City of Calistoga
Green Committee
Agenda Item Summary

DATE July 12, 2013

AGENDA ITEM 6.A. – Preliminary Draft of Climate Change Protection Plan

Attached are the first chapters of the Draft Climate Change Protection Plan that provide background information for the Plan.

Climate Change Mitigation Plan

Committee Review Draft

July 2013

CREDITS AND ACKNOWLEDGEMENTS *TO BE COMPLETED*

Calistoga City Council

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GLOSSARY OF ACRONYMS

ARB	California Air Resources Board
$MTCO_2e$	Metric tons of carbon dioxide equivalent
CCMP	Calistoga's Climate Change Mitigation Plan
CEQA	California Environmental Quality Act
CPC	Climate Protection Campaign (Sonoma County)
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse gas
gpd	Gallons per day
kWh	Kilowatt hours
ICLEI	International Council for Local Environmental Initiatives
IPCC	International Panel on Climate Change
LCFS	Low-carbon fuel standard
$MMTCO_2e$	Millions of metric tons of carbon dioxide equivalents
MPO	Metropolitan planning organization
MTC	Metropolitan Transportation Commission
MWh	Megawatt hours
ppm	Parts per million
RPS	Renewable portfolio standard
SCS	Sustainable Communities Strategy
tpd	Tons per day
VMT	Vehicle miles traveled
ZEV	Zero emission vehicle

I. INTRODUCTION

The gases that make up the Earth's atmosphere are in a delicate, natural balance. The ability of these gases to trap the sun's heat has long been recognized as a natural "greenhouse effect" that makes the Earth habitable. Recent human activity has put too much of certain greenhouse gases into the atmosphere. This imbalance is enhancing the natural greenhouse effect and causing the planet to heat up – with significant environmental, economic and health consequences as a result.

Purpose of the Climate Change Mitigation Plan

The City of Calistoga recognizes that local governments have broad influence, and, in some cases, exclusive authority over activities that contribute to greenhouse gas (GHG) emissions.

The Climate Change Mitigation Plan (CCMP):

- Provides a brief summary of the science behind climate change, its potential local impacts, and current climate policy.
- Establishes a baseline inventory of community emissions and sets an emissions reduction target.
- Outlines a set of reduction strategies that will enable the City to reach its GHG reduction targets, quantifies their emissions reduction potential.
- Establishes a plan for implementation of the GHG reduction strategies, including long-term monitoring.

Through actions outlined in this Plan, the City can help mitigate, to the extent feasible at the local level, the potential impacts of climate change. Many of the strategies in the plan – reducing automobile dependence, promoting renewable energy, increasing energy efficiency, conserving water, and eliminating waste – provide co-benefits to the community. They have the potential not only to reduce GHG emissions, but also to improve air quality, lower energy and water bills, reduce dependence on imported oil, and enhance Calistoga's quality of life.

Although the State has not mandated that local governments take independent action to reduce their emissions, developing a plan now will prepare Calistoga for possible future mandates.

Additionally, it will help inform the City's environmental review, since GHG emissions now must be considered under the California Environmental Quality Act (CEQA).

Climate Science Basics

Greenhouse gases such as carbon dioxide (CO_2) and methane occur naturally in Earth's atmosphere. These gases act like the glass panes of a car's windows or a greenhouse roof, trapping heat in what is termed the "greenhouse effect." This greenhouse effect helps stabilize the Earth's temperature; without it, the average surface temperature of the Earth would be about 60°F cooler[1].

