 Original to 2005 Adjusted		
	Tonnes CO ₂ e Difference	Change as % 2005 Original
2005 Municipal Original Total	12,016	
Reason for Change		
More Accurate Fleet Data	-103	-0.86%
More Accurate Electricity Accounting	-437	-3.64%
More Standby Generator Data Availability	+2	0.02%
More Accurate PG&E Electricity Coefficient	-198	-1.65%
More Accurate PG&E Natural Gas Coefficient	-762	-6.34%
More Accurate Cogen Emissions Factors/Calculations	-208	-1.73%
2005 Municipal Adjusted Total	10,281	-14.44%

The 2005 revised inventory is 14.44% lower than the original published in 2008. The most significant contributor to the 1,735 tonne drop in emissions was the natural gas coefficient specific to PG&E, which led to a 762 tonne decrease. The change in natural gas coefficients had a large effect on the overall 2005 inventory due to the high use of natural gas at the WWTF’s cogeneration facility. The next largest reduction came from removing a double counting problem for water pumping accounts not caught in the original inventory. The only increase in emissions is a result of the additional tracking of fossil fuels used in backup generators located at various City facilities.

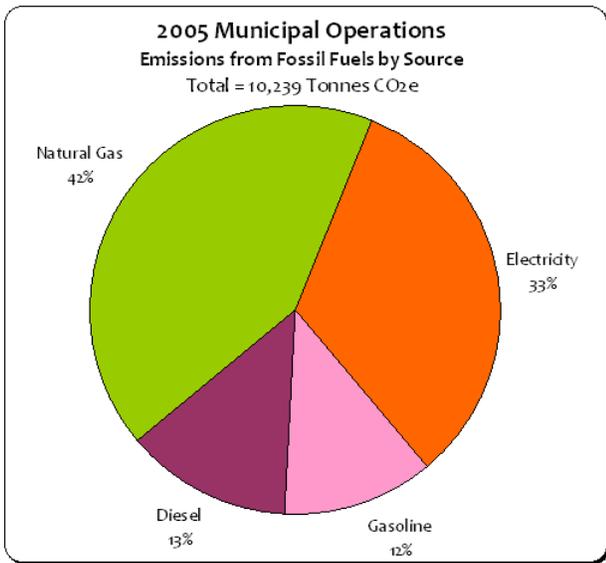


Figure 6: Municipal Emissions by Source

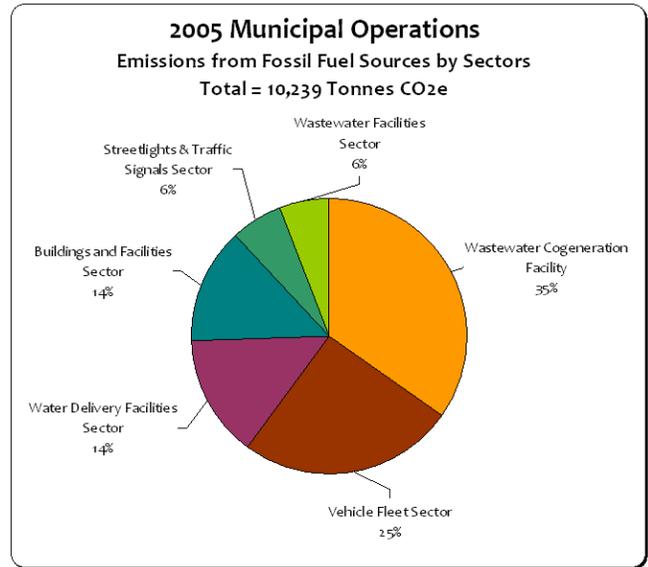


Figure 7: Municipal Emissions by Sector

As in 1996, natural gas is the largest fossil fuel source of emissions due to the increase use, compared to 2000, at the cogeneration facility. The WWTF used so much natural gas at their plant that the cogeneration plant was the single largest contributor to municipal emissions in 2005.

4 2008 Municipal Emissions Inventory

4.1 Introduction

The first step in creating a GHG emissions inventory is collecting energy use and waste disposal data from various sources both inside and outside of the municipal departments. The second step is breaking up the data into Municipal and Community sectors and quantifying the emissions. The municipal inventory includes all direct and indirect emissions associated with the execution of all public services within the City of Santa Cruz. The 2008 emissions factor for PG&E electricity is 641.25 pounds of CO₂e per Megawatt-hour of electricity used and 11.7 pounds per therm of natural gas used.

4.2 Emissions Sectors

The 2008 municipal GHG emissions inventory is reported within the following broad sectors to be consistent with previous inventories and guide department actions:

- **Buildings** – includes all city-owned buildings except those associated with waste, water or wastewater
- **Fleet** – includes all city-owned vehicles
- **Lighting** – includes lighting of all streets, parks, public parking lots, traffic signals and traffic notification signs
- **Water** – includes all pumping, treatment and distribution of water within City limits as well as the buildings used by the water department
- **Wastewater** – includes all treatment and pumping of waste and storm water, buildings associated with the wastewater department
 - Cogeneration facility sub-sector
- **Refrigerant Leaks, Employee Commute and Air Travel** – not yet quantified although tracking mechanisms are under development.

