A

Appendices

APPENDIX A

COMMUNITY AND MUNICIPAL GREENHOUSE GAS AND CRITERIA AIR POLLUTANT EMISSIONS INVENTORY

INTRODUCTION AND ADDENDUM

Inventory & Projection Methodology

The inventory was calculated using the Clean Air and Climate Protection (CACP) software developed by ICLEI. The CACP software is an emissions-management tool that allows the user to track electricity and natural gas consumption, vehicle miles traveled, and solid waste tonnages. The software then converts the data into quantified GHG emissions.

Generating this emissions inventory required the collection of information from a variety of sources, including the Pacific Gas and Electric Company (PG&E), the California Public Road Data—Highway Performance Monitoring System, the California Integrated Waste Management Board, the City of Chico, and Butte County Solid Waste Management.

Once the inventory baseline was established, it became possible to project future emissions levels. That forecast, known as a "Business as Usual" Emissions Scenario, represents a critical tool for gauging the extent of actions necessary to reduce emissions to target levels. The scenario assumes that all emissions-producing activities continue at the same level as in 2005, with no action taken to mitigate emissions. It also takes into account population growth and the associated increase of GHG emissions.

Chico's community-wide emissions levels were projected through the year 2020 based on growth rates for five emissions sectors:

- Transportation
- Waste
- Commercial Energy Consumption
- Residential Energy Consumption
- Industrial Energy Consumption

Each sector has a different relative overall contribution to emissions levels, and each has a slightly different growth rate.

Adjustments to Original Inventory and Projections

Revised 2005 Baseline Emissions:

After making the necessary emissions-factor adjustments, the baseline emission level was revised to 516,869 MtCO2e. The inventory found 64% of the emissions came from the transportation sector, 16% from commercial energy consumption, 14% from residential energy consumption, 5% from solid waste sent to the landfill, and less than 1% from industrial energy consumption. Given a population of 94,887 in 2005, the annual per capita emissions generated during the base year translated to approximately 5.45 MtCO2e per person.

Energy Emission Factor Revision:

The basic process of an emissions inventory comprises identifying the activities that generate emissions, quantifying the scale on which they are occurring, and converting those aggregated impacts into a measurement of GHG emissions. That final conversion is made using what is known as an emissions factor: a coefficient that represents the per-unit emissions generated by an activity.

The emissions factor for energy consumption that had been used in the original inventory was based on an average of several utility companies in the Pacific Northwest region; this was the default calculation in the CACP software. The Chico community, however, is primarily served by only one energy utility, Pacific Gas and Electric (PG&E). Many of the other utilities included in the default average had "dirtier" grid mixes than PG&E in terms of GHG emissions, due in part to PG&E's expansive hydroelectric generation.

Using the default average resulted in an over-inflated emissions impact from the consumption of energy by the Chico community. Subsequently, City staff received energy-generation figures from PG&E and calculated an emissions factor specific to the Chico area. City staff adjusted the baseline emissions levels accordingly.

Growth Projection Revisions:

Part of the inventory process involved projecting future growth by looking at five growth factors, one for each sector — solid waste, transportation and residential, commercial and industrial energy use. The original GHG Emissions Inventory used the best available default growth averages available at that time to project the "Business as Usual" 2020 emissions.

Shortly after the inventory was completed, the city began updating its General Plan. The Climate Action Plan is a companion document to the General Plan Update (GPU); thus, the future emissions projections were recast based on the residential, commercial and industrial growth rates used in the GPU, rather than the default averages initially in the inventory.

The results that follow are projections in line with the GPU. The five adjusted growth rates used to project future emissions levels average out to an overall growth rate of just over 2% per year. This is consistent with the historical trend of roughly 2% annual population growth for Chico. At this rate, emissions for the community of the Greater Chico urban area are projected to increase to a level of 698,006 MtCO2e by the year 2020. The emission and growth adjustment factors used to revise the GHG inventory are depicted in the following tables:

Appendix A: Emissions Factor Adjustments

All unlabeled values are Metric Tons of CO_2 Equivalent

Original Emissions Inventory Results

Emissions Sector	Base Year Emissions
Transportation	332,602
Waste	19,987
Residential Energy	119,135
Commercial Energy	138,527
Industrial Energy	700
TOTAL	610,951

SOURCE: GHG Inventory table 3.1

Emissions Sector	Percent of Energy Emissions from Electricity
Residential Energy	44%
Commercial Energy	66%
Industrial Energy	66%

SOURCE: GHG Inventory sections 3.2.4.1 & 3.2.5.1

Assumption: % Emissions from Electricity for Industrial set same as Commercial

Adjusted Electricity Consumption Emissions Factor

E.F. Source	Factor (MtCO2e/ gWh)
Original - Regional	675
Adjusted- PG&E Specific	223
Variance:	67%

SOURCES: Pacific Gas & Electric; ICLEI's Clean Air & Climate Protection Software

Adjusted Base Year Emissions from Electricity Consumption

Sector	Original Base Year Emissions	Adjusted Base Year Emissions
Residential Electricity	52,419	17,323
Commercial Electricity	91,428	30,214
Industrial Electricity	462	153

Adjusted Base Year Emissions from Energy Consumption (Electricity & Natural Gas)

Sector	Adjusted Electricity Emissions	Additional Sector Emissions	Adjusted Aggregate Base Year Energy
Residential Energy	17,323	66,716	84,039
Commercial Energy	30,214	47,099	77,313
Industrial Energy	153	238	391

Adjusted Aggregate Base Year Emissions

Sector	Base Year Emissions
Transportation	332,602
Waste	19,987
Residential Energy	84,039
Commercial Energy	77,313
Industrial Energy	391
TOTAL	**514,331**

Appendix A: Derivation of Growth Rates for Adjustment to 'BAU' Emissions Projections

Population (Residential Sector) Growth Rate

Pop. Sphere of Influence, 2008:	99,451
Projected Increase 2008-2030:	40,262
Pop. 2030 Projection:	139,713
Annual Growth Rate, 2008-2030:	1.56%

SOURCE: City of Chico General Plan 2030 Update LU 3-2

Transportation Sector Growth Rate

Year:	2001	2002	2003	2004	2005	2006	2007
Daily Vehicle Miles Traveled:	1,267,500	1,326,370	1,308,000	1,352,300	1,527,900	1,523,800	1,440,070
Annual VMT:	462,637,500	484,125,050	477,420,000	493,589,500	557,683,500	556,187,000	525,625,550
% Change from Previous Year:		4.64%	-1.38%	3.39%	12.99%	-0.27%	-5.49%
Avg. Annual Growth Rate, 2001-2007:		2.31%					

SOURCE: *California Public Road Data* Highway Performance Monitoring System- CDOT. http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php

Commercial / Industrial Sector Growth Rate

Job Sector	# Employees		Increase	Growth Rate 2008–2030
	2008	**2030**		
Retail:	13,936	18,879	4,943	1.39%
Office:	11,095	15,030	3,935	1.39%
Industrial:	9,506	12,877	3,371	1.39%

SOURCE: *BAE Market Opportunities and Land Absorption ProjectionsTables #6, #7*

Waste Sector Growth Rate

Same rate as originally used in GHG Inventory:	1.62%

SOURCE: *Original GHG Inventory CACP Software*

Appendix A Derivation of Growth Rates for Adjustment to 'BAU' Emissions Projections

Population (Residential Sector) Growth Rate

Pop. Sphere of Influence, 2008:	99,451
Projected Increase 2008-2030:	40,262
Pop. 2030 Projection:	139,713
Annual Growth Rate, 2008-2030:	1.56%

SOURCE: City of Chico General Plan 2030 Update LU 3-2

Transportation Sector Growth Rate

Year:	2001	2002	2003	2004	2005	2006	2007
Daily Vehicle Miles Traveled:	1,267,500	1,326,370	1,308,000	1,352,300	1,527,900	1,523,800	1,440,070
Annual VMT:	462,637,500	484,125,050	477,420,000	493,589,500	557,683,500	556,187,000	525,625,550
% Change from Previous Year:		4.64%	-1.38%	3.39%	12.99%	-0.27%	-5.49%
Avg. Annual Growth Rate, 2001-2007:		2.31%					

SOURCE: *California Public Road Data* Highway Performance Monitoring System- CDOT. http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php

Commercial / Industrial Sector Growth Rate

Job Sector	# Employees		Increase	Growth Rate 2008–2030
	2008	**2030**		
Retail:	13,936	18,879	4,943	1.39%
Office:	11,095	15,030	3,935	1.39%
Industrial:	9,506	12,877	3,371	1.39%

SOURCE: *BAE Market Opportunities and Land Absorption ProjectionsTables #6, #7*

Waste Sector Growth Rate

Same rate as originally used in GHG Inventory:	1.62%

SOURCE: *Original GHG Inventory CACP Software*

City of Chico Greenhouse Gas & Criteria Air Pollutant Emissions Inventory

Summer 2008

City of Chico
COMMUNITY AND MUNICIPAL GREENHOUSE GAS AND CRITERIA AIR POLLUTANT EMISSIONS INVENTORY

April 2008

Project Director
Mark Stemen

Project Manager
Daniel Salazar

Assistants
Daniel DiMeo
Amelia Gulling
Anthony Sudderth

The first step to reduce our carbon footprint.

Acknowledgments

Many individuals and organizations contributed to the completion of this report by providing guidance, data, and other general information. The following people helped in this endeavor to quantify the greenhouse gas emissions for the City of Chico and the Chico community.

City of Chico

Denice F. Britton
Erik Gustafson
Linda Herman
Holly Keeler
Ruben Martinez
Fritz McKinley
Brian Mickelson
Kim Parks
Steve Peterson
Marc Sulik
Brendan Vieg
Wyatt West
Kirby White

City of Chico Sustainability Task Force

Ann Schwab, Chair
Jason Bougie
Kristin Cooper-Carter
Tom DiGiovanni
Chris Giampaoli
Jim Goodman
Ken Grossman
Amelia Gulling
Jon Luvaas
Scott McNall
Jim Pushnik
Tami Ritter
Jim Stevens
Scott Wolf
Julian Zener

Pacific Gas & Electric

Jasmin Ansar
Tino Nava
Andrew Yip

Butte County Air Quality Management District

Gail Williams

Butte County Association of Governments

Brian Lasagna
Andy Newsom

ICLEI USA

Micah Lang
Brooke Lee
Xico Manarolla
Alex Ramel

We would like to thank the above for their suggestions and corrections. Any errors that remain are solely those of the authors.

TABLE OF CONTENTS

List of Figures

List of Tables

1. Introduction

1.1. Climate Change

Over the past 20 years, the extent, cause and impacts of global climate change have been debated with some uncertainty. However, more than 21,500 of the world's top climate scientists have reached consensus that global climate change is a human-created environmental and economic challenge of significant scope. According to the report *Climate Change 2007: The Physical Science Basis* prepared by more than 1,500 scientists of the Intergovernmental Panel on Climate Change (IPCC):

> *"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level" (IPCC, 2007).*
>
> *"Most of the observed increase in globally average temperatures since the mid-20th century is* very likely[1] *due to the observed increase in anthropogenic greenhouse gas concentrations"(IPCC, 2007).*
>
> *"Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would* very likely *be larger than those observed during the 20th century" (IPCC, 2007).*

While the effects of global climate change may be difficult to perceive in Chico, scientists have observed significant changes in seasonal timing, or phenology. In a recent article published by the Associated Press and printed in the *Chico Enterprise-Record*, science writer Seth Borenstein wrote that "The fingerprints of man-made climate change are evident in seasonal timing changes for thousands of species on Earth."[2] This phenomenon is coupled with early warm storms that threaten the snow pack of the Sierra Nevada on which Californians are dependent for drinking water, agriculture, and power production. Other broader indicators of climate change include[3]:

- The six hottest years of recorded history (looking at average global temperatures) have all occurred in the last eight years (see Figure 1.1).
- The year 2005 was the hottest on record for the global climate. The average global surface temperature of 14.77 degrees Celsius (58.6 degrees Fahrenheit) was the highest since recordkeeping began in 1880.

[1] The IPCC defines "very likely" as greater than 90 percent.
[2] "Global warming rushes timing of spring." Seth Borenstein, Associated Press Science Writer. Article launched: 03/22/2008.
[3] "2005 Hottest Year on Record." Joseph Florence. http://www.earth-policy.org/Indicators/Temp/2006.htm

- Using records stored in ice, tree rings, and fossils, scientists have estimated that the Northern Hemisphere is warmer now than at any time in the past 1,200 years.
- Another study reported that atmospheric levels of CO_2 and methane, another greenhouse gas, are higher today than at any time in the last 650,000 years.
- The rise in sea surface temperature has also contributed to a record-breaking Atlantic hurricane season, with 27 named storms and 15 hurricanes in 2005.

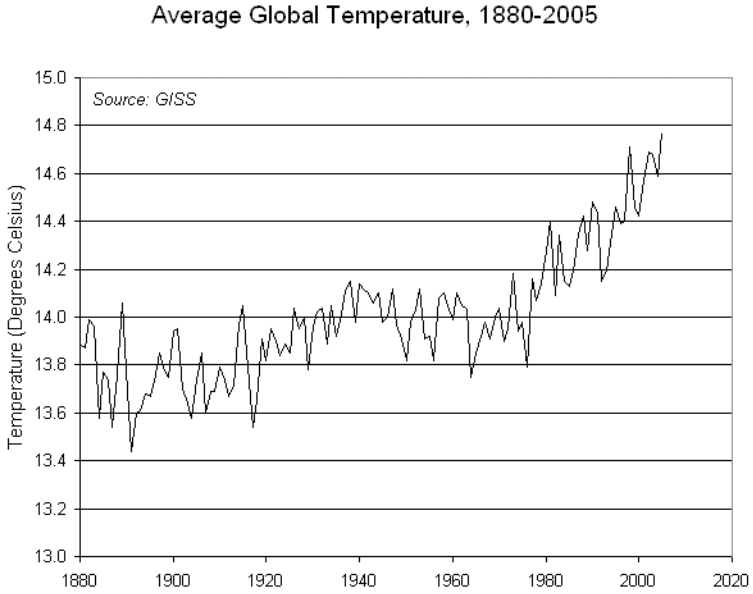

Figure 1.1 Average Global Temperature Change (1880-2005)

Chico is the largest city in Butte County, with more than 70,000 people living within the city limits and more than 100,000 people residing in the Greater Chico Area. Greenhouse gas (GHG) emissions are generated in this locale and contribute to global warming.

The City government and, to a greater extent, the local community are primary contributors of GHG emissions and air pollutants generated in the northern portion of the Central Valley.

An emissions inventory of the Chico community and government is timely. Initiating one of the first emissions inventories in the region makes it likely that similar studies will follow. Additional studies in the region will provide a more comprehensive understanding of Chico as an emissions generator.

1.2. Carbon Footprints and Greenhouse Gas Inventories

The GHG inventory process is relatively new. GHG inventories originated as an international response to mitigating global climate change. Fundamentally, a GHG inventory measures the amount of heat-trapping gases that an entity contributes to the atmosphere. By quantifying

emissions, GHG generators can estimate their "carbon footprint" and benchmark their status against other emissions producers.