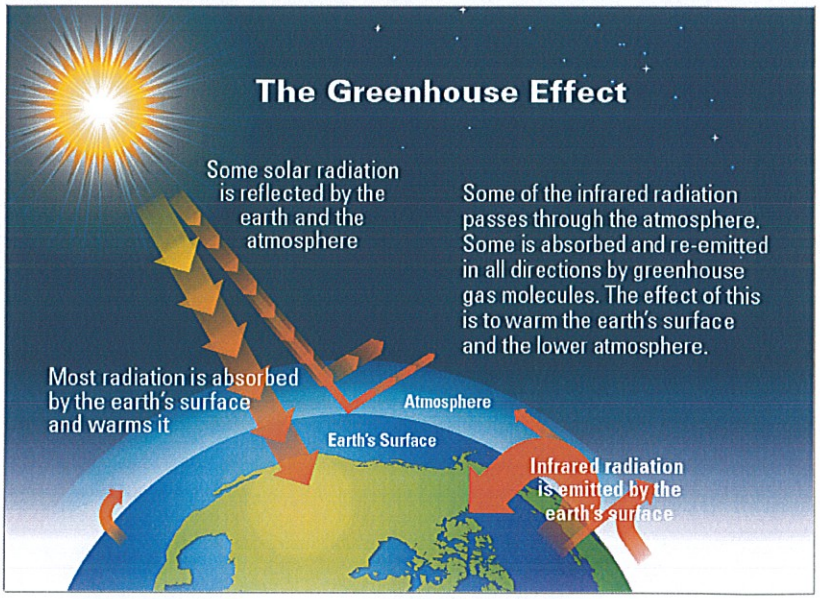


Figure 1 The Greenhouse Effect
U.S. Environmental Protection Agency, 2009

For the past 10,000 years, the concentration of carbon dioxide in the atmosphere remained stable at around 280 parts per million (ppm)[2]. Then, with the advent of industrialization, humans began to emit large quantities of carbon dioxide into the atmosphere, and the atmospheric concentration of CO_2 began to increase at an increasing rate, reaching 390 ppm by 2010 and currently rising at approximately 2 ppm per year[3]. Although atmospheric concentrations of CO_2 have been increasing since the beginning of industrialization, the majority of cumulative emissions have occurred in recent decades.

Scientists believe that in order to prevent the most catastrophic effects of climate change, the concentration of GHGs in the atmosphere cannot continue to increase. Even though technology is available to stabilize emissions, evidence suggests that based on current mitigation efforts and development practices, emissions will continue to grow over the next few decades.

[1] United States Global Change Research Program, 2009
[2] IPCC, 2007
[3] Tans, 2012

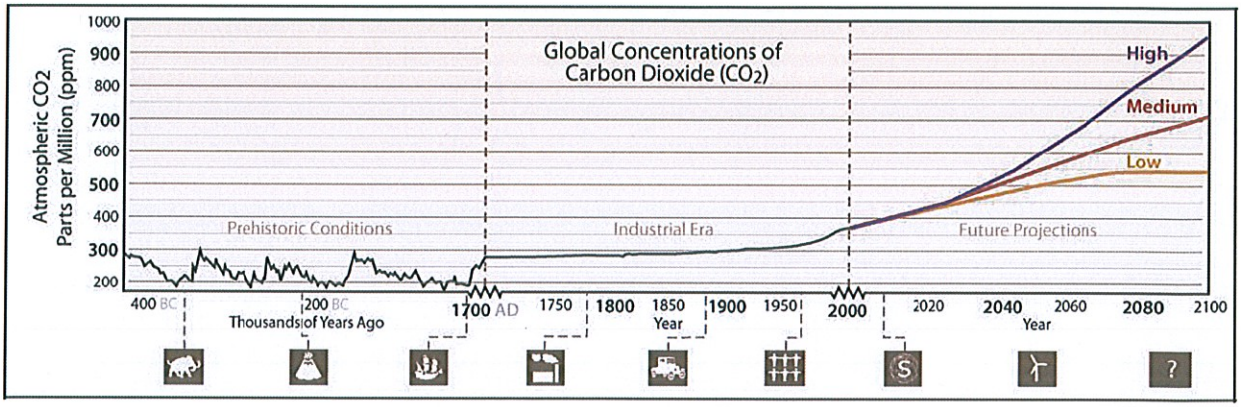


Figure 2 Global Concentrations of CO_2

Even if emissions can be stabilized at or below current levels, atmospheric concentrations will not instantly stabilize because once in the atmosphere, GHGs can persist for centuries. Due to the time scales associated with climatic processes, past actions will result in some degree of additional climate change[4]. However, actions taken today can dramatically affect the rate of change in the long term. Without action, the impacts of climate change will become increasingly severe and at some point will spiral beyond man's ability to control or reverse them.

The Earth's climate has a number of potential positive feedback loops that scientists fear could exacerbate global warming. For instance, melting snow and ice expose darker land surfaces that will in turn absorb more heat from the sun, raising temperatures and accelerating the further loss of snow and ice. There are also potential climatic tipping points that could abruptly and irreversibly change the climate system. For example, currently the oceans are absorbing a significant portion of our carbon dioxide emissions, but at some point scientists anticipate the oceans will reach saturation and will no longer provide the same mitigation.

Experts have identified an increase of 3.6°F as the potential threshold beyond which the impacts of climate change are likely to be particularly grave[5]. Unfortunately, scientists cannot predict with certainty the atmospheric concentration of GHGs that will generate this level of warming. The IPCC estimates that an eventual warming of 3.6 to 4.5°F will require stabilizing atmospheric concentrations of GHGs at 445 – 490 ppm. In order to achieve this stabilization level, emissions reductions of 50 – 85% from 2000 levels will be required by 2050. However, IPCC's projections may be too conservative because they do not factor in the possibility of

[4] Rechtschaffen et al., 2009.

[5] Ibid.

feedback loops and they do not take into account the unexpectedly high growth rate in GHG emissions during the 2000s[6].

The empirical evidence to date shows that, so far, the climatic effects of man's actions have been drastically underestimated. For instance, arctic sea ice is retreating at a significantly faster rate than predicted by all 18 of the models used by IPCC. The arctic permafrost and the world's largest glaciers are also melting faster than predicted.