4.3 Municipal Emissions from Energy Sources

The LGOP recommends using the earliest year possible, from which complete records are available, for the baseline inventory. The Climate Action Program does have utility records from 1993 municipal operations only, but has chosen 1996 as a baseline as 1993 numbers were still abnormal due to continued reconstruction efforts after the Loma Prieta Earthquake in 1989 and the lack of other data including fleet fuel use and community utility data. The City of Santa Cruz’s GHG reduction goal is to reduce emissions 30% below baseline levels by 2020 to 7,148 Tonnes.

In 2008 Municipal emissions were estimated to be 10,228 Tonnes CO₂e

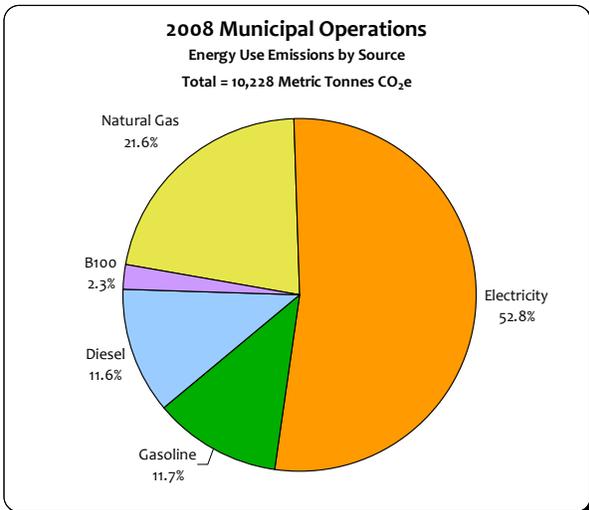


Figure 9: Municipal Energy Emissions by Source

Figure 9 shows the municipal emission broken up into source (natural gas, electricity, biodiesel, diesel and gasoline). A majority of the municipal emissions came from purchased electricity. PG&E controls how the how much CO₂ is associated with their electricity and it fluctuates from year to year. It is for this reason that the Climate Action Program has decided to make the tracking of energy use a priority. In theory if we reduce our energy use (specifically utility energy use from PG&E) our emission will also decrease pending a stagnant or

decreasing carbon content of PG&E electricity. PG&E natural gas has a fairly constant carbon content and the reduction in natural gas emissions correlates almost directly with a reduction in gas use.

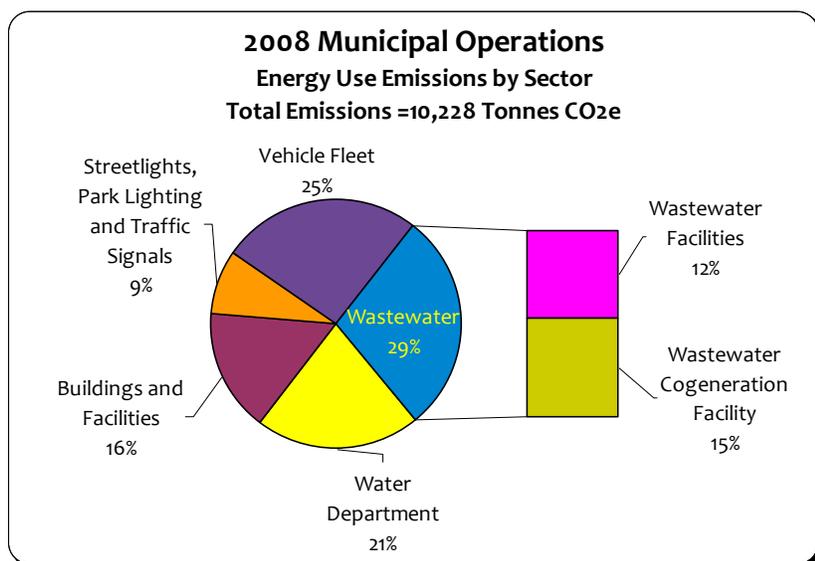


Figure 10 breaks down the municipal emissions into sector (i.e. individual municipal departments). A majority of the emissions came from the Wastewater treatment Facility (which serves most of the county) and the vehicle fleet. An in depth of municipal emissions by sector is in Section 4.5 below.

Figure 10: Municipal Emissions by Sector

An overview of municipal emissions, fossil fuel use, and alternative energy generation found in the Table 4, below.