Each year, the U.S. Environmental Protection Agency (EPA) prepares a national greenhouse gas inventory report. The 2008 report, which presents estimates of U.S. greenhouse gas emissions and sinks for the years 1990-2006, defines a GHG inventory as:

> *"A greenhouse gas inventory is an accounting of the amount of greenhouse gases emitted to or removed from the atmosphere over a specific period of time (e.g., one year). A greenhouse gas inventory also provides information on the activities that cause emissions and removals, as well as background on the methods used to make the calculations. Policy makers use greenhouse gas inventories to track emission trends, develop strategies and policies and assess progress. Scientists use greenhouse gas inventories as inputs to atmospheric and economic models" (EPA, 2008).*

1.3. Local Solutions for a Global Problem

While international and national efforts to mitigate global climate change have stalled, many cities and locales across the country and around the world have initiated local GHG emissions studies and programs to reduce GHG emissions. Bottom-up initiatives are taking root and growing rapidly in local communities. Actions to abate GHG emissions are rarely global or national. Lasting reductions in GHG emissions are possible only when individuals and organizations change their behavior and activities, and employ different technologies.

Monitoring GHG emissions is the critical first step to setting a goal for emissions reductions, developing polices and programs to achieve that goal, and measuring progress toward reductions. This work represents the first comprehensive effort to quantify GHG emissions generated by the City of Chico municipal government and the Chico community.

1.4. Nine Reasons to Take Action

1. **Reduce our Contribution to Global Climate Change.** The number one reason to create a greenhouse gas action plan is to reduce the quantity of CO_2 produced by the Greater Chico Area and thereby slow our contribution to climate change.

2. **Improve Service Delivery.** Energy efficiency initiatives will enable the City to offer services more efficiently and economically.

3. **Reduce Cost**. By reducing energy consumption, the City and local citizens will save money on energy bills. While energy efficiency initiatives may require an initial capital investment, paybacks within about four to seven years can be expected in many cases and savings will continue beyond the payback period. Furthermore, by reducing energy consumption, the City and its citizens will be less vulnerable to fluctuations in the market price of energy.

4. **Increase Energy Independence.** By generating our own energy through the utilization of local energy resources (e.g., solar, wind, small hydro), Chico can reduce its dependence on remote and centralized sources that are susceptible to fluctuations in market price and reliability.

5. **Improve Air Quality and Public Health**. Air quality in Chico has been identified as the third worst in California.[4] Combustion of fuel wood and fossil fuels used to produce electricity, heat buildings, and power vehicles emit a variety of pollutants known to have negative health impacts and reduce local air quality. Less energy consumption means fewer local air pollutants.[5] Additionally, climate change may lead to an increase in the spread of vector-borne and heat-related diseases, so taking steps to reduce GHG emissions reduces the likelihood of climate-related health problems.

6. **Improve Asset Management.** Asset management is a proactive approach to facility management that includes a systematic review of the state of facility operations and implementation of a logical repair/upgrade schedule. Preventative maintenance improves the value of the City's assets by reducing operating cost, modernizing equipment, and decreasing deferred maintenance. Furthermore, increasing the efficiency of facilities and operations leads to better-run operations and greater client satisfaction, along with increased energy efficiency and the resulting cost savings and emission reductions.

7. **Provide Community Leadership**. By taking concrete steps to address climate change, the City of Chico will provide a solid example for the community, county, and Northern California.

8. **Improve Quality of Life for Citizens/Healthy Cities.** The City can use savings generated by improved efficiency to improve critical community services. Programs that reduce emissions, such as bike paths, public transit, and smart growth, also increase the quality of life by improving air quality, promoting active lifestyles, and creating a more beautiful community. Together, these measures help build a healthier, more sustainable community.

9. **Create Jobs.** The transition to a low emissions society will require innovation and effort. As homes and businesses are retrofitted, new jobs will be created. The transition to a "climate-friendly economy" will also require new educational programs, new technologies, and new businesses, which will create new jobs in our community.

---

[4] *Chico Enterprise-Record*. Jan. 26, 2008. Section: Local. Steve Schoonover. Article ID: 8084706.

[5] See Section 2.3.3: "Understanding Analysis Results" for a complete list of criteria air pollutants.

2. Project Background and Purpose

2.1. Project Background

2.1.1. U.S. Mayors Climate Protection Agreement

In October 2006, City of Chico Mayor Scott Gruendl signed the U.S. Mayors Climate Protection Agreement. To date more than 600 mayors have signed the agreement, including more than 115 California cities.[6] Under the U.S. Mayors Climate Protection Agreement, Chico has committed to taking the following three actions:

- Strive to meet or beat the Kyoto Protocol targets, through such actions as anti-sprawl land-use policies, urban forest restoration projects, and public information campaigns.
- Urge state and federal governments to enact policies and programs to meet or beat the greenhouse gas emission reduction target suggested for the United States in the Kyoto Protocol—7 percent below 1990 levels by 2012.
- Urge the U.S. Congress to pass the bipartisan greenhouse gas reduction legislation, which would establish a national emission trading system.

2.1.2. ICLEI's Cities for Climate Protection Campaign

In 1993, at the invitation of ICLEI – Local Governments for Sustainability, municipal leaders met at the United Nations in New York and adopted a declaration that called for the establishment of a worldwide movement of local governments to reduce greenhouse gas emissions, improve air quality, and enhance urban sustainability. The result was the Cities for Climate Protection (CCP) Campaign.

The CCP Campaign has proven that cumulative local actions have a positive impact on global climate change.

Since its inception, the CCP Campaign has grown to involve more than 650 local governments worldwide that are integrating climate change mitigation into their decision making processes. Based on recent analysis, CCP participants account for about 15 percent of global anthropogenic greenhouse gas emissions.[7] Cumulative nationwide CCP members have reported a reduction of more than 23 million $MTCO_2E$ (metric tons of carbon dioxide equivalent) greenhouse gas emissions.[8]

---

[6] For a complete list of cities that have signed the U.S. Mayors Climate Protection Agreement or more information about the agreement, please visit http://www.ci.seattle.wa.us/mayor/climate/default.htm - who

[7] http://www.iclei.org/index.php?id=811

[8] Because CCP member cities only voluntarily report emission reductions to ICLEI, the total number of reductions associated with the CCP campaign likely far exceeds the 23 million $MTCO_2E$ mentioned above. Source: Personal communication with Ayrin Zahner, program associate, ICLEI USA.

As part of Chico's participation in the CCP Campaign, the City has voluntarily committed to completing the following milestones:

I. Conduct a baseline emissions inventory and forecast.
II. Set an emissions reduction target.
III. Develop an action plan to meet the emissions reduction target.
IV. Implement the action plan.
V. Monitor and verify progress and results.

This report completes milestone I. Milestones II—V are explained in detail in Chapter 5: Next Steps.

2.2. Purpose of the Study

Completion of the GHG inventory represents the first milestone of ICLEI's CCP Campaign. The purpose of this study is to inventory GHG and criteria air pollutant (CAP) emissions produced by the City of Chico's government and the larger community of residents and businesses in the Greater Chico Area. Reporting the City's emissions will aid policy makers in forecasting emission trends, identifying the point sources of emissions generated, and setting goals for future reductions and mitigation.

If you don't measure it, you can't manage it.

The underlying purpose of this study is to move the Chico community toward a sustainable future. A sustainable future requires a shift from valuing what we measure to measuring what we value. By measuring what we value, we can produce meaningful indicators that can influence our current and future behaviors. A good indicator should be resonant, valid, and motivational.

- **Resonant**—Within the user's sphere of understanding and relevance.
- **Valid**—Data from which the indicator is drawn need to be as comprehensive and credible as possible, and the method used to develop the indicator must be as transparent as possible.
- **Motivational**—Reflect issues that are within the user's sphere of influence, provoking and inspiring change.

This project also aspires to assist in identifying and developing information that can improve and complete our understanding of GHG emissions. This includes the gap between knowledge of how emissions are generated locally and how those emissions contribute to global climate change. This investigation also aims to assist in finding common ground between operations and policy makers. The ultimate purpose of this study is to provide a starting point for the City government and greater community to lower their emissions.

2.3. Methodology and Organization

2.3.1. Software

This project was completed using Clean Air and Climate Protection (CACP) Software developed by Torrie Smith Associates (2003) in conjunction with State and Territorial Air Pollution Program Administrators (STAPPA), Association of Local Air Pollution Control Officials (ALAPCO), and International Council for Local Environmental Initiatives (ICLEI). CACP

software is an emissions management tool that allows the user to track emissions and reductions of GHG and CAP emissions associated with electricity, fuel use and waste disposal.[9] The software contains thousands of emission factors that are used to calculate emissions based on simple fuel and energy use data, or by using information on waste disposal. This flexible tool allows the user to enter data in a number of different forms, utilize information collected through other inventory tools, customize emission coefficients, and create new fuel and vehicle types.[10]

2.3.2. Project Organization and Baseline Year

CACP Software is divided into two distinct analyses: a government analysis and a community analysis. The community analysis creates an inventory of the GHG and CAP emissions produced in the Greater Chico Area. The government analysis creates an inventory of the GHG and CAP emissions produced by all municipal government operations. **All GHG and CAP emissions detailed in the government analysis are included in, and not in addition to, the community analysis (Figure 2.1)**. In both analyses, emissions are quantified on data derived from fuel use, electrical use, and waste.

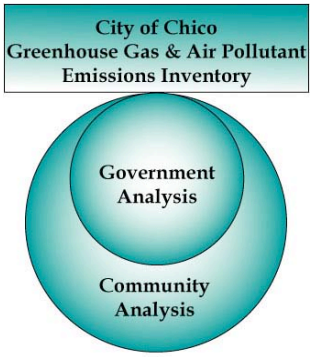

Figure 2.1 Basic project organization

For both the government and community analyses, 2005 was chosen as the baseline year.

ICLEI recommended choosing 2005 as the baseline year because many Californian ICLEI members already decided to use the same year. By conforming to this regional consensus, the City of Chico Community and Municipal Greenhouse Gas and Criteria Air Pollutant Emissions Inventory will more easily be compared with similar analysis from other cities in the region. In addition to 2005, information for adjacent years has been compiled in this analysis in order to establish trend lines.

[9] See section 2.3.3 Understanding Analysis Results for a complete list of GHGs and CAPs.
[10] For more information about CACP Software, visit http://www.cacpsoftware.org/

2.3.3. Understanding Analysis Results

There are six greenhouses gases that are typically measured and monitored in GHG inventories. They are: carbon dioxide (CO_2), nitrous oxide (NO_2), methane (CH_4), sulfur hexafluoride (SF_6), and hydrofluorocarbons (HFCs). CACP software does not, however, quantify the amounts of these individual gases. Instead, the software quantifies all GHG emissions in CO_2 equivalency (CO_2E). This is a convenient way to compare separate gases with distinct global warming properties on the same playing field. Due to the scale of this project, all results are conveyed in metric tons of carbon dioxide equivalency ($MTCO_2E$). A metric ton is equivalent to 2,205 pounds, and one pound of CO_2 can fill about 120 party balloons. This means that one $MTCO_2E$ could fill more than 260,000 party balloons.

There are five criteria air pollutant (CAP) emissions inventoried in this project. These pollutants harm both human health and the environment, but they do not contribute directly to global climate change. They are: carbon monoxide, sulfur dioxide, nitrogen oxides, volatile organic compounds, and particulate matter smaller than 10mm.

1. **Carbon monoxide (CO)—**Can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues.
2. **Sulfur dioxide (SO_2)—**Contributes to respiratory illness, particularly in children and the elderly, and aggravates existing heart and lung diseases. SO_2 contributes to the formation of acid rain, which damages trees, crops, historic buildings, and monuments; and makes soils, lakes, and streams acidic. SO_2 also contributes to the formation of atmospheric particles that cause visibility impairment, most noticeably in national parks.
3. **Nitrogen oxides (NO_x)**—Cause a wide variety of health and environmental impacts because of various compounds and derivatives in the family of nitrogen oxides, including nitrogen dioxide, nitric acid, nitrous oxide, nitrates, and nitric oxide.
4. **Volatile organic compounds (VOCs)—**Include a variety of chemicals associated with short- and long-term adverse health effects. VOCs also participate in photochemical reactions.
5. **Particulate matter (PM_{10})**—Fine particles that contain microscopic solids or liquid droplets so small that they can get deep into the lungs. Particulate matter can cause respiratory health problems such as decreased lung function, aggravated asthma, development of chronic bronchitis, irregular heartbeat, non-fatal heart attacks, and premature death in people with heart or lung disease.[11]

Results concerning the listed CAP emissions will be conveyed in pounds (lbs.) and will be listed separately because there is currently no way to combine these distinct air pollutants for analysis.

[11] U.S. EPA, http://www.epa.gov/air/urbanair/

3. Community Analysis

3.1. Community Analysis Scope

The community analysis provides an estimate of all of the GHG and CAP emissions produced within the "Greater Chico Area" by residents, businesses, and agencies. Five primary sectors are included in the community analysis: Residential, Commercial, Industrial, Transportation, and Waste. Each of the five sectors may be broken down further into source subsectors as indicated in Figure 3.1.

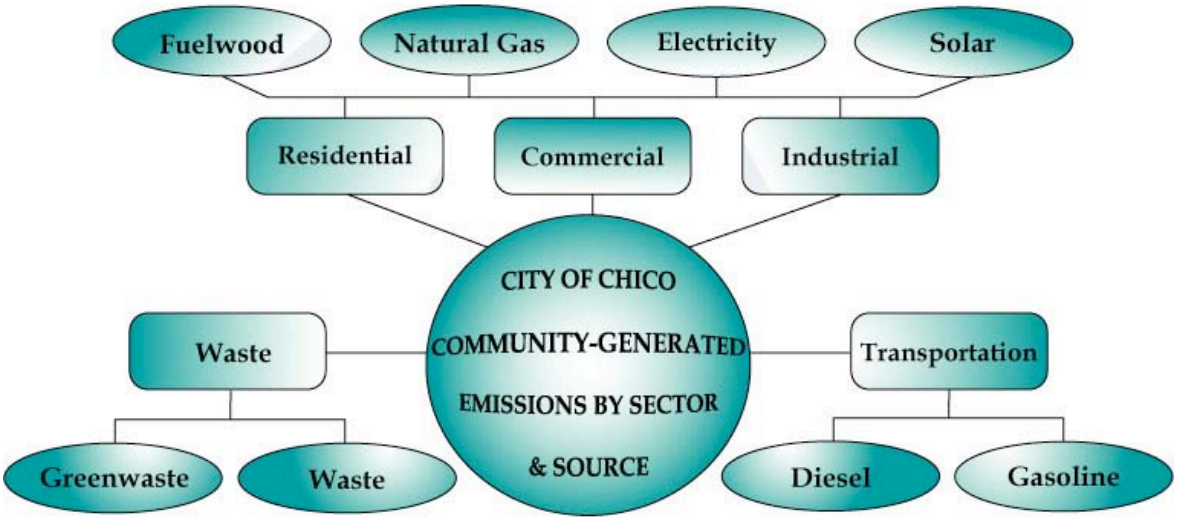

Figure 3.1 Community analysis design flowchart

3.1.1. Community Analysis Data Sources

The primary data used to determine the amount of emissions for the residential, commercial, and industrial sectors was obtained through the local utility—Pacific Gas and Electric (PG&E). Data provided by PG&E included four years (2003-2006) of electrical and natural gas information. Data for the transportation sector was obtained from the *California Public Road Data—Highway Performance Monitoring System*. This annual report provides daily vehicle miles traveled for the Greater Chico Area.[12] Transportation data included three years (2004-2006). Data for the waste sector was provided by City of Chico Management Analyst Linda Herman and Butte County Solid Waste Manager Bill Mannel. Additional information was also gathered from the California Integrated Waste Management Board Web site.[13] Waste sector data includes three years (2005-2007). Obtaineing multiyear data sets allowed for a more comprehensive analysis and aided in the forecasting/backcasting process.