Table 4: Municipal Energy Use and Emissions Summary

2008 Municipal Energy Use									
	Electricity (kWh)	Natural Gas (Therms)	Gallons	Fossil Energy Used (GJ)	Tonnes CO ₂ e Emitted	Cost	Alternative Energy Used (GJ)	Tonnes CO ₂ e Avoided	Cost Avoided
Buildings and Facilities	3,524,833	109,901	-	24,281	1,613	\$646,824	-	-	-
Solar PV, City Hall	19,676	-	-	-	-	-	71	6	\$2,558
Solar PV, Corp Yard	52,304	-	-	-	-	-	188	15	\$6,800
Fleet	-	-	269,138	37,291	2,642	\$880,227	2,462	269	-
Streetlights & Signals	3,010,539	-	-	10,838	876	\$475,680	-	-	-
Water	7,283,677	9,870	-	27,262	2,172	\$895,994	-	-	-
Solar PV, Locust	43,003	-	-	-	-	-	155	13	\$5,591
Solar PV, GHR	24,510	-	-	-	-	-	88	7	3,187
Wastewater	4,589,257	11,313	-	18,085	1,396	\$525,190	-	-	-
Cogeneration (NG)	2,710,988*	289,149*	-	30,499	1,522	\$268,275	-	-	-
Cogeneration (DG)	4,590,739	-	-	-	8	-	16,527	22,408^	\$442,976
Solar PV	48,500	-	-	-	-	-	175	14	\$6,306
Total	25,358,026	420,233	269,138	148,256	10,228	\$3,692,190	19,666	22,732	\$467,418

*2,710,988 kWh is the amount of electricity generated by burning 289,149 therms of Natural Gas burned.
 ^ Emissions savings associated with converting CH₄ (a potent GHG) in digester gas to CO₂. See Appendix E. The cost savings are from not buying natural gas.
 ^ Savings from the 26,524 gallons of Biodiesel used in B20 Blend
 See Appendix D for all negative costs
 See Appendix C for cogeneration electricity calculations
 See Appendix G for "Solar PV, Corp Yard" calculations

In 2008 the City of Santa Cruz generated an impressive 187,994 kWh of solar electricity and an additional 9,793,589 kWh of clean, fossil fuel free electricity. The nearly 10 million kWh of clean electricity produced made up about 40% of the total electricity used by the municipality. The estimated savings associated with using renewable and clean energy sources is \$467,415 annually (see Appendix D). Of the 22,719 Tonnes CO₂e not emitted, 22,408 Tonnes are a result the methane capture and cogeneration system at the WWTF (see Appendix E).

In 2007, the City fleet switched from using regular diesel fuel to B20 biodeisel (80% conventional diesel and 20% biogenic diesel) and the City has made it a policy to purchase biodeisel manufactured within California from recycled vegetable oil and does not purchase biodeisel made from palm oil created from tropical deforested plantations. The savings come from burning 20% biogenic diesel (non fossil origin) resulting in a comparable emissions reduction.

4.4 Scope 1 Municipal Emissions from Landfill

Landfill emissions are classified within two CARB emissions categories (Scopes). Scope 1 emissions account for landfill gases (LFGs) that leak from the landfill as methane though the anaerobic breakdown of biogenic material placed over the last 100 years. Scope 3 emissions are classified by CARB as the emissions that will occur in the future when the waste deposited during the year in question goes through anaerobic breakdown. The benefit of tracking Scope 3 emissions is that these