Boundaries for this study were an issue from the beginning. Most inventories include only emissions generated within city limits. Nonetheless, after reviewing the nature of the data

[12] Source: http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php
[13] http://www.ciwmb.ca.gov/Profiles/Juris/JurProfile2.asp?RG=C&JURID=80&JUR=Chico

available and listening to the aspirations of the City of Chico Sustainability Task Force to include the Greater Chico Area, the geographic boundaries of the project were expanded. Data provided by PG&E includes what they refer to as Chico's "Town and Territory." Despite multiple requests, PG&E was unable to define the exact geographical parameters of what they refer to as the "Town and Territory." In this section, it is assumed that the "Town and Territory" roughly equates to the "Greater Chico Area."

3.2. Community Analysis Results

3.2.1. Overview

In 2005, the Chico community generated 610,951 $MTCO_2E$. Fifty-four percent of those emissions were produced by the transportation sector. The commercial sector was the second largest contributor, accounting for 23 percent, followed by the residential sector (19%), the waste sector (4%), and the industrial sector (less than 1%) (Figure 3.2).

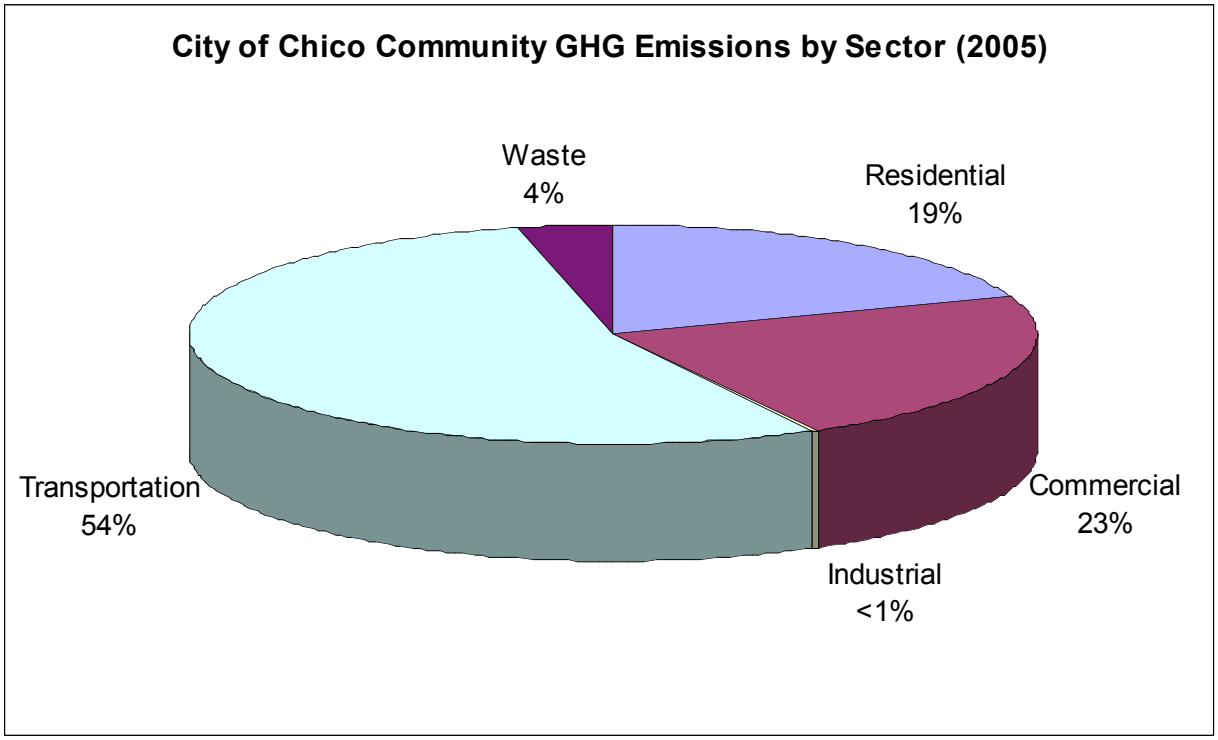

Figure 3.2 Community greenhouse gas emissions by sector (2005)

Table 3.1 provides a summary of energy use, CAP and GHG emissions produced by each sector. The number in the last column of Table 3.1 represents the amount of energy (MMbtu) per amount of GHG emissions ($MTCO_2E$). This ratio provides an indicator demonstrating the efficiency of each sector in terms of GHG emissions (a lower number indicates lower efficiency). The transportation sectors scored the lowest rating primarily because the burning of fossil fuels (especially gasoline and diesel) emits large amounts of CO_2 per unit of energy combined with the relatively low efficiency of today's automobile.

SECTOR (unit)	Energy (MMBtu)	NO_x (lbs.)	SO_x (lbs.)	CO (lbs.)	VOC (lbs.)	PM_{10} (lbs.)	Emissions ($MTCO_2E$)	MMBtu/ $MTCO_2E$
Residential	2,256,421	438,266	143,300	2,359,050	427,344	399,233	119,135	**18.9**
Commercial	1,895,994	485,605	241,336	213,915	27,934	156,997	138,527	**13.6**
Industrial	13,158	3,869	1,853	1,097	194	137	700	**18.8**
Transportation	4,273,595	**2,519,382**	135,290	**19,363,257**	**2,018,542**	73,106	332,602	**12.8**
Waste	N/A	N/A	N/A	N/A	N/A	N/A	19,987	**N/A**
TOTAL	**8,439,168**	**3,447,122**	**521,779**	**21,937,319**	**2,474,014**	**629,473**	**610,951**	**16.03 AVG**

Table 3.1 Energy, Air Pollutants, GHG emissions, and MMBtu per $MTCO_2E$ by sector

Per capita comparative analysis can be a useful metric for progress made in reducing GHG emissions and for comparing one community's emissions with other communities or against regional and national averages.

Currently it is difficult to make meaningful comparisons between cities because of variation in the scope of inventories conducted and data collection methods.

Region	Per Capita $MTCO_2E$
Chico Community (2005)	5.8
Sonoma County (2000)	8.2
Menlo Park (2005)	14.7
City of Durham, NC (2005)	28.2
State of California	12.0
National (2004)	24.1

Table 3.2 Per capita GHG emissions of different regions

In the near future, a universal reporting standard will be developed and adopted through a process being driven by ICLEI.

Per capita GHG emissions in Chico are considerably lower than the national average. During 2005, Chico generated approximately 5.8 $MTCO_2E$ per capita.[14] This is enough GHG emissions for every Chico citizen to fill 1.5 million party balloons in one year. In 2004, per capita GHG emissions in the U.S. were approximately 24.1 $MTCO_2E$.[15] However, total U.S. emissions include some sources not included in this CCP inventory (e.g., agricultural soil management, air transportation, and industrial emissions not related to energy use). If these additional remote sources of GHG emissions had been included in this inventory, the per capita emissions in Chico would be higher.

When examined by end-use sector, 21 percent of the national energy related emissions are residential, 18 percent are commercial, 28 percent are industrial, and 33 percent are transportation related. By comparison, the transportation sector

Sector	Nat. Avg.	Chico
Residential	21%	19%
Commercial	18%	23%
Industrial	28%	<1%
Transportation	33%	54%
Waste	N/A	4%

Table 3.3 End-use sector (national vs. Chico)

[14] Greater Chico Area population calculated by the percent increase from Chico's population in 2004 to 2005. Percent increase calculated to 2004 Greater Chico Area numbers. Source: Chico Chamber of Commerce.

[15] Source: Based on 2004 population estimates published by U.S. Census Bureau and total GHG emissions produced in the U.S. in 2004 as published by U.S. EPA.

(54%) and commercial sector (23%) are considerably higher in Chico than the national average. The residential (19%) and industrial (<1%) sectors are lower than the national average. It is worth noting that national end use data excludes GHG emissions derived from waste, so comparing other sectors can be misleading. Furthermore, because Chico's industry sector is so small, it is difficult to make meaningful comparisons to national averages, where industry plays a large role in GHG emissions.

3.2.2. Source of Community Greenhouse Gas Emissions

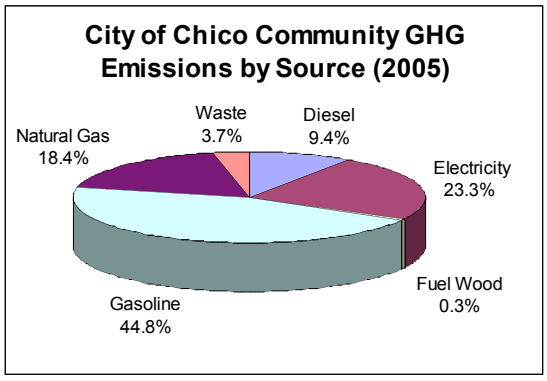

Figure 3.3 Community GHG emissions by source (2005)

This section provides an analysis of GHG emissions by fuel type. The majority of GHG emissions generated by the Chico community originate from gasoline, which generated nearly half of all GHG emissions. The second largest source of GHG emissions was electricity (23.3%), followed by natural gas (18.4%), diesel (9.4%), waste (3.7%), and fuel wood (0.3%) (Figure 3.3).

3.2.3. Community-Generated Air Pollutants

According to the EPA, the airshed Chico belongs to recently ranked third worst in California. A recent article in the *Chico Enterprise-Record* claimed that Chico was the only city in the airshed that was out of compliance with recently adopted standards for particulate matter.[16]

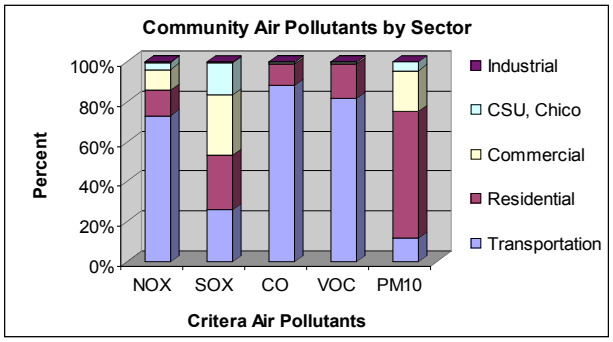

Figure 3.4 Community air pollutants by sector

In 2005, the Chico community generated 629,473 lbs of particulate matter smaller than 10mm, 521,779 lbs of sulfur dioxide, 2,474,014 lbs of volatile organic compounds, 3,447,123 lbs of nitrogen oxides, and 21,937,320 lbs. of carbon monoxide. The transportation sector produced about 80% of all community-generated nitrogen oxides, carbon monoxide, and volatile organic compounds. The residential sector was the largest emitter of particulate matter, generating roughly 60 percent (Figure 3.4).

[16] *Chico Enterprise-Record*. Jan. 26, 2008. Section: Local. Steve Schoonover. Article ID: 8084706.

3.2.4. Residential Sector

3.2.4.1. Residential Emissions

In 2005, the residential sector generated 119,135 $MTCO_2E$, representing over 19 percent of community-generated GHG emissions (Figure 3.2). On average, each household[17] produced roughly 2.3 $MTCO_2E$. Comparatively, the national average for GHG emissions per household is 12.5 $MTCO_2E$.[18] Despite the residential sector having low per household scores, residential GHG emissions have undergone a 15.6 percent increase from 2003 to 2007. The majority of this increase occurred from 2004 to 2005 (Figure 3.5). The primary sources of residential emissions were generated from electricity (44%), natural gas (54%), and fuel wood (2%).

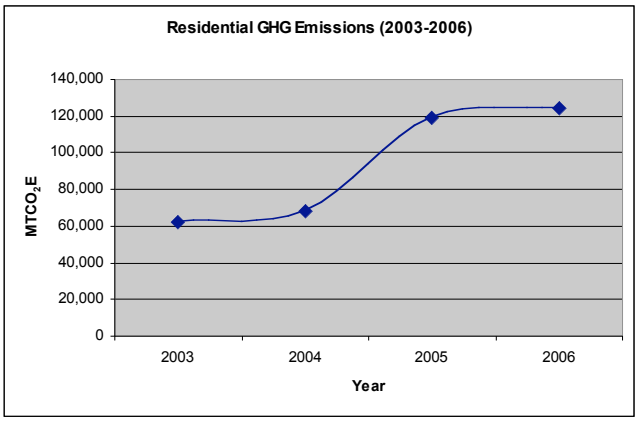

Figure 3.5 Residential sector GHG emissions (2003-2006)

Residential Emission Sources	Energy (MMBtu)	NO_x (lbs.)	SO_x (lbs.)	CO (lbs.)	VOC (lbs.)	PM_{10} (lbs.)	Emissions ($MTCO_2E$)	MMBtu / $MTCO_2E$
Electricity	758,148	196,929	131,378	124,697	14,012	108,424	51,980	**14.6**
Natural Gas	1,222,404	214,621	8,182	53,028	11,311	6,279	65,024	**18.8**
Fuelwood	268,334	26,716	3,740	2,181,325	402,021	284,530	2,131	**126**
Solar	7,536	0	0	0	0	0	0	**∞**
Total	**2,256,422**	**438,266**	**143,300**	**2,359,050**	**427,344**	**399,233**	**119,135**	**N/A**

Table 3.4 Residential sector GHG and CAP emissions, energy, and MMBtu/$MTCO_2E$ by source

On a per household basis, the residential sector in Chico is substantially <u>below</u> the national average in GHG emissions.

Fuel wood generated the smallest amount of GHG emissions, with about 2 percent of GHG emissions for the residential sector. Despite fuel wood being the smallest contributing source of GHG emissions, fuel

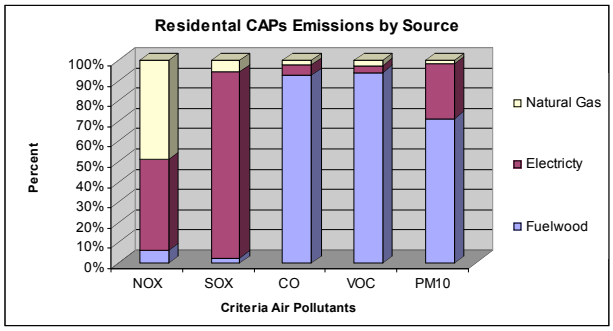

Figure 3.6 Residential criteria air pollutants by source

[17] Number of households calculated by percentage increase of population from the City of Chico to the Greater Chico Area, multiplied by the number of households in the City of Chico. Source: Chico Chamber of Commerce.

[18] Source: Calculated using the national per capita GHG emissions average of 24.1 tons and the end-use residential sector emissions (21%) included in the U.S. EPA GHG Inventory, and the average people/household (2.47) sector emissions (21%) included in the U.S. EPA GHG Inventory, and the average people/household (2.47).

wood does produce an enormous amount of air pollution. For example, fuel wood only generated 12 percent of total residential energy yet it generated 71 percent of particulate matter, 94 percent of volatile organic compounds, and 92 percent of carbon monoxide. Residential criteria air pollutants are illustrated in Figure 3.6.

Chico Residential Solar

There are more than 200 residential grid-tied solar projects in the Greater Chico Area possessing an inverter capacity of 1.1 megawatts. These solar projects have the potential to produce roughly 2,000 MWh annually. By producing this electricity with energy from the sun rather than from the local utility, the residential sector achieves over a 450 $MTCO_2E$ reduction. In addition to this considerable GHG emissions reduction, the solar projects also decrease air pollution and are impervious to electricity price increases.

3.2.5. Commercial Sector

3.2.5.1. Commercial Emissions

The commercial sector generated 138,527 $MTCO_2E$, representing 23 percent of community-generated GHG emissions (Figure 3.2). In comparison, the commercial sector produces 17 percent of the total national fossil fuel-derived GHG emissions or 4.1 $MTCO_2E$ per capita.[19] On average, each employee the in Greater Chico Area produced 2.9 $MTCO_2E$, or 1.3 $MTCO_2E$ per capita, which is lower than the national average.

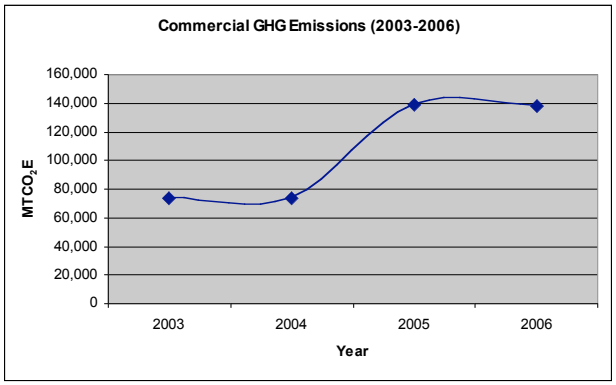

Figure 3.7 Commercial GHG emissions (2003-2006)

[19] Source: EPA National GHG Inventory.

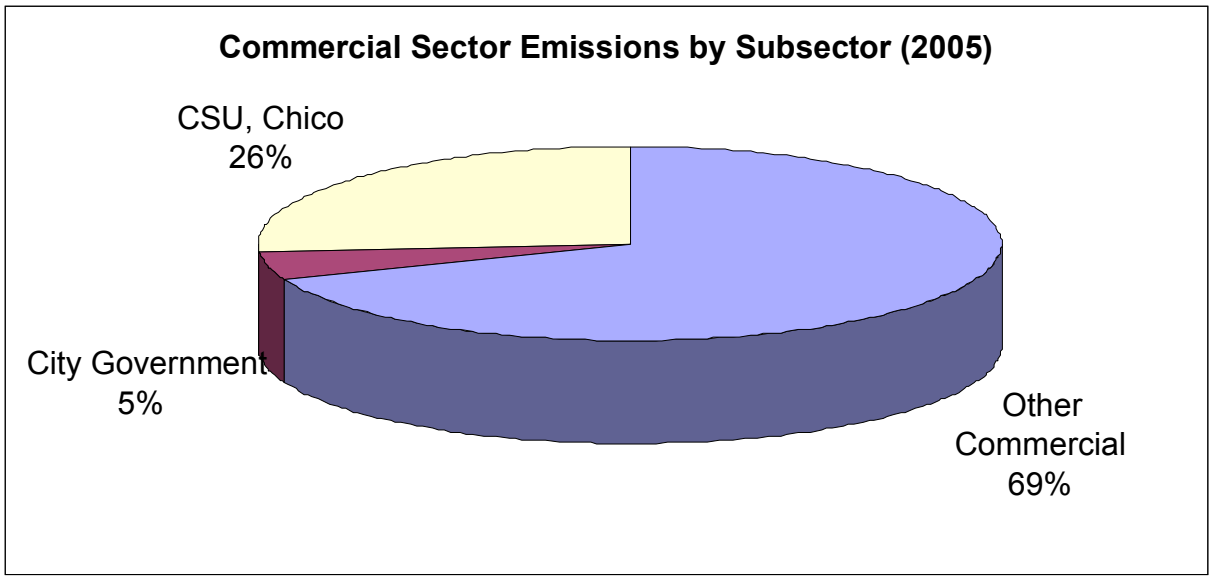

Figure 3.8 Commercial sector GHG emissions by subsector (2005)

Analyzing commercial sector GHG emissions by end-use subsectors reveals that only 5 percent were generated by the City of Chico municipal government. Sixty-nine percent were produced by other businesses, and roughly one-quarter of all commercial GHG emissions were produced by CSU, Chico.

Commercial Subsector	Energy (MMBtu)	GHG ($MTCO_2E$)	MMBtu $MTCO_2E$
Municipal Government	94,004	6,678	14.0
CSU, Chico	216,488	36,599	5.9
Other Commercial	1,585,542	95,250	17.1
TOTAL	1,895,994	138,527	AVG 12.3

Table 3.5 Commercial subsector energy use and GHG emissions

CSU, Chico generated GHG emissions that were higher than all other subsectors in terms of energy per $MTCO_2E$ (Table 3.5). The University's low energy-to-GHG-emissions ratio results from the source of electricity it purchases. CSU, Chico buys its electricity from Arizona Power Supply (APS). APS generates electricity from a variety of sources, as do most utilities. What differentiates APS from PG&E and nearly all West Coast utilities is that more than 40 percent of its "grid-mix" originates from coal and coal-generated electricity, which produces large amounts of GHG and CAP emissions.

GHG emissions from the commercial sector originated from two sources: electricity and natural gas. The majority of commercial sector emissions were produced from electricity (66%), with the remainder originating from natural gas (34%). Solar-generated electricity was responsible for producing only 2 percent of electrical energy (MMBtu) but resulted in no GHG or CAP emissions.

Fuel Type	Energy (MMBtu)	NO_x (lbs.)	SO_x (lbs.)	CO (lbs.)	VOC (lbs.)	PM_{10} (lbs.)	GHG ($MTCO_2E$)
Electricity	988,054	32,465	22,113	20,201	2,260	16,844	**91,178**
Natural Gas	890,127	10,259	0	1,392	366	293	**47,349**
Solar	17,812	0	0	0	0	0	**0**
Total	**1,895,993**	**45,155**	**29,688**	**22,085**	**2,709**	**17,427**	**138,527**

Table 3.6 Commercial sector: 2005 energy use, CAP and GHG emissions by fuel type

Chico Commercial Solar

There are about 20 commercial grid-tied solar projects in Chico with an inverter capacity of 2.6 megawatts. These projects have the potential to produce more than 5,000 MWh annually. By producing this electricity with energy from the sun rather than from the local utility, the residential sector achieves over a 1,200 $MTCO_2E$ reduction. In addition to this considerable GHG emissions reduction, the solar projects also decrease air pollution and are impervious to electricity price increases.

3.2.6. Transportation Sector

3.2.6.1. Background

Chico's transportation network is characterized by two state highways. California State Highway 99 runs north/south and California State Highway 32 runs east/west. Arterial streets provide regional and local access. The majority of Chico residents reside in the City of Chico limits. Compared with other cities, mobility within the City is generally good, with an average commute time of 17.4 minutes. The low commute time results from the City's compact form and the availability of commercial centers, educational institutions, medical facilities, and recreational sites within city limits. Despite efforts to create a balanced transportation system that serves bicyclists and pedestrians, roughly 70 percent of commuters commute in single-occupancy vehicles (Table 3.7).[20]

Commuter Behavior	Percent
Drive Alone	**70**
Carpool/Vanpool	**12.6**
Public Transportation	**1.9**
Walk	**5.5**
Other	**6.2**
Work From Home	**3.8**

Table 3.7 Chico commuter behavior

The transportation sector includes GHG emissions generated from privately and publicly owned passenger vehicles, transport trucks, public transit vehicles, and all other on-road vehicles associated with personal, commercial, industrial, and government activities. Information for this sector was obtained from the California Public Road Data—Highway Performance Monitoring System. This annual report provides daily vehicle miles traveled for the the Greater Chico Area.[21]

[20] U.S. Census for Chico, CA.
[21] Source: http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php

3.2.6.2. Transportation Sector Emissions

Overall, the transportation sector produced 332,602 $MTCO_2E$, representing about 54 percent of all community GHG emissions (Figure 3.9). Eighty-three percent of transportation sector emissions were generated from gasoline combustion, while the remaining 17 percent originated from diesel combustion.

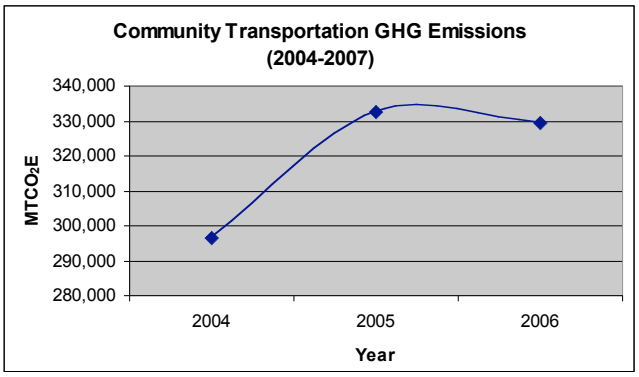

Figure 3.9 Transportation sector greenhouse gas emissions (2004-2006)

The transportation sector generates more GHG and CAP emissions than all other community sectors combined.

In addition, the transportation sector is responsible for roughly 83 percent of all community CAP emissions—claiming 73 percent of the nitrous oxides, 26 percent of sulfur dioxide, 88 percent of carbon monoxide, 81 percent of volatile organic compounds, and 11 percent of particulate matter smaller than 10 millimeters (Figure 3.4). For a complete breakdown of transportation-generated energy, CAP, and GHG emissions, refer to Table 3.8.

Fuel Type	Energy (MMBtu)	NO_x (lbs.)	SO_x (lbs.)	CO (lbs.)	VOC (lbs.)	PM_{10} (lbs.)	GHGs ($MTCO_2E$)
Gasoline	3,542,877	1,669,183	100,012	18,704,657	1,928,989	36,774	**275,066**
Diesel	730,718	850,199	35,278	658,600	89,553	36,332	**57,537**
Total	**4,273,595**	**2,519,382**	**135,290**	**19,363,257**	**2,018,542**	**73,106**	**332,603**

Table 3.8 Transportation Sector: 2005 energy use, CAP and GHG emissions by fuel type

3.2.7. Solid Waste Sector

3.2.7.1. Background

Currently, two waste disposal companies serve the Chico urban area: NorCal Waste Systems and North Valley Waste Management. Each company disposes the majority of collected waste in two separate landfills.[22] North Valley Waste Management transports waste to the Neal Road Landfill, while NorCal Waste Systems transports waste to Ostrum Road Landfill in Sutter County.

Both landfills use similar waste-handling methods. Daily operations consist of covering waste with a minimum of six inches of soil[23] and/or tarps. Eventually, modules are closed and covered with 12 inches of soil and capped with a 40 mil geo-membrane, followed by 12 inches of soil

[22] Roughly 1.3 percent of Chico waste goes to the following landfills: Altamont L.F. (Alameda), Bakersfield S.L.F. (Kern), Azusa L.R. (Los Angeles), Sacramento County L.F., and North County L.F (San Joaquin).
[23] It is also common to use wastewater sludge/cake as an alternative to soil.

added on top of the geo-membrane and seeded to promote vegetative growth. These closed modules generate methane as the waste decomposes under anaerobic conditions.

The Landfill Gas Collection and Control System at Neal Road uses a series of 36 gas collection wells and seven vadose zone wells that are under vacuum to extract the landfill gas, which is captured and then flared. A similar system exists at the Ostrum Road Landfill, and the landfill managers at both facilities says that 100 percent of the methane is captured and flared. By flaring (igniting) methane gas, the landfills greatly reduce their global warming potential by converting it to carbon dioxide. Since methane is 21 times more potent than CO_2 as a GHG, flaring the gas reduces its global warming potential by 21 times.[24] The methane gas captured at landfills, however, can be used as an alternative fuel source. According to Neal Road Landfill Manager Bill Mannel, the facility has plans for a sustainable energy project to utilize a methane recovery system in 2009.

Solid waste data was collected from City of Chico Management Analyst Linda Herman and Butte County Solid Waste Manager Bill Mannel. Additional information was also gathered from the California Integrated Waste Management Board Web site.[25] These sources have provided the necessary information concerning community waste and landfill technology to complete this report. There is, however, no complete and accurate information of the compositional breakdown of the community's waste stream, therefore percentage breakdowns that are represented in this report were provided by ICLEI.

3.2.7.2. Solid Waste Emissions

In the 2005 calendar year, the City of Chico sent 88,307 tons of waste to the landfill. This amount of waste emitted 19,987 $MTCO_2E$, representing 4 percent of total community-generated GHG emissions. The majority of GHG emissions generated by the solid waste sector originated from the decomposition of paper (81%) and food waste (16%) (Table 3.9).

On average, each person living in the Chico urban area generates roughly 0.2 $MTCO_2E$ of waste-related emissions a year. There were no CAP emissions in the solid waste sector because decomposing waste produces only methane gas. GHG and CAP emissions resulting from the transportation of solid waste are included in the transportation sector of the community inventory.

Waste Type	Materials	GHGs ($MTCO_2E$)
Solid Waste	Paper Products	**16,273**
	Food Waste	**3,152**
	Plant Debris	**77**
	Wood/Textiles	**485**
Total		**19,987**

Table 3.9 Solid waste emissions breakdown

3.3. Community Analysis Forecast and Backcast

The CACP software allows users to estimate future GHG emissions that will be generated if the community implements no further reduction measures. In 2005, the community produced 610,951 $MTCO_2E$. In a "business as usual" scenario, GHG emissions are projected to increase

[24] Source: Intergovernmental Panel on Climate Change Third Assessment Report, 2001.
[25] http://www.ciwmb.ca.gov/Profiles/Juris/JurProfile2.asp?RG=C&JURID=80&JUR=Chico

more than 64 percent, or to 1,004,161 $MTCO_2E$ by the year 2020. This projection is based off annual percent increases in population, households, commercial establishments, waste tonnage, gasoline, diesel, natural gas, and electricity. In most cases, growth rates were derived from multiple-year data sets gathered for this report.