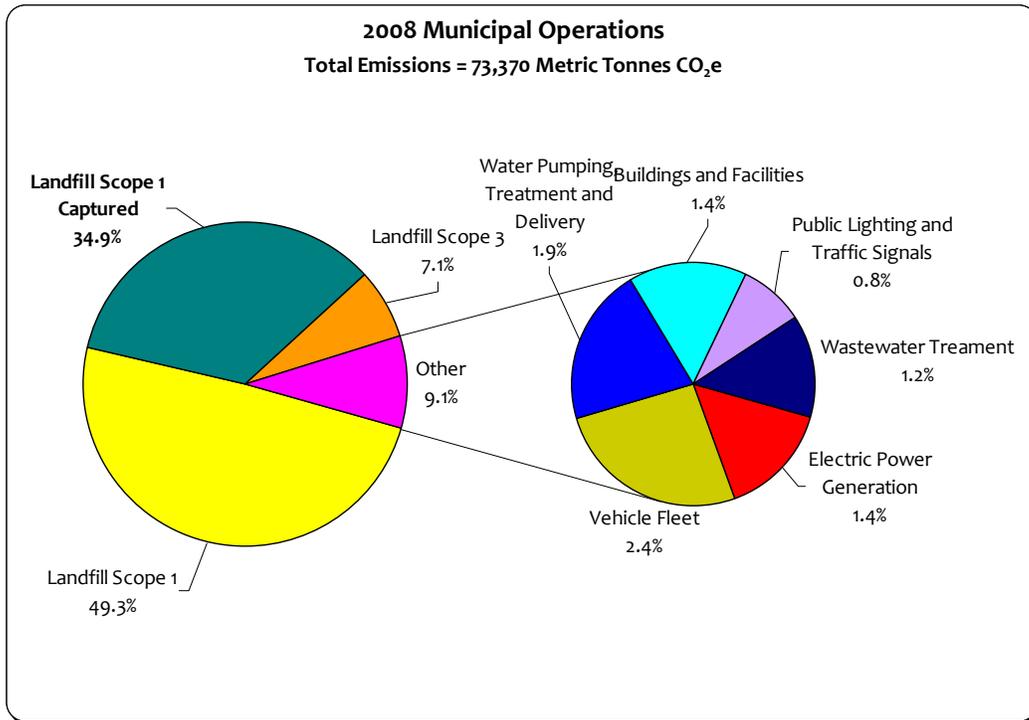


Figure 11: Municipal Emissions Fuels and Waste

emissions characterize reductions from current recycling and composting efforts rather than past practices. Before the release of the State inventory guidance (LGOP 2008), the Climate Action Program had no methodology to calculate Scope 1 emissions (Scope 3 emissions are calculated in CACP software). After the release of the LGOP, ICLEI provided the City with a worksheet that calculates Scope 1 emissions. Since 1989, methane at the Dimeo Lane facility has been captured and burned for electricity, much like the digester gas from the WWTF. The ICLEI worksheet enables the City to estimate the amount of methane captured and the amount assumed to have leaked out as fugitive emissions. The worksheet uses annual volume of gas collected, area of landfill covered by capture system, area of landfill not covered by the system, collection efficiency and other factors. ForstiStar Methane Group is the third party that operates the LFG facility and provided the Climate Action Program with all necessary factors. The collection efficiency at the facility is uncertain and therefore, the LGOP directs the city to adopt the default value of 75%. Approximately 60% of the area is covered by collection infrastructure. While other areas of the landfill are capped with concrete, which directs methane towards the collection system, the LGOP method requires a general assumption regarding capture efficiency. Using the LGOP methods, we calculate that 45% of the LFG emitted by the landfill is captured and used to generate electricity, resulting in the reduction of the City's potential emissions footprint by about 35% (Fig 11, Scope 1 captured).

Using these LGOP assumptions to calculate landfill emissions, can (and we feel it does) cause erroneous results. Specifically, the City has improved its methane capture and collection system over time, leading to greater volumes of methane being captured and burned. Using the LGOP assumptions of 25% fugitive emissions, the greater capture rates the city has achieved through system efficiency, result in higher assumed fugitive emissions, when in fact, the system upgrades are reducing fugitive emissions by some percentage. Discussions regarding additional methods to increase the LFG capture efficiency continue are ongoing and will most likely remain a cost effective emissions reduction program. Again, while Scope 1 emissions are a significant contribution to GHG emissions, future reduction options other than continued management of the capture system are few; directing the city towards expanding Scope 3 recycling and bio-waste programs.

4.5 Value of a Municipal Inventory

Completing an emissions inventory is an important part of planning for climate change mitigation. Careful inspection of current use and trends in energy use throughout the City has also proved a value in spurring dialog among departments. Buildings that waste energy have been identified and retrofitted to be more energy efficient. Benefits of renewable energy production and efficiency upgrades will continue to be analyzed to help prioritize future actions.

A report that outlined the energy use and emissions from several San Francisco Bay Area water service providers stated that the Santa Cruz Water Department was one of the least energy intensive systems studied^{5,6}. With the increase in the installation of PV and energy efficiency upgrades, the fossil fuel energy use of the Water Department's system has decreased, making the Department one of the energy efficiency leaders once again.

WWTF Cogeneration Plant

Among city energy use sectors (lighting, landfill operations, buildings, the water department and the wastewater treatment facility), the wastewater treatment facility is the largest natural gas user and second largest user of electricity. In 2005, the WWTF ran the cogeneration system with natural gas more often than in 2008 when it used more grid electricity and less natural gas. As a result, 2008 natural gas use was 43% less than in 2005, while electricity use increase by 124%. This shift in energy sources from natural gas to electricity resulted in a 23% decrease in GHG emissions and an 86% decrease in cost. Initial conclusions point towards the reconsideration of continued operation of the cogeneration facility using natural gas. However there is the unseen benefit of on-demand energy production for a vital piece of City infrastructure. The purchase of a new engine at the WWTF was recently approved by City Council which may alter this assessment, suggesting that final decisions should be made once the new engine has been up and running to analyze its performance.

The use of digester gas (a byproduct of the sewage treatment process) at the WWTF cogeneration plant generated over 4.5 million kWh of clean energy (38% of electricity used) and has made Santa Cruz one of the leaders in the utilization of biogenic technologies. In the September 2009 issue of *Water and Wastes Digest*, a well respected wastewater industry journal, the Santa Cruz facility was hailed as a leader in renewable energy and environmental stewardship programs for its state-of-the-art digester gas system in place for the past 20 years⁷.