In addition to the future projection, Figure 3.10 includes a reverse projection, or backcast. In order to find 1990 GHG emissions levels, ICLEI recommended using 25 percent below 2005 levels to find the Kyoto Protocol target. Seven percent above Kyoto levels represents the amount of GHG emissions generated by the Chico community in 1990, or 490,287 $MTCO_2E$.[26]

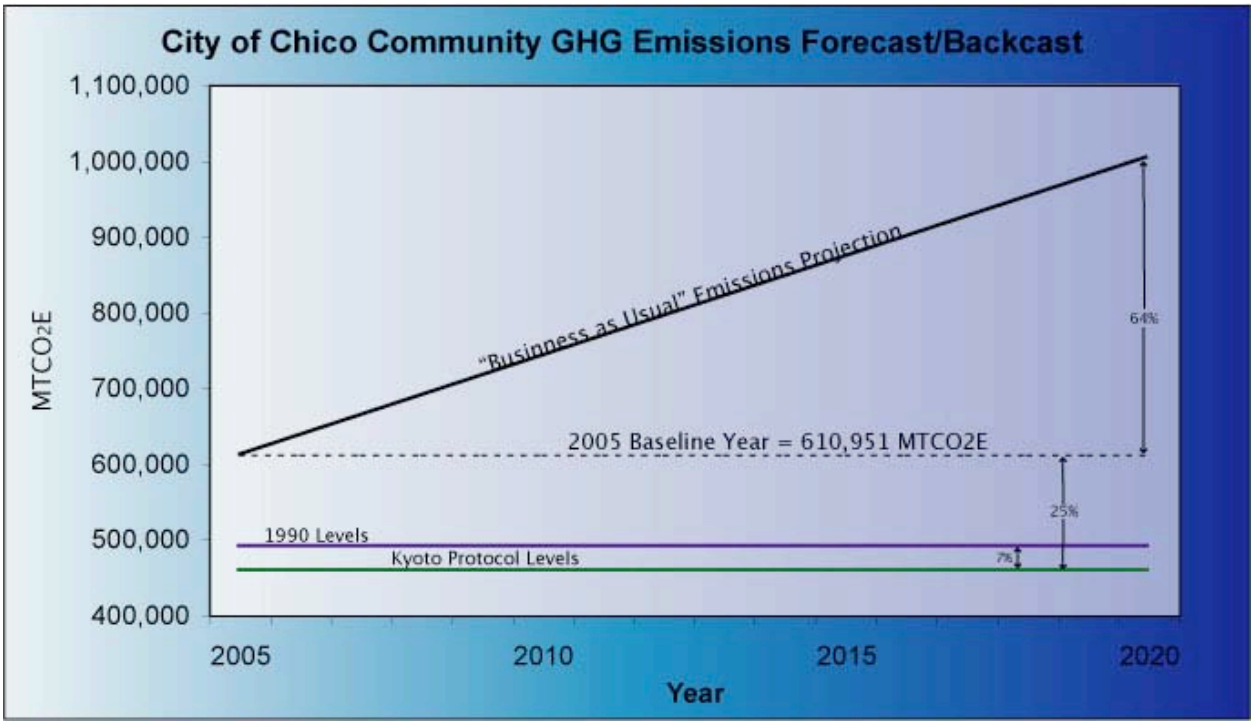

Figure 3.10 City of Chico GHG emissions projection (2005-2020)

[26] ICLEI USA

4. Government Analysis

4.1. Government Analysis Scope

The government analysis covers all buildings and facilities, operations, programs, the employee commute, and vehicles owned and operated directly by the City of Chico municipal government. Data acquisition and results have been divided into the following sectors: buildings, vehicle fleet, employee commute, streetlights, water/sewage, and waste (Figure 4.1). The baseline year for the government analysis is 2005. Energy, fuel, and waste data were collected for 2005. Data for adjacent years were also collected based on availability. The government analysis is more detailed than the community analysis because the data is more refined; it includes detail for more sectors and identifies specific point sources of emissions and air pollutants.

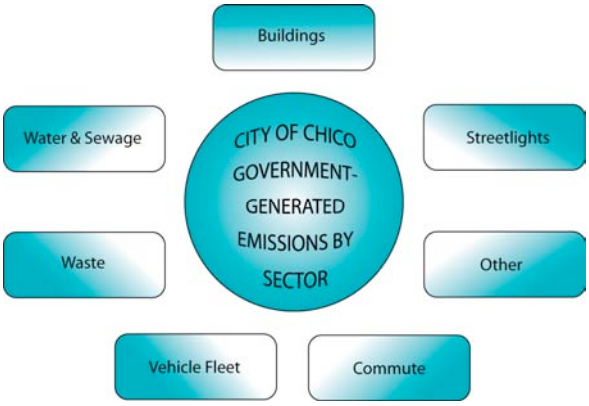

Figure 4.1 City of Chico government emissions analysis by sector

4.2. Government Analysis Results

4.2.1. Overview

In 2005, the City of Chico Government operations generated 6,678 $MTCO_2E$ and consumed approximately 94,000 MMBtu of energy. Cost associated with this energy use was near $1.9 million.

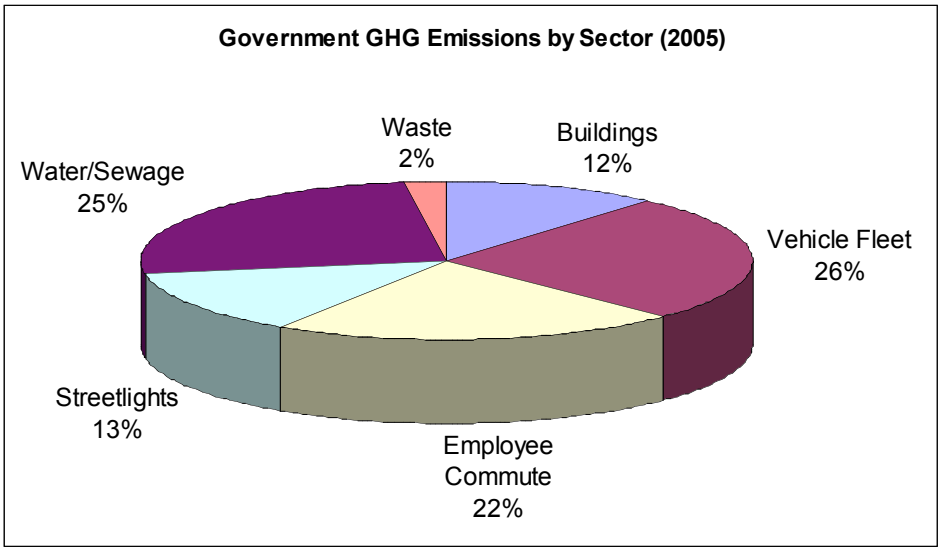

Figure 4.2 Government-generated GHG emissions by sector

Figure 4.2 shows the percentage of GHG emissions emitted from each sector. GHG emissions associated with the vehicle fleet and the Water Pollution Control Plant account for roughly half of all government-generated GHG emissions. The third largest GHG emissions generating sector was the employee commute, accounting for 22 percent, followed by the streetlights sector (13%), the buildings sector (12%), and the waste sector, accounting for only 2 percent of all government-generated emissions.

4.2.2. Source of Government Greenhouse Gas Emissions

GHG emissions generated by the City of Chico government originate from five primary sources. Figure 4.3 shows that the majority of GHG emissions were generated from gasoline (38%), followed by purchased electricity (37%), natural gas (13%), diesel (10%), and waste (2%). Combined gasoline and diesel fuel emissions represent nearly half of all government-generated emissions.

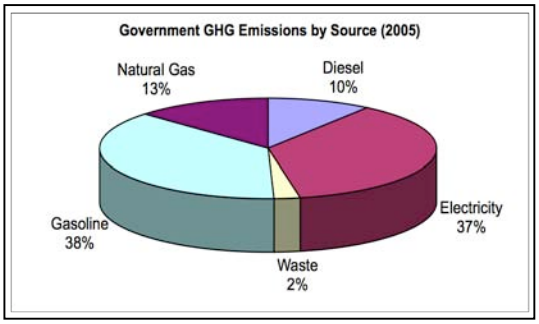

Figure 4.3 Government GHG emissions by source

GHG emissions resulting from the combustion of gasoline and diesel fuels are exclusively from the vehicle fleet and employee commute sectors. GHG emissions resulting from natural gas originate from the heating of government buildings and the heating of the digesters at the Water Pollution Control Plant (WPCP). GHG emissions resulting from electricity originate from the electrical use in government buildings and from electrical pump stations associated with the WPCP.

4.2.3. Government-Generated Air Pollutants

In 2005, the most abundant criteria air pollutant (CAP) emission generated from government operations was carbon monoxide. The second most emitted criteria air pollutant emissions were nitrogen oxides, followed by volatile organic compounds, sulfur dioxide, and particulate matter. Nearly all of the carbon monoxide and volatile organic compounds were emitted from the vehicle fleet and employee commute sector as a result of gasoline and diesel combustion (Figure 4.4).

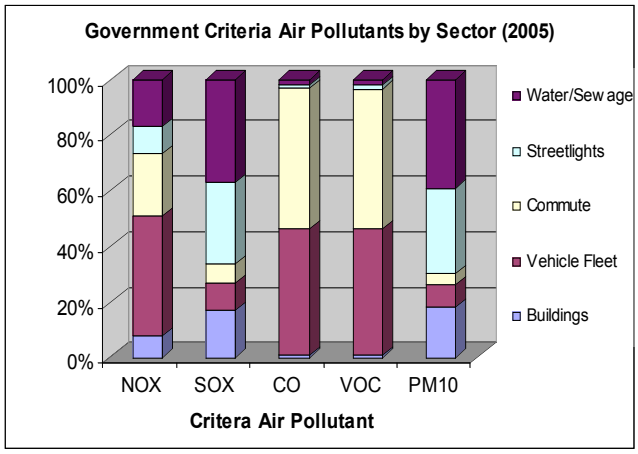

Figure 4.4 City of Chico government-generated criteria air pollutants by sector

CAP emissions nitrogen oxides, sulfur dioxide, and particulate matter were more evenly distributed throughout the government sectors. For a complete breakdown of government-generated criteria air pollutants, refer to Table 4.1.

SECTOR	NO_X (lbs.)	SO_X (lbs.)	CO (lbs.)	VOC (lbs.)	PM10 (lbs.)
Buildings	2,740	1,301	1,420	181	1,072
Vehicle Fleet	15,210	734	78,077	8,224	500
Commute	7,848	517	87,273	9,168	224
Streetlights	3,352	2,236	2,123	239	1,846
Water/Sewage	6,028	2,832	3,106	398	2,332
TOTAL	**35,178**	**7,620**	**171,999**	**18,210**	**5,974**

Table 4.1 Criteria air pollutants by sector

4.2.4. Vehicle Fleet Sector Analysis

The vehicle fleet sector contributed 1,737 $MTC0_2E$, representing approximately 26 percent of total government-generated emissions (Figure 4.2). GHG emissions generated from this sector originate from the burning of gasoline and diesel in city owned/operated vehicles.

In 2005, the city purchased approximately 120,600 gallons of gasoline costing $252,730. Additionally, the City purchased 59,588 gallons of diesel costing $139,458. Combined, the City purchased 180,188 gallons of transportation fuel costing $392,188.

Source	$MTCO_2E$	MMBtu	Gallons	Cost
Gasoline	1,163	15,019	120,600	$252,730
Diesel	574	7293	59,588	$139,458
TOTAL	**1,737**	**22,312**	**180,188**	**$392,188**

Table 4.2 Vehicle fleet GHG emissions, energy, gallons, and cost

The 2005 City of Chico fleet consisted of more than 360 gasoline- and diesel-combusting vehicles and equipment that may be divided into subfleets as indicated in Figure 4.5. In addition to gasoline- and diesel-powered vehicles, at least one WPCP vehicle has flexible-fuel capability. This vehicle has the capacity to run on either gasoline or compressed natural gas (CNG). Because the amount of CNG is negligible, it has been omitted in this report.

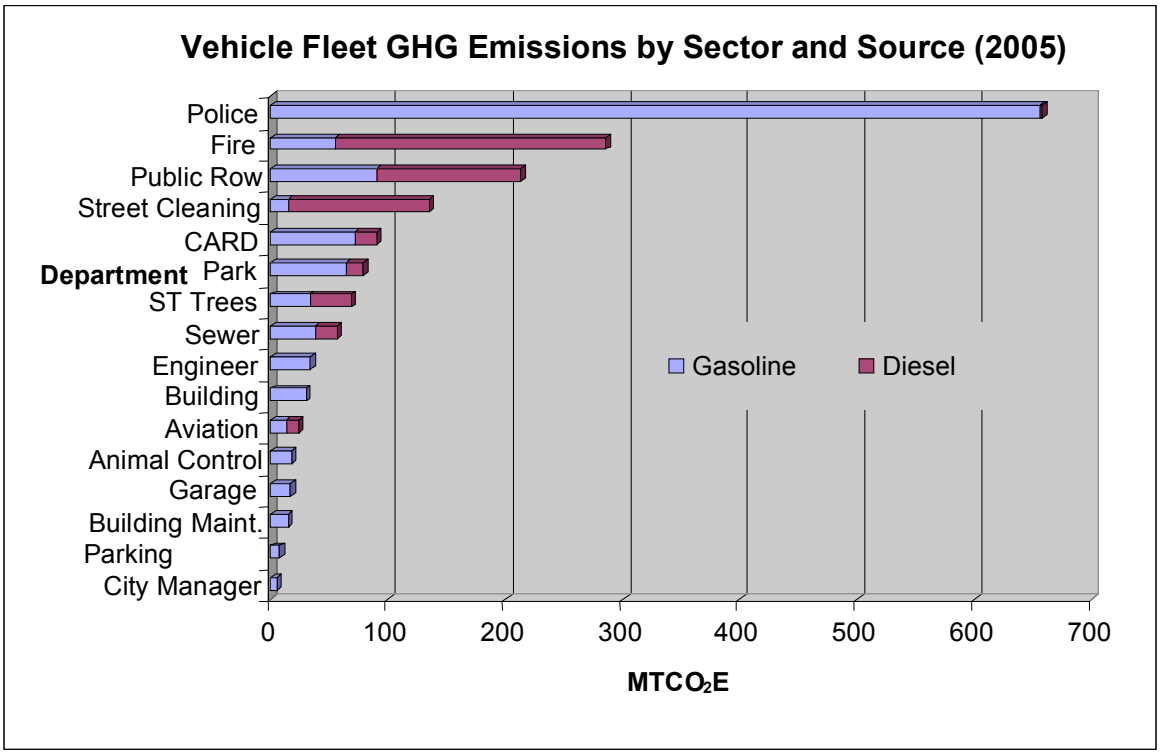

Figure 4.5 Fleet sector GHG emissions by fleet and source (2005)

Figure 4.5 shows that of the 16 subfleets, GHG emissions generated by the police department far exceeded those of other departments. The police department represents 37 percent of all vehicle fleet emissions and originated almost entirely from gasoline. The fire department ranked second, claiming 13 percent of all vehicle fleet sector emissions and more than 40 percent of all diesel-generated emissions within the sector.

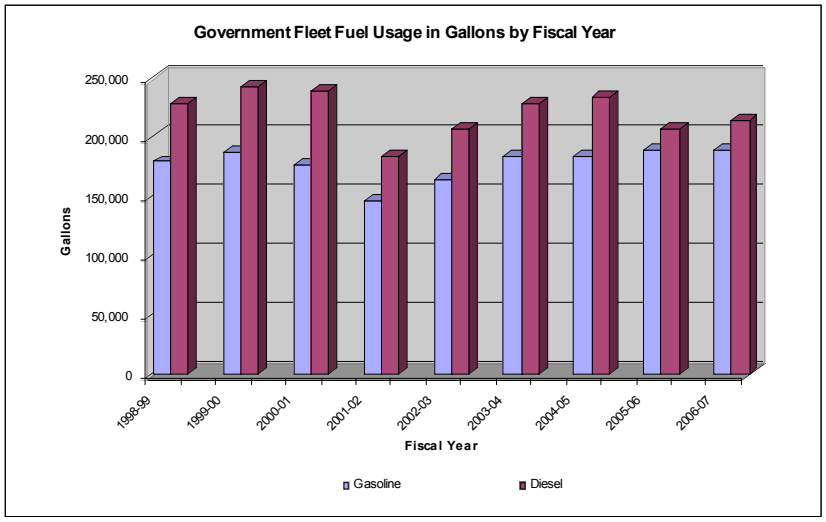

Figure 4.6 Government fleet fuel usage in gallons by fiscal year

Greening the City Fleet

The City has made efforts to improve the efficiency of its fleet by purchasing 10 hybrid vehicles. Of the 10 hybrids, four were purchased in 2005 or prior and have been included in the 2005 analysis. The remaining six were purchased after 2005 and were not included in the 2005 analysis.

4.2.5. Building Sector Analysis

In 2005, the building sector generated 768 $MTC0_2E$, representing about 11.5 percent of total government-generated emissions (Figure 4.2). GHG emissions generated from this sector originate from purchased electricity and natural gas.

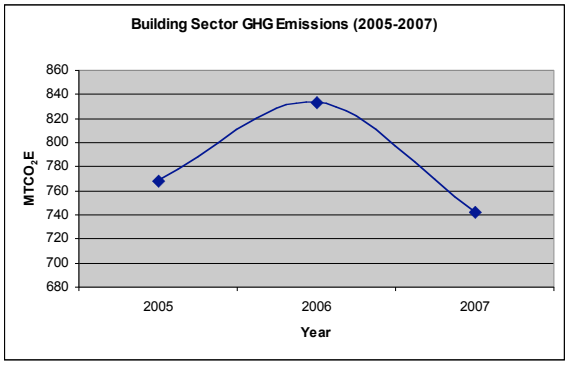

Figure 4.7 Building sector GHG emissions (2005-2007)

Electricity is primarily used in City buildings for lighting and office equipment. In 2005, the City purchased $300,590 of electricity, which averages to $12,024 of electricity for each building. In addition, the City purchased $63,909 of natural gas, which averages to $2,556 of natural gas per building. Natural gas is primarily used to heat water and air in the buildings.

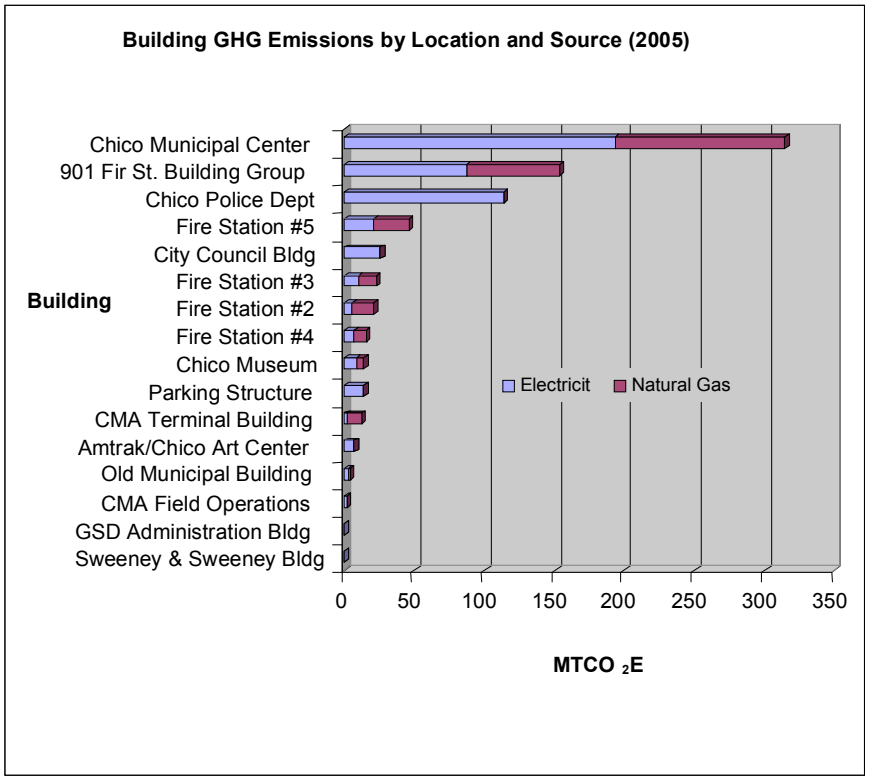

Figure 4.8 City of Chico government GHG emissions by building and source (2005)

The Chico Municipal Center generated the most GHG emissions of any City building. The 901 Fir St. Building Group contributed the second largest amount of GHG emissions, followed by the Police Department. The 901 Fir St. Building Group includes GSD/Field Supervisor Office, Central Garage, Carpenter/Sign Shop, GSD Warehouse, Fire Training Center, Fire Training Tower, Crime Lab Storage, and the Coverage Storage Shelters. All these building are grouped because there is no sub-metering for any of these facilities.

4.2.6. Waste Sector Analysis

In 2005, the government produced 644 tons of waste, which in turn generated 155 $MTCO_2E$, representing only 2 percent of total government GHG emissions (Figure 4.2). Emissions from this sector include waste that was generated by local government operations. More specifically, this sector includes all waste generated from government operations, employee waste, and waste generated at municipal government facilities including parks and buildings.

The majority of emissions generated in the waste sector originated from the decomposition of paper, claiming more than 75 percent of all waste-sector GHG emissions. This is likely due to the intensive use of paper products associated with many municipal governments. Food waste ranked second in GHG emission production, generating nearly 15 percent, followed by plant debris (10%) and wood and textiles (about 2.5%).

4.2.7. Streetlight Sector Analysis

In 2005, the streetlight sector generated 885 $MTCO_2E$, representing 13.2 percent of total government-generated GHG emissions (Figure 4.2). These emissions originate entirely from purchased electricity used to illuminate street and highway lights, traffic control signal lights, and various city park lighting costing the city $622,879.

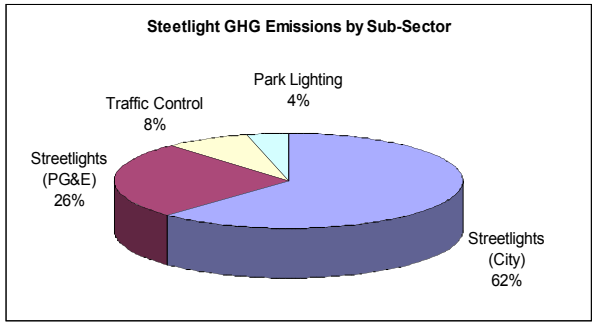

Figure 4.9 Percent of streetlight sector greenhouse gas emissions by type of light

Eighty-eight percent of emissions generated by the streetlight sector were generated from streetlights either owned by the City or PG&E (Figure 4.9). Each streetlight uses about 1.5 MMBtu of energy, costs about $125, and generates one-tenth of a $MTC0_2E$ annually. The City currently uses high-pressure sodium vapor lamps—one of the most energy-efficient street light technologies available. In contrast,

Type of Streetlight	$MTCO_2E$	MMBtu	MMBtu/ $MTCO_2E$	Cost
Streetlights (PG&E Owned)	230	3,354	14.6	**$306,517**
Streetlights (City Owned)	551	8,034	14.6	**$247,134**
Traffic Signal Control Lights	70	1,026	14.7	**$49,683**
Park Lighting	34	491	14.4	**$19,545**
Total	**885**	**12,905**	**AVG14.6**	**$622,879**

Table 4.3 Streetlight by type, GHG, energy, and cost

traffic control signals are much more energy intensive, cost significantly more to operate, and generate nearly seven times the amount of GHG emissions per light unit. The majority of the traffic control signal lights in the City of Chico are LED lights, again the most energy-efficient type of signal available.

4.2.8. Water and Sewage Sector Background

The City of Chico operates one Water Pollution Control Plant (WPCP) on the east edge of town on Chico River Road (4827 Chico River Rd). The WPCP treats more than 9 million gallons per day (GMD) and is connected to more than 28,000 homes. Wastewater from the city, with the help of nine lift pump stations, flows downward to the WPCP, where the wastewater goes through a process of being physically and chemically broken down and treated.

The WPCP uses a secondary treatment process utilizing anaerobic digestion to separate the toxic chemicals and solids from the water—this process creates methane as a byproduct. The captured methane can either be flared to reduce its harmful effects on the environment or can be used as fuel source in cogeneration. Once the liquids are separated from the solids, the water undergoes a chemical process to treat the affected water. When cleaned to EPA standards, the secondary treated plant water is discharged into the Sacramento River. The remaining solid residuals are placed in large drying bins and the cake must be at a minimum of 50 percent dried before it can be hauled off to the landfill. Approximately 1,100 dried tons of cake (biosolids) are produced each year at the WPCP and hauled off to the Neal Road Landfill, where it is used as landfill cover material.

In 1984, the WPCP reused its captured methane in a cogeneration process that produced about half of the plant's output that year. This system went off-line in 2004 due to mechanical problems. The WPCP is currently under expansion, and the City estimates that by November 2009, the plant should have a new co-generation system up and running to reduce its electricity even further.

In October 2005, the solar project came on-line, with the installation of a 1.1 megawatt on-site solar photovoltaic power system providing about 40 percent of the WPCP's electrical needs. Most cities find their wastewater treatment facilities have a high impact on the total level of GHG emissions. Due to the positive steps Chico has already taken, by installing an on-site solar photovoltaic power system, this sector does not have an outstanding impact on total government-generated emissions. The solar photovoltaic system installed in 2005 curbed 47 $MTCO_2E$ from being emitted into the atmosphere.

The plant could take additional steps by using its end byproducts for better use. For example, the city could reuse the treated water for irrigation instead of discharging it into the Sacramento River. This could save millions of gallons of water from having to be pumped from the Tuscan Aquifer. Additionally, biosolids could be composted instead of sent to the landfill and utilized as a nutrient-rich fertilizer.

4.2.9. Sewage Sector Emissions

The water and sewage sector is the second largest contributor of GHG emissions to the City government's carbon footprint, having generated 1,691 $MTCO_2E$ in 2005. This represents about 25 percent of total government-generated GHG emissions (Figure 4.2). Nearly all (99%) of the emissions originating from the water/sewage sector were generated from the Water Pollution Control Plant (WPCP). This is primarily due to the energy intensive process of wastewater treatment. However, the majority of local water services are provided by Cal Water. Emissions generated by Cal Water have been omitted from this analysis because the City has no ownership of or control over this entity.

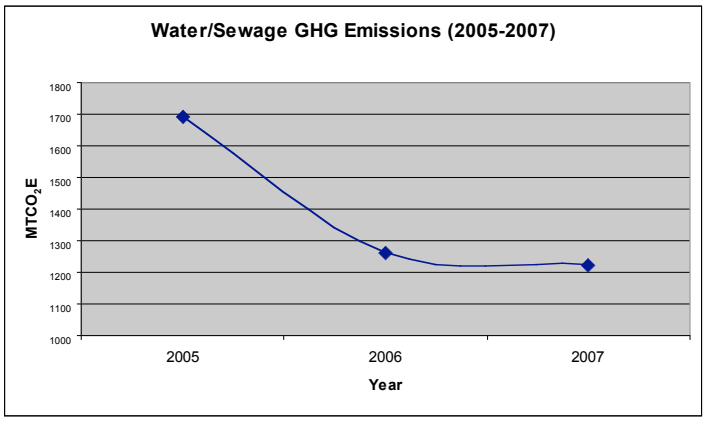

Figure 4.10 Water and sewage GHG emissions (2005-2007)

Sixty-four percent of GHG emissions generated in the water and sewage sector originated from purchased electricity. The remaining 36 percent originated from the combustion of natural gas used to heat digesters and other operations.

In addition to GHG emissions generated by purchased electricity and natural gas the WPCP also emits methane from the digesters that decompose human waste. This methane is flared, or ignited, and never reaches the atmosphere, greatly reducing its global warming potential. Alternatively, the methane gas could potentially be utilized as an on-site fuel source to heat the digesters, reducing the WPCP's natural gas consumption.

4.2.10. Employee Commute Sector Analysis

Although not considered part of direct city operations, emissions from the employee commute were assessed in this report because there are potential reduction measures that could influence employee commuting behavior. The employee commute sector has one characteristic that distinguishes it from all other government sectors:

The employee commute represents the only sector in which city employees have complete control over the amount of GHG emissions and air pollution generated.

Data for the employee commute sector was gathered by survey (see Appendix B). Out of 427 city employees, 157 (37%) completed and returned the survey. The survey results were extrapolated to represent the entire employee population. The primary aim of the survey was to determine the amount of miles driven by city employees for their respective vehicle types,

enabling the calculation of GHG and CAP emissions. Secondarily, the survey was intended to have city employees think about their driving habits. Upon analyzing the survey results, the following findings surfaced (Table 4.4).

Findings From the Employee Commuter Survey
• **The average distance from home to work = 13 miles.**
• **94.6 % of city employees drive and 90% of those employees drive alone.**
• **Only 5.4% of city employees walk/bike to work.**
• **3% of city employees drive hybrids.**
• **The most popular commuting vehicle is the medium size truck/sports utility vehicle.**
• **10% of city employees carpool or vanpool.**
• **Only 0.1% of city employees use the transit bus service.**

Table 4.4 Findings from the employee commuter survey

The City of Chico employee commute sector generates 1,443 $MTCO_2E$ of GHG emissions a year, representing 21% of total government-generated emissions (Figure 3.2). While the employee commute sector ranks as only the third largest contributing sector of GHG emissions, it is the largest contributing sector in production of criteria air pollutants (Figure 4.4).