Wasteful Buildings

There are several major facilities that use a large amount of energy every year. The most noteworthy high energy use buildings are the Library Main Branch, the Civic Center, the Police Station and the Loudon Nelson Community Center. Periodically the Library used more electricity than the wastewater treatment facility buildings. High energy use at the Police Station is understandable due to its 24-hour operation schedule; however there are certainly steps the Department can make to reduce its overall energy use. A prime example of how much can be done in building energy use can be seen in the figure below.

The municipality can meet its 2020 goals if more energy efficiency and renewable energy renovation projects, such as the recently remodeled City-owned Union Street office building, are completed within the next decade. In Figure 8, the red area represents electricity use of the Union Street building if it was designed to just meet California’s Title 24 energy efficiency building codes. The light blue area represents the proposed electricity use of the building based on engineering specifications in the building plans, and the green area shows the actual electricity use of the building.

The exciting information lies in the dark blue area. This shows the actual electricity pulled from the grid. In the summer months, the Water building used so little electricity it was able to pump clean solar energy into the PG&E grid. Recent renovations of the new Water Department Building and installation of a solar photovoltaic (PV) system have demonstrated the value of the combined use of Green Building practices and solar PV installations for energy savings as well as an improved work environment (Figure 8).

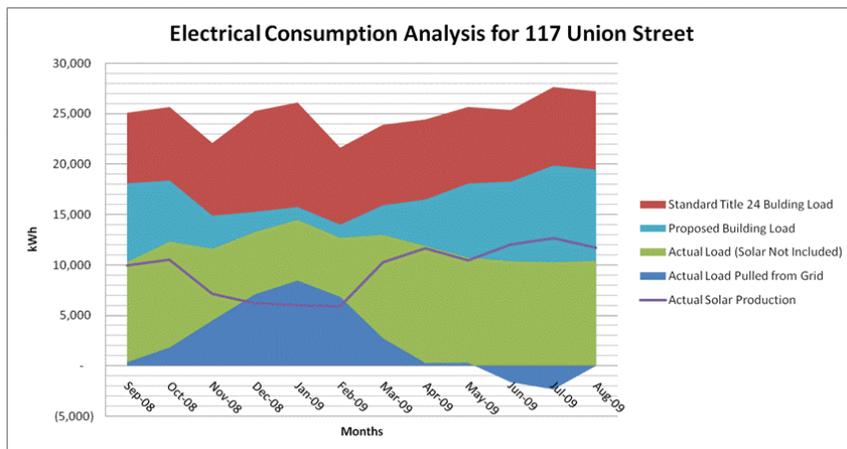


Figure 8 – LEED Certified Water Department Building.

Municipal Sectors Emissions over the years

Table 5: Historic Municipal Emissions

Emissions by Department in Metric Tonnes CO₂e

	1996	2000	2005	2008
Buildings and Facilities	2,017	1,557	1,383	1,613
Fleet	4,266	2,192	2,581	2,642
Water	1,569	2,396	1,483	2,172
Wastewater	1,438	2,604	4,158	2,925
Streetlights	921	1,483	635	876
Total Energy Emissions	10,211	10,231	10,239	10,228
Scope 3 Landfill	9,881	12,353	8,584	7,914
Total Emissions	20,092	22,584	18,823	16,904

Municipal emissions from energy use have increased slightly by less than 1% since 1996 (from 10,211 to 10,228 Tonnes). When scope 3 waste emissions are taken into account, the municipality has reduced its emissions by 16 percent since 1996. The Wastewater Treatment Plant had an abnormally large amount of emissions in 2005 due to an increased use of natural gas in its cogeneration facility (57% more than in

2008). This corresponds to such a large increase in emissions because of the higher carbon emissions from burning natural gas as opposed to purchasing electricity. All sectors other than wastewater and water have achieved reductions since the baseline year of 1996. Because the wastewater and water department operations are subject to annual weather patterns (storm water and water collection pumping) these departments are the two emissions sectors that fluctuate annually due to a combination of environmental factors and use of public services.

Emissions Projections

The figure below outlines the historical municipal emissions from 1996, 2000, 2005 and 2008 and the future goals for 2010, 2015 and 2020, represented by the yellow points. The pink line represents future emission following a business as usual trend. While it is a very good sign that the City’s current trend will lead to a significant decrease in emissions by 2020, the municipality must