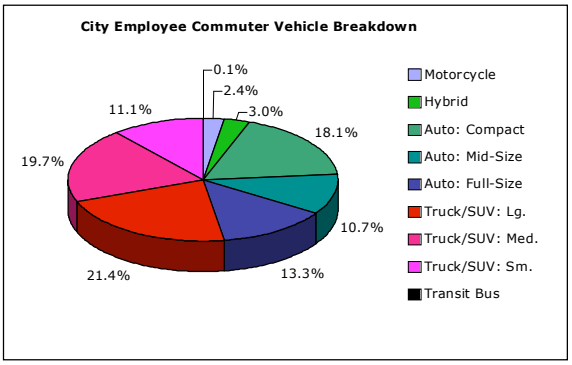

Figure 4.11 Employee commuter vehicles

5. Next Steps

5.1. Milestone II: Setting an Emissions Reduction Target

The establishment of a community emissions baseline and projection prepares the City to complete the next step by setting an emissions reduction target. An emissions reduction target will allow the City to develop a reasonable policy and programmatic response to reduce its contribution to global climate change. A well-developed emissions reduction goal should possess the following qualities:

- **Ambitious**—showcase Chico as a continuing sustainable city.
- **Attainable**—set a goal that is achievable; consider what other cities have achieved.
- **Agreeable**—establish a goal that people in the community can agree upon. After all, it is the changes in their behavior that will make the goal attainable.

When choosing among these emissions reduction targets, some issues to consider include:

1. The state of California has accepted the following reduction targets:
   - **1990 levels by 2020**
   - **80% below 1990 levels by 2050**
2. Setting a goal that is too distant can be dangerous because implementation may be put off.
3. Cities can typically reduce first-year emissions by as much as 5 percent by pursuing the "low-hanging fruit," while the next 5 percent may take years.
4. Setting intermittent goals is a good way to monitor progress and stay on track.

Potential GHG Emissions Reduction Targets:
The city council may consider the following as potential targets to set a reasonable and obtainable goal of emissions reductions for the City and the community.

1. **25% by 2020**
   Twenty-five percent below 2005 levels by the year 2020 equates to lowering emissions **2.08%** per year for the next 12 years.

2. **20% by 2020**
   Twenty percent below 2005 levels by the year 2020 equates to lowering emissions about **1.67%** per year for the next 12 years.

3. **15% by 2015**
   Fifteen percent below 2005 levels by the year 2015 equates to lowering emissions about **2.14%** per year for the next seven years.

4. **10% by 2010**
   Ten percent below 2005 levels by the year 2010 equates to lowering emissions about **5%** per year for the next two years.

5.2. Milestone III: Develop an Action Plan

After determining an agreed-upon reduction target, the City of Chico will develop a cohesive action plan based on the information revealed in this study. Developing an action plan will likely involve multiple steps including: 1) researching activities undertaken by other communities; 2) prioritizing GHG emission reduction actions by the Chico City Council and the community; 3) identifying costs and benefits associated with technological and behavior changes to reduce GHG emissions; 4) selecting policies and programs; and 5) developing an implementation and education program for GHG emissions reduction for City employees, businesses, and community residents.

5.2.1. Conducting Research

The first step to developing an action plan is to research measures, policies, and programs already developed by other communities. Efforts that were successful and seem applicable to Chico will be formulated into a master list. The tables in Appendix C outline many activities undertaken by other communities to reduce their production of GHG emissions.

5.2.2. Creating a Master List

Potential measures can be both broad and creative. In some cases, the City has already adopted measures that are successfully being implemented to reduce GHG emissions; these measures will also be rolled into the final strategy. Now may also be a good time to reassess the effectiveness of already implemented measures.

5.2.3. Selecting Policies and Programs

Preferred policies and programs to reduce greenhouse gas emissions should be selected through a community-based planning exercise that empowers and educates residents, business owners and City staff to take ownership of efforts to reduce GHG emissions. In addition, the preferred polices and programs should be based on the following criteria:

- GHG emissions reduction potential
- Cost
- Other feasibility issues
- Additional benefits associated with the measure (e.g., quality of life, city beautification)

5.2.4. Developing GHG Emission Reduction Strategy

Selected policies and programs will be rolled into a draft of the Chico Greenhouse Gas Reduction Action Plan. The action plan will be made available to the public for review through the City's Web site and at City Hall. A public forum will also be held to present the draft plan to the community and to solicit input. Public input may also be received through regularly scheduled meetings, written submissions, or through the development of a task force/committee. All public input should be reviewed and incorporated into the plan as appropriate.

5.3. Milestone IV: Implementation Plan

Measures selected for the Chico Greenhouse Gas Reduction Action Plan are likely to be too numerous and/or expensive to implement all at once. Instead, a small contingent of key measures should be chosen for implementation in the first year or two. Once these measures have been implemented, the plan can be revisited and a second set of measures chosen for implementation. This process should be repeated on an annual basis until the City meets its GHG and CAP goals.

The implementation plan will include:

- What is to be done.
- How it is to be accomplished.
- Who is responsible for what.
- Where the resources will come from.
- When it will be accomplished by.

5.4. Milestone V: Monitoring and Evaluation

As measures are implemented, efforts must be employed to track their progress in reducing GHG and CAP emissions. City staff will perform this work and will use the CACP software, following the methods recommended by the ICLEI/CCP for tracking reductions of GHG and CAP emissions. A Community and Municipal Greenhouse Gas and Criteria Air Pollutant Emissions Inventory should be completed in five-year increments starting in the year 2010.

5.5. Concluding Remarks

This report has broken down a complex issue, revealing clear trends and opportunities to reduce carbon production through meaningful steps to change behaviors. The rest is up to Chico!

6. Appendix A: List of Acronyms

APS – Arizona Power Supply; a utility that provides electricity to CSU, Chico.

Btu – British Thermal Units; a standard unit of measure equivalent to the quantity of heat required to raise the temperature of one pound of water by 1 degree Fahrenheit at the temperature at which water has its greatest density (approximately 39 degrees Fahrenheit).

CACP – Clean Air and Climate Protection; the software used by ICLEI to calculate GHG emissions.

CAP – Criteria air pollutant; a category of air pollutants including: nitrogen oxides (NOx) sulfur oxides (SOx), carbon monoxide (CO), particulate matter (PM), and volatile organic compounds (VOC), which have adverse effects on human health.

CCP – Cities for Climate Protection; a program developed by ICLEI – Local Governments for Sustainability to help local governments reduce GHG emissions from their operations and communities.

CNG – Compressed gatural gas; a fuel primarily composed of methane. Used as an alternative fuel to gasoline and diesel in flex-fuel vehicles or converted vehicles.

EPA – Environmental Protection Agency

GHG – greenhouse gas; primarily consisting of: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

GMD – Million of gallons per day; terminology used in wastewater treatment and water services.

ICLEI – Local Governments for Sustainability (formerly the International Council for Local Environmental Initiatives); more than 800 local governments that have made a commitment to sustainable development.

IPCC – Intergovernmental Panel on Climate Change

kWh – Kilowatt-hour; a unit commonly used to measure electricity. Equivalent to 1,000 watts.

LED – Light-emitting diode; a low-energy-demanding lighting technology.

LPG – Liquid petroleum gas; commonly referred to as propane. Used as an alternative fuel to gasoline and diesel in flex-fuel vehicles and converted vehicles.

MMBtu – Millions of British Thermal Units.

$MTCO_2E$ – Metric ton of carbon dioxide equivalent.

WPCP – Water Pollution Control Plant.

VMT – Vehicle miles traveled; a measure of the total distance traveled within a community. This is used to estimate fuel consumption and GHG emissions.

Appendix B Business As Usual Emissions Projections

All unlabeled values are Metric Tons of CO_2 Equivalent

	Year	Population	Emissions Sector					Aggregate Emissions
			Transportation	Waste	Residential Energy	Commercial Energy	Industrial Energy	
Growth Rate:		1.56%	2.31%	1.62%	1.56%	1.39%	1.39%	2.03%
	2005	94,869	332,602	19,987	84,039	77,313	391	**514,332**
	2006	96,372	340,285	20,311	85,350	78,388	396	524,730
	2007	97,900	348,146	20,640	86,681	79,477	402	535,346
	2008	99,451	356,188	20,974	88,034	80,582	408	546,185
	2009	101,002	364,416	21,314	89,407	81,702	413	557,252
	2010	102,578	372,834	21,659	90,802	82,838	419	568,551
	2011	104,178	381,446	22,010	92,218	83,989	425	580,089
	2012	105,803	390,258	22,367	93,657	85,157	431	**591,869**
	2013	107,454	399,273	22,729	95,118	86,340	437	603,897
	2014	109,130	408,496	23,097	96,602	87,540	443	616,178
	2015	110,833	417,932	23,471	98,109	88,757	449	**628,718**
	2016	112,562	427,586	23,852	99,639	89,991	455	641,523
	2017	114,318	437,464	24,238	101,194	91,242	461	654,599
	2018	116,101	447,569	24,631	102,772	92,510	468	667,950
	2019	117,912	457,908	25,030	104,375	93,796	474	681,583
	2020	119,752	468,485	25,435	106,004	95,100	481	**695,505**
% Total, 2020:			67.36%	3.66%	15.24%	13.67%	0.07%	100%

APPENDIX C
EMISSIONS FACTORS AND COST CALCULATIONS FOR COST BENEFIT ANALYSIS

EMISSIONS FACTORS

ELECTRICITY

Emissions/kWh PG&E Grid Mix 2008

	CO2	CH4	N2O
lbs/ megawatt per hour (mWh)	641.35	0.0302	0.0081
Metric Tons/ mWh	0.29091181	1.37E-05	3.67E-06
Metric Tons/ kilowatt per hour (kWh)	0.00029091	1.37E-08	3.67E-09
mtCO2e/ kWh	0.00029091	3.15E-07	1.09E-06
mtCO2e/ gigawatt per hour (gWh)	292.314412		
mtCO2e/ kWh	**0.00029**		

Sources: ***CO2: PG&E CCAR Reporting Year 2008***
CH4/ N2O: EPA eGRID WECC Calif. Subregion Data Year 2005

NATURAL GAS

Emissions/Therm Natural Gas (National Average)

	CO2e
Metric Tons/ Therm	0.00560219
mtCO2e/ therm	**0.00560**

Source: ***ICLEI's CAPPA V1.0***

GASOLINE

Emissions/Gallon Gasoline (Nat'l Avg.)

	CO2	CH4	N2O
Metric Tons/ Gallon	0.00941273		
mtCO2e/gallon	**0.00941**		

Source: ***ICLEI's CAPPA V1.0***
Emission factors for gas exclude CH4 and N2O 'due to the difficulty of combining technology dependent emissions factors with thos for CO2, which rely on volume of fuel consumed only. The effect of this omission is small relative to CO2 emissions..'

DIESEL

Emissions/ Gallon Diesel Fuel (Nat'l Avg.)

	CO2	CH4	N2O
Metric Tons/ Gallon	0.00953091		
mtCO2e/ gallon	**0.00953**		

Source: ***ICLEI's CAPPA V1.0***
Emission factor for gas exclude CH4 and N2O 'due to the difficulty of combining technology dependent emissions factors with thos for CO2, which rely on volume of fuel consumed only. The effect of this omission is small relative to CO2 emissions..'

APPENDIX C
EMISSIONS FACTORS AND COST CALCULATIONS FOR COST BENEFIT ANALYSIS

COMPRESSED NATURAL GAS

Emissions/ Standard Cubic Foot CNG (Nat'l Avg.)	
	CO2
Metric Tons/ SCF	0.000054
mtCO2e/ SCF	**0.00005**

Source: ***ICLEI's CAPPA V1.0***

Emission factors for gas exclude CH4 and N2O 'due to the difficulty of combining technology dependent emissions factors with thos for CO2, which rely on volume of fuel consumed only. The effect of this omission is small relative to CO2 emissions.

COSTS

PRICE OF ENERGY

Electricity	
$0.12	per kWh
Natural Gas	
$1.12	per Therm

Source: Pacific Gas & Electric

PRICE OF WATER

		Conversions	
$0.88	per 100 cu. ft.		
$0.0088	per 1 cu. ft.	7.48	gallons/cu. ft.
$0.0012	per gallon	0.13369	cu. ft./gallon

Source: California Water Service Co. Schedule NO. CH-1-NR (July 2010)

PRICE OF FUEL

CNG:		**Conversions**	
$1.93	per gge	1.14	therms/ gge
$1.74	per therm	100	cu. ft./ therm
$0.02	per cubic foot		
Gasoline:			
$3.69	per gallon		
Diesel:			
$3.62	per gallon		
B20 Biodiesel:			
$3.69	per gallon		

Source: ***DOE "Clean Cities Alternative Fuel Price Report" 2010***

APPENDIX C
COST BENEFIT ANALYSIS OF ENERGY, WATER, AND TRANSPORTATION SECTOR ACTION

	Energy and Water Actions	Up-Front Costs/ Unit	Simple Payback (Years)	Net Cost/ MteCO2 Mitigated
1	Low Maintenance Landscaping	$0	0.0	-$793
2	Central Irrigation Control System	$1,500	4.4	-$784
3	Energy Star Printers	$10	0.2	-$362
4	Occupancy Sensors	$0	0.2	-$354
5	Energy Star Copiers	$50	0.6	-$338
6	PC Power Mgmt Software	$20	0.6	-$329
7	Energy Star Clothes Washers	$150	4.4	-$318
8	Energy Star Vending Machines	$200	1.0	-$310
9	Energy Star Window AC	$10	0.9	-$302
10	LED Exit Signs	$57	1.7	-$282
11	Decrease Street Light Hours (2 hrs/day)	$0	0.0	-$260
12	Torchiere Exchange	$46	2.3	-$260
13	Install Low Flow Showerheads	$29	0.8	-$250
14	Lights Out at Night Policy	$0	0.0	-$227
15	Energy Star Refrigerators	$200	3.6	-$226
16	Landfill Gas Energy Generation	$1,400	4.9	-$193
17	Energy Star Water Coolers	$100	4.1	-$186
18	Building Retro-commissioning	$1	3.5	-$184
19	Green Business Program Participation	$100	0.1	-$172
20	Green Building to Code	$2	2.7	-$169
21	Low Income Weatherization	$0	0.0	-$155
22	Commercial Efficiency Retrofits	$1	4.4	-$154
23	Commercial Lighting Upgrades	$85	7.9	-$151
24	Energy Fitness Program: Lighting	$1	7.9	-$150
25	Use Wind Energy	$1,540	8.4	-$141
26	Energy Star Dishwashers	$90	4.2	-$138
27	Reflective Roofing	$0	8.7	-$137
28	Plant Trees to Shade Buildings	$224	9.2	-$135
29	Energy Star Water Heaters	$1,049	5.4	-$131
30	Efficient/ Affordable New Housing	$3,000	6.4	-$129
31	Energy Star Computers	$100	4.1	-$128
32	Water Pump Efficiency	$80	7.5	-$122
33	Residential Efficiency Campaign	$500	1.2	-$120
34	LED Street Lights	$688	10.7	-$118
35	Home Weatherization Retrofit at Sale	$750	4.7	-$105
36	Wastewater Gas Energy Generation	$7,612	8.0	-$23
37	Purchase Carbon Offsets	$10	N/A	$10
38	Solar Hot Water Heaters	$3,000	15.4	$67
39	Chiller Retrofits	$18	21.4	$71
40	Install Solar PV	$7,800	29.7	$207
41	HVAC Control Retrofits	$7	31.5	$238
42	Energy Star Computer Monitors	$100	13.7	$430
43	Geothermal Heat Pump	$12,380	(None)	$1,033

APPENDIX C
COST BENEFIT ANALYSIS OF ENERGY, WATER, AND TRANSPORTATION SECTOR ACTIO

	Transportation Actions	Up-Front Costs/ Unit	Simple Payback (Years)	Net Cost/ MteCO2 Mitigated
1	Provide Bikes for Daily Trips	$250	(None)	-$338
2	Compressed Natural Gas Vehicle Conversion	$3,000	3.2	-$324
3	Electric Vehicle Charging Stations	$1,500	2.3	-$240
4	Telecommuting (Once a Month)	$0	0.0	-$217
5	Parking Cashout Program	$0	0.0	-$217
6	Limit Heavy Truck Idling	$0	0.0	-$210
7	Limit Transit Bus Idling	$0	0.0	-$210
8	Franchise Waste Zones	$0	0.0	-$210
9	Limit School Bus Idling	$0	0.0	-$210
10	Safe Routes to School Program	$0	0.0	-$187
11	Fuel Efficient (EV) Parking Enforcement	$8,000	4.1	-$183
12	Transit-Oriented Development	$8,000	4.1	-$183
13	Subsidize Employee Bus Ridership	$242	(None)	-$168
14	Transportation Ed. (8% VMT reduction)	$29	(None)	-$151
15	Hybrid Vehicles	$7,000	5.4	-$125
16	Electric Vehicles	$7,000	4.4	-$118
17	Flex Scheduling (9/10 days)	$0	0.0	-$84
18	Carpooling Program	$8,500	(None)	-$72
19	Carshare Program	$0	0.0	-$42
20	Expand Bus Service	$186	1.0	-$11
21	B20 Biodiesel Conversion	$2,033	(None)	$181
22	New Bike Paths	N/A	N/A	N/A
23	Transportation & Circulation Planning Committee	N/A	N/A	N/A
24	Support Local Businesses	N/A	N/A	N/A

APPENDIX D
CALCULATION OF GHG EMISSIONS REDUCTIONS FOR PHASE I TRANSPORTATION ACTIONS

	PHASE I TRANSPORTATION SECTOR ACTIONS	Implementation Unit of Measurement	Units Measured or Estimated	Annual Emissions Reduction/ Unit	Estimated Emissions Reductions (MtCO2e)		
					City of Chico	Greater Community	Total Reduction
Objective 1: Reduce Vehicle Miles Traveled							
1.1	Promote Car Share Programs	# participants	850	2.18342		1,856	1,856
1.2	City Fleet Optimization	# of gallons of gas reduced	32,731	0.00941	308		308
1.3	Subsidize Employee Bus Ridership	# employees offered	2,000	2.15394		4,308	4,308
1.4	Flexible Work Schedules	# employees offered	148	0.15529	23		23
1.5	City Travel Demand Management Plan		TBD		TBD		TBD
1.6	Carpooling Program	# groups of 150 members	10	28.77000		288	288
1.7	Employer Trip Reduction Programs	# employees offered	TBD			TBD	TBD
1.8	Expanded and Improved Bus Service	# additional daily riders	2,250	2.15394		4,846	4,846
1.9	Regional Transportation Planning					TBD	0
1.10	Sustainable Policy/Regulatory Framework including:	# of gallons of gas reduced	823,981	0.00941		7,754	7,754
	1 Tiered City Fee Structure	Included in Action 1.10					incl. in 1.10
	2 Pedestrian Connections for New Development	Included in Action 1.10					incl. in 1.10
1.11	Expand Bicycling/Pedestrian Infrastructure	Included in Action 1.10					incl. in 1.10
1.12	Complete Streets Policy	Included in Action 1.10					incl. in 1.10
1.13	Corridor Management/Traffic Calming		TBD			TBD	TBD
1.14	New Bike Paths	# of gallons of gas reduced	154,644	0.00941		1,455	1,455
1.15	Solid Waste Franchise System	# of gallons of diesel reduced	71,636	0.00953		683	683
1.16	Safe Routes to Schools	# students offered	TBD	0.07000		TBD	TBD
1.17	Update of City Parking Standards		TBD			TBD	TBD
Objective 2: Expand Use of Alternative Fuels							
2.1	Community Use of Biodiesel (B20)	# vehicles converted	8	1.36156		11	11
2.2	Hybrid Vehicles	# vehicles switched	266	3.28962	53	822	875
2.3	Electric Vehicles	# vehicles switched	13	5.71651		74	74
2.3	Electric Vehicle Charging Stations	# stations installed	2	1.69702		3	3
2.5	Compressed Natural Gas (CNG) Conversion:	# B-Line buses converted	12	15.50000		186	186
					384	**22,286**	**22,670**

APPENDIX D
CALCULATION OF GHG EMISSIONS REDUCTIONS FOR PHASE I ENERGY SECTOR ACTIONS

PHASE I ENERGY SECTOR ACTIONS		Implementation Unit of Measurement	Units Measured or Estimated	Annual Emissions Reduction/ Unit	Estimated Emissions Reductions (MtCO2e)		
					City of Chico	Greater Community	Total Reduction
Objective 1: Upgrade and Tune-up Equipment							
1.1	Energy Star Appliances and Equipment	# of Kwh saved	17,213,218	0.00029		4,992	4,992
		# of Therms saved	34,331	0.00560		192	192
1.2	Personal Computer Recycling and Power Mgmt.	# of Kwh saved	106,020	0.00029	31		31
1.3	HVAC/Boiler Retrofits	sq. ft. of facilities-HVAC	228,000	0.00056		128	128
		sq. ft. of facilities-Boiler	530,097	0.00209	717	391	1,108
		# of Kwh saved	374,000	0.00029	27	108	135
Objective 2: Green Building and Energy Efficiencies							
2.1	CalGreen Building Standards	sq. ft .'green' construction	506,918	0.00065		329	329
2.2	Reflective or Cool Roofs	sq. ft. reflective roofing installed	397,500	0.00025		99	99
2.3	Low Income Weatherization Program	# homes weatherized	12,736	1.00483		12,798	12,798
2.4	Home Energy Requirement Upon Resale (RECO)	# homes weatherized	50	0.75362		38	38
2.5	Innovator Pilot Energy Efficiency Program	# homes participating	100	0.75362		75	75
2.6	Financial Incentives for Energy Efficiency (PACE)	types of improvements installed	TBD	TBD		TBD	TBD
Objective 3: Improve Lighting Efficiency							
3.1	LED Street Lights	# streetlights replaced	1,141	0.1402	160		160
3.2	Commercial Light Upgrades	sq. ft. of facilities	488,263	0.02619		12,788	12,788
		# of Kwh saved	145,529	0.00029	42		42
3.3	Occupancy Sensors	sq. ft. facilities with sensors	150,988	0.0007		106	106
3.4	LED Exit Signs	# exit signs replaced	100	0.0795	8		8
3.5	Energy Fitness Commercial Lighting Upgrades	# of Kwh saved	14,564,058	0.00029		4,224	4,224
Objective 4: Renewable Energy Generation							
4.1	Solar Photovoltaic Systems	Kw produced	12,005	0.64020		7,686	7,686
		kWh produced	2,190,000	0.00029	635		635
4.2	CSU, Chico Switch in Energy Providers	MtCO2e saved	8,730	n/a direct		8,730	8,730
4.3	Wastewater Treatment Plant Methane Recovery	kWh produced	2,641,140	0.00029	766		766
Objective 5: Promote a Healthy Urban Forest							
5.1	Urban Forest Management Plan	number of trees planted	TBD			TBD	TBD
Objective 6: Water Conservation Strategies							
6.1	Weather Based Irrigation Controllers	# acres on central controller	41	0.22013	6	4	10
6.2	Water Efficient Public Landscaping (AB 1881)	# gallons of water saved	TBD	0.00350	TBD	TBD	TBD
6.3	Low Maintenance Landscaping	acres of low maint. landscaping	251	0.37118		93	93
6.4	CA 20 by 2020 Water Conservation Plan	# gallons of water saved	TBD	0.00350	TBD	TBD	TBD
6.5	Free Water Audit Program	# gallons of water saved	TBD	0.00350	TBD	TBD	TBD
			TOTALS:		**2,391**	**52,780**	**55,171**

APPENDIX D
CALCULATION OF GHG EMISSIONS REDUCTIONS FOR PHASE I WASTE & COMMUNITY OUTREACH ACTIONS

PHASE I SOLID WASTE SECTOR ACTIONS		Implementation Unit of Measurement	Units Measured or Estimated	Annual Emissions Reduction/ Unit	Estimated Emissions Reductions (MtCO2e)		
					City of Chico	Greater Community	Total Reduction
Objective 1: Expand Recycling Efforts							
1.1	Residential/Multifamily Recycling	Tons Diverted	TBD	0.0140		TBD	TBD
1.2	Commercial/Industrial Recycling	Tons Diverted	857	0.0140		12	12
1.3	City Municipal Recycling Program	Tons Diverted	TBD	0.0140	TBD		TBD
1.4	Environmentally Preferable Purchasing				TBD		TBD
Objective 2: Expanded Composting							
2.1	Yard Waste and Other Organic Composting	Tons Diverted	12,756	0.0132	63	105	168
Objective 3: Green Building							
3.1	CalGreen Building Standards (50% C&D Diversion)	Tons Diverted	TBD	0.0140		TBD	TBD
Objective 4: Renewable Energy Generation							
4.1	Landfill Methane Gas Recovery	Landfill Gas Emissions Rate	1018	0.0841		86	86
				TOTALS:	**63**	**203**	**266**

PHASE I COMMUNITY OUTREACH ACTIONS		Implementation Unit of Measurement	Units Measured or Estimated	Annual Emissions Reduction/ Unit	Estimated Emissions Reductions (MtCO2e)		
					City of Chico	Greater Community	Total Reduction
Objective 1: Community Outreach							
1.1	Sustainable Business Recognition Program	# of businesses participating	100	5.41762		542	542

APPENDIX E
GHG EMISSIONS REDUCTIONS FROM EXTERNAL ACTIONS

PG&E Grid Mix Change			
	2005	2015	2020
Grid Mix Makeup			
Nat Gas:	39%	32%	27%
Nuclear:	22%	22%	22%
Large Hydro:	16%	16%	16%
Renewable:	14%	26%	33%
Coal:	9%	4%	2%
Other:	(1%, accounted from 'coal')		
Total:	**100%**	**100%**	**100%**
Projected kWh consumption:		**591,680,443**	**636,298,665**
Emissions/yr Using 2005 Mix (MtCO2e):		156,241	
Emissions/yr Using 2015 Mix (MtCO2e):		108,734	116,934
Emissions/yr Using 2020 Mix (MtCO2e):			90,160
Total Reduction (Variance):		**47,507**	**26,774**

FUEL EFFICIENT VEHICLES (PAVLEY)			
	2008 (2005)	2015	2020
Projected VMT gasoline Use		651,705,808	730,536,660
Projected VMT diesel Use		49,053,126	54,986,632
Emissions/gal gasoline	0.00941		
Emissions/gal diesel	0.00953		
Average Vehicle Fuel Efficiency			
Gasoline	19.70	21.75	24.01
Diesel	5.50	6.07	6.70
(Assumed 2% incease/yr)			
Emissions/yr With 2005 Levels (MtCO2e):			
Gasoline		311,387	316,148
Diesel		85,004	86,303
Emissions/yr at Expected New Levels (MtCO2e):			
Gasoline		282,033	286,345
Diesel		76,991	78,168
Estimated GHG Reduction (gasoline):		29,354	29,803
Estimate GHG Reduction (diesel):		8,013	8,136
Total Estimated Reductions:		**37,367**	**37,939**

Summary of Total Emissions Reductions from External Actions by 2020	Phase I MtCO2e	Phase II MtCO2e
Estimated Total GHG Reductions :	**84,874**	**64,713**

APPENDIX F
COST BENEFIT ANALYSIS OF CITY IMPLEMENTED PROJECTS FOR PHASE I

Project	Upfront Costs	Rebates	Net Up-Front Costs	Additional Annual Operating Costs	Annual Savings		Annual $ Savings	Project Lifetime	Internal Simple Payback	Annual Emissions Reduction	Additional/ External Annual Savings	Net Present Value
Transportation	**(City)**				**Gallons of Gasoline**			**Years**	**Years**	**MtCO2e**	**(Community)**	
Flex Schedule	$0	$0	$0	$0	2,458		$9,070	2	N/A	23	$0	$17,834
New Bike Path- 99	$3,425,000	$0	$3,425,000	$13,500	75,417		$0	15	(None)	710	$278,289	-$255,082
New Bike Path- 2nd Street	$200,000	$0	$200,000	$0	79,227		$0	15	(None)	746	$292,348	$3,284,941
Police on Bikes	$6,000	$0	$6,000	$200	4,516		$63,462	5	0.1	43	$0	$278,241
Franchise Waste Zones	$0	$0	$0	$0	71,636		$0	40	N/A	683	$0	$0
Additional Hybrid Vehicles	$112,000	$0	$112,000	$0	5,592		$20,634	10	5.4	53	$0	$65,608
Energy Conservation					**kWh**	**Therms**						
PC Power Mgmt	$7,500	$5,700	$1,800	$0	106,020		$12,722	10	0.1	31	$0	$107,710
HVAC Control Retrofits	$348,792	$0	$348,792	$0	92,142		$11,057	25	31.5	27	$0	-$160,177
CH/CC Chillers	$880,014	$61,945	$818,069	$0	343,097		$41,172	25	19.9	100	$0	-$115,748
LED Street Lights	$786,528	$120,850	$665,678	$0	548,295		$73,796	25	9.0	160	$0	$593,168
Lighting Upgrades	$68,772	$8,458	$60,314	$0	145,529		$17,463	25	3.5	43	$0	$237,584
Innovator Pilot Program	$0	$0	$0	$0	128,500	4,250	$0	2	N/A	61	$20,180	$39,678
Solar PV	$8,400,000	$4,200,000	$4,200,000	$0	2,190,000		$262,800	25	16.0	640	$0	$282,939
Wastewater Methane Capture	$2,550,000	$0	$2,550,000	$0	2,641,140		$316,937	10	8.0	772	$0	$178,093
Water Conservation					**kWh**	**g Water**						
Additional Acreage CIC	$37,500	$0	$37,500	$0	18,827	5,379,000	$8,577	15	4.4	6	$0	$64,746
Waste Management					**Tons**							
Additional City Composting	$0	$0	$0	$0	4,776		$0	10	N/A	63	$0	$0
									TOTALS:	**4,160**		**$4,619,536**