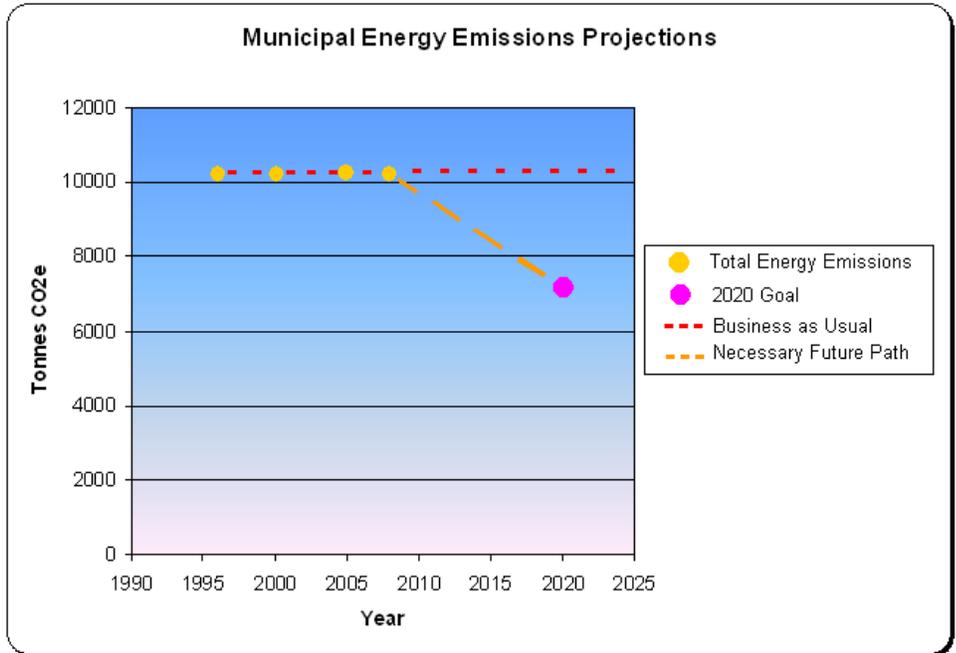


Figure 12: Municipal Emissions Trajectory

reduce its emission by about 160 Tonnes per year for the next ten years in order to meet established goals. Currently installed solar PV systems have reduced CO₂e emissions by 42 tons annually; suggesting that other conservation, efficiency and renewable resources should be found in addition to a continued investment in solar PV to meet the 2020 objectives.

5 2008 Community-Wide Emissions Inventory

5.1 Introduction

The community wide inventory quantifies the emissions from residential, commercial and industrial energy use in buildings, personal transportation and municipal operations. The Municipality is part of the community of Santa Cruz and community wide numbers including the municipal values. The 2008 emissions factor for PG&E electricity (Tonnes CO₂e emitted per kWh) was not available during the study; therefore the 2005 emissions factor was used.

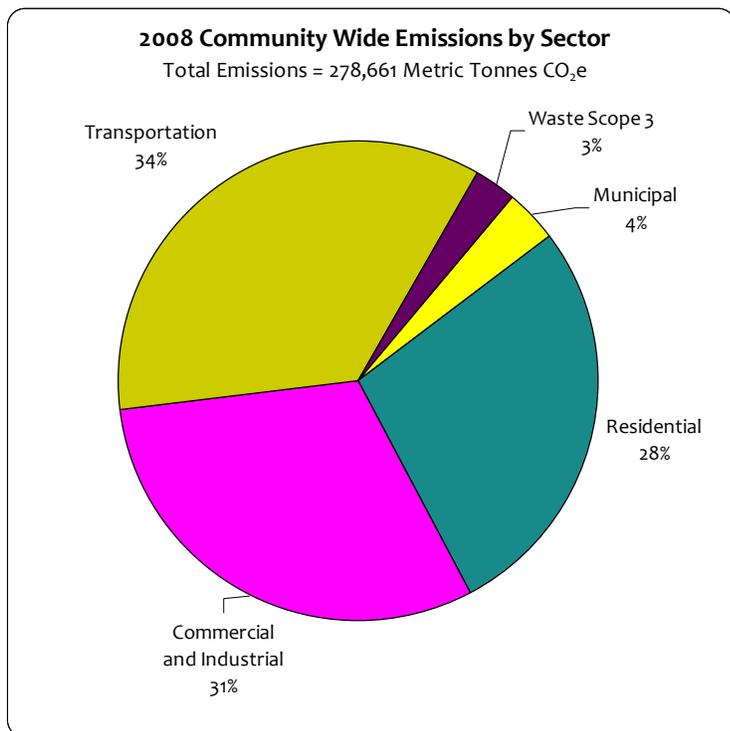
5.2 Emissions Sectors

The Community-Wide emissions inventory was conducted by collecting electricity and natural gas use data directly from PG&E. Transportation numbers generated during previous emissions inventories used an unknown method that could not be repeated so the Climate Action Staff developed a simple and easily replicable model for transportation emissions and recalculated all previous transportation emissions (see Appendix A).

The community-wide emissions inventory includes five sectors:

- **Residential** – Includes all natural gas and electricity use in residential dwellings within the City limits
- **Commercial/Industrial** – Includes all utility emissions from businesses and industrial factories and plants. These are reported together due to confidentiality requirements from PG&E.
- **Transportation** – Includes all vehicle traffic on local roads, Highway 1, Highway 9 and Highway 17 within the City limits.
- **Waste Scope 3** – The future emissions that will occur as a result of the waste placed in the landfill in 2008.
- **Municipal** – Includes all sectors of municipal inventory except Waste Scope 1 (see section 4).

5.3 Community-Wide Emissions Inventory



The 2008 Community-Wide inventory calculated emissions of 278,661 Tonnes of CO₂e. The municipal emissions were 4 % of the overall community. Commercial/Industrial and residential properties emitted 85,957 and 76,802 Tonnes respectively (approximately 29% of total community emissions each). Community wide transportation emissions accounted for 34 percent of the total overall emissions (97,759 Tonnes) as a result of over 200 million vehicle miles traveled within city limits.

Figure 13: Community Wide Emissions

5.4 Community Clean Energy Production

The table below lists the sources of renewable energy generated for Santa Cruz’s residential and municipal sectors in 2008. A significant portion of the clean energy generated (3,141,088 kWh or about 31% of the total) is from residential solar PV systems. The remaining 69% of the renewable energy produced is from City-owned facilities including several solar PV systems, digester gas combustion at the WWTF, and landfill gas combustion at the Dimeo Lane landfill. An overview of the digester

Table 6: Community Wide Renewable Energy Use

City-Wide Renewable Energy			
Location	Energy Source	Output (kWh)	Tonnes CO ₂ e Avoided
Residential	Solar PV - 2,171kW	3,141,088	914
City Hall Complex	Solar PV - 14kW	19,677	6
Waste Water Treatment Facility	Solar PV - 51kW	48,500	14
	Digester Gas Cogeneration	4,590,739	22,408
Water Department, Locust St.	Solar PV - 75kW	43,003	13
Graham Hill Water Treatment Plant	Solar PV - 128kW	24,510	7
Corporation Yard	Solar PV - 55kW	52,304	15
Landfill	Methane Gas Electricity	5,203,120	0
	Residential Total	3,141,088	914
	Municipal Total	9,981,853	23,376

gas cogeneration energy production can be found in Appendix C. Since the generation system at the landfill is owned and operated by a third party (and the electricity is sold to the grid by said party), the monetary savings to the City come from royalties. Through long term investments in renewable energy use and energy efficiency upgrades, the community of Santa Cruz has achieved significant emissions reductions in the past twelve years

5.5 Historic Community Inventories and Tracking

The community emitted 384,427 Tonnes of greenhouse gases in 1996. The 1996 emissions values, however, include significant contributions from several industrial businesses (Wrigley's & Salz Tannery) that have since closed. The large decrease in commercial/industrial emissions from 1996 to 2000 is the direct resulted from the loss of these key industries. Climate Action staff has determined that counting the loss of

Table 7: Historic Community Wide Emissions

Community Wide GHG Emissions (Tonnes CO ₂ e)						
Community Sector	1996	2000	2005	2008	% change from 1996	2020 Emissions Objective
Municipal	10,211	10,231	10,239	10,228	0%	7,148
Residential	98,705	87,605	68,368	76,802	-22%	69,094
Commercial/Industrial	167,689	95,769	75,461	85,957	-10%	67,039
Transportation	97,942	101,769	109,655	97,759	0%	68,559
Waste (Scope 3)	9,881	12,353	8,584	7,914	-20%	6,916
Total	384,427	(312,508)*	307,727	278,661	-11%	218,755

* 1996 Total Emissions include Commercial/Industrial emissions from 2000 as to not count the loss of key industries (from 1996 to 2000) as an emissions benefit. All reductions and goals in Commercial/ Industrial sector are based on 2000 for the same reason, therefore the baseline from which all goals and reductions will be based is 312,508 Tonnes

industry as an effective way to reduce emissions is not a sound Climate Action. The city has adjusted its 1996 emissions baseline to be 312,508, which is the sum 1996 emissions for all sectors of the community except commercial/industrial which uses the 2000 emissions as that sectors baseline. While more difficult to describe, this baseline better reflects a starting point from which to quantify reductions. The community's goal of reaching 30% below 1996 levels (259,062 Tonnes) is based off of 1996 emissions for all sectors but commercial/industrial. The Municipal, residential, commercial, transportation and waste sector percent emissions reductions are represented above (Table 7). The only sector that has failed to reduce emissions since 1996 is transportation which has neither increase nor decrease by any significant amount.

Through the continual purchase and use of photovoltaic solar panels since 2000 (2,171 kW installed in 2008 with an estimated output of 3,141,088 kWh per year), along with participation in the Monterey Bay Area Green Business Program, commercial and industrial businesses have reduced their emissions by 20% since their effective 2000 baseline. Together with investments in energy efficient appliances and upgrades in home energy efficiency, the residential sector has nearly met their 2020 emissions

The community of Santa Cruz emitted 384,427 Tonnes CO₂e in 1996 with an effective baseline inventory of 312,508 Tonnes. The community of Santa Cruz has reduced annual GHG emissions below baseline levels by 11%. Most notably, residential home emissions have dropped 22% since 1996.

objectives (excluding transportation which has remained relatively stable over the years). Scope 3 landfill emissions (future emissions from this year's waste collection) were reduced 20% below 1996 levels and are an excellent example of how receptive the public is to waste reduction programs provided by the city. A visual representation of the community's significant emissions reductions can be seen below in figure 14.

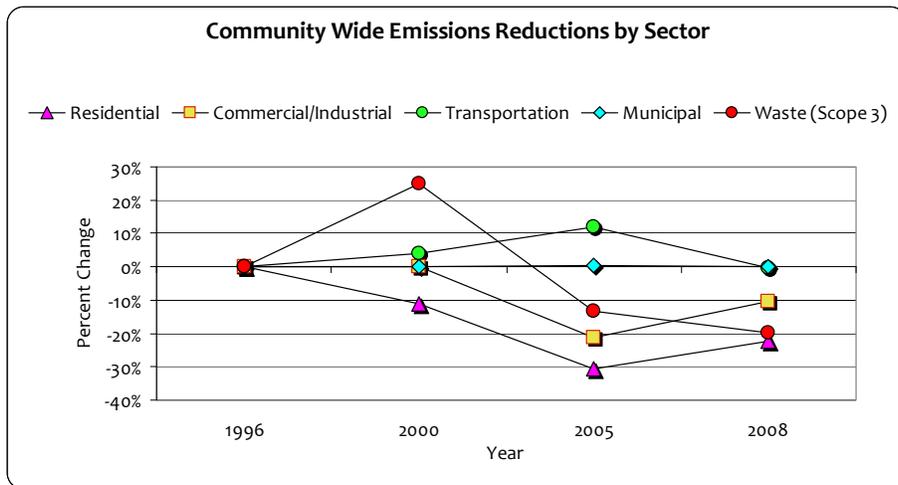


Figure 14: Community Wide Emissions Reductions

6 Conclusions

The community of Santa Cruz has followed a trend of reducing emissions steadily since 2000 (Figure 15). However many improvements must be made (specifically regarding transportation) on order for the City to meet the 30% reduction goals by 2020. The bar in Figure 15 for 2020 shows the emissions each sector should be emitting in the goal year (30% below 1996 levels). In order to meet these community wide goals, each sector must contribute a portion of the total emissions

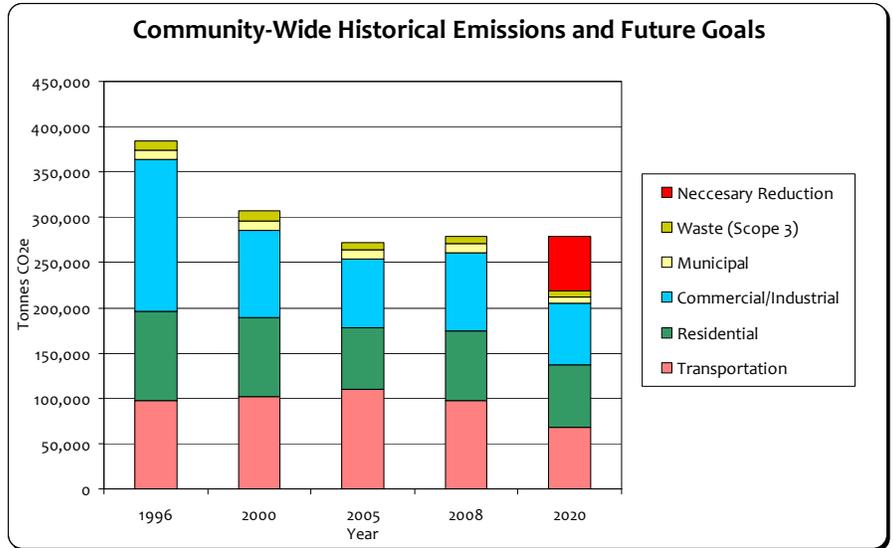


Figure 15: Santa Cruz Emissions Over Time

reduction represented by the red section of the 2020 column. In is the goal of the City of Santa Cruz’s Climate Action Plan to reach this reduction goal through various community and municipal programs. With energy prices expected to continue to increase, conservation and efficiency upgrades are wise investments and have already led to significant emissions reductions throughout the community. In 2005, the City of Santa Cruz saved \$750,000 on energy costs compared with 2003. In 2008, Municipal energy costs were higher than in 2005 even though energy use was reduced, suggesting even greater savings. Businesses and residents have also seen savings through reductions in energy use. Investments made to achieve these reductions are investments in local infrastructure that will continue to save money and reduce emissions for years to come.



The community of Santa Cruz has been a leader in addressing Climate Change both through words and actions. Continued support of these partnerships is necessary and efforts must be made to reach out to others to do more. The 2008 Emissions inventory provides the necessary data on city emissions to complete a City of Santa Cruz Climate Action Plan which will prioritize options, provide specific information on possible methods to meet the City goals and will take advantage of local opportunities and public interest. The Climate Action Plan will document how Santa Cruz can make a significant contribution to how the world responds to this environmental threat, and in doing so build a better, more sustainable community.

Citations

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⁷ *Water and Wastes Digest*, September 2009, p36 – 7