Based on this science, it is clear that a precautionary approach should be taken in an attempt to reduce emissions and stabilize greenhouse gas concentrations as quickly as possible.

Effects of Climate Change

Statewide Climate Change

Climate change is expected to affect different areas of the world disproportionately. The effects on California are well-documented and already underway. Over the past 50 years, California's winter and spring temperatures have been warmer, spring snow levels in lower and mid-elevation mountains have dropped, snowpack has been melting one to four weeks earlier, and flowers are blooming one to two weeks earlier.

Predictions of future effects of climate change in California are summarized by the California Climate Change Research Center in its 2006 report, "Our Changing Climate." The report describes the following potential changes and resulting risks to California:

- The sea level has risen seven inches along California's coast in the past century and is projected to rise another 4 to 28 inches in the next hundred years.
- Weather is predicted to become more extreme and variable, with higher highs and lower lows and a greater frequency and degree of high intensity storms.

Human Health

Human health is projected to be negatively impacted by climate change in three ways: (1) Higher temperatures will increase the formation of ozone, exacerbating air pollution; (2) Extreme heat events will worsen in both frequency and intensity, putting people at greater risk of death from dehydration, heat stroke, heat exhaustion, heart attack, and respiratory distress; and (3) Infectious diseases will spread, particularly those that thrive in warm areas such as West Nile virus, cholera, and Lyme disease.

[6] Ibid.

- The amount of precipitation is not expected to change drastically, but a greater percentage is expected to fall as rain instead of snow, with a corresponding decrease in snowpack.
- Demand for water is expected to increase because of rising temperatures and a growing population. Higher demand, coupled with decreased snowpack, could result in water shortages.
- A smaller snowpack increases the potential for winter flooding as water that would normally be reserved as snow until spring could flow into rivers concurrently with winter storm events.
- Energy shortages may result from increases in temperature and possibly reduced hydropower potential from diminished snowmelt flowing through dams.
- A hotter, drier climate could promote up to 90% more northern California fires by the end of the century, negatively affecting the economy and air quality.
- Increased flooding, droughts, and wildfires will test ecosystem resiliency. As the climate changes, species' geographic ranges will shift, and those species who fail to migrate or adapt will go extinct.
- Many crops will increase in productivity with a few degrees of warming as long as water is available and crops are not already at the warm-end of their temperature range. Shifts in the range and abundance of invasive plants and other agricultural pests will likely occur and affect crop yields.

Wine Production

High-quality wines produced throughout the Napa and Sonoma Valleys and along the northern and central coasts generate $3.2 billion in revenue annually. Temperature increases are expected to have only a modest effect on grape quality in most regions over the next few decades. However, toward the end of the century, wine grapes could ripen as much as one to two months earlier, affecting grape quality.

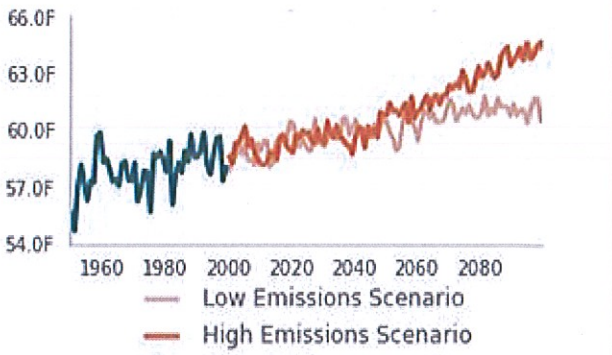
Local Climate Change

Because of Calistoga's elevation and location in an inland valley, it is not directly threatened by flooding from sea level rise. However, Calistoga has regional, state, national and global connections and will thus be affected. The Bay Area's economy is particularly vulnerable to sea level rise, with large commercial and industrial areas at risk of flooding, especially in San Francisco, Oakland and Silicon Valley. In addition, flooding could impact the delivery of products and services in the Bay Area as important highways, rail lines and airports lie near sea level

around the bay. For instance, approximately 72 percent of each of the San Francisco and Oakland Airports is at risk of inundation from a 16-inch sea level rise[7].

Calistoga's water supply has a number of sources, including Kimball Reservoir, Lake Hennessey, and Milliken Reservoir, which collect runoff from their watersheds. Calistoga is therefore not at as great of a risk of water shortages as the many Californian cities that rely on the Sierra Nevada snowpack for their water.

Cal-Adapt, a tool developed by Berkeley scientists and sponsored by the California Energy Commission, uses multiple future emissions scenarios to make projections on the effects of climate change at the local level in California. Depending on future emission levels, the average temperature in Calistoga is projected to rise three to five and one-half degrees by the end of the century



Historical Average	58.0 °F	
Low-Emissions Scenario	61.1 °F	+3.1 °F
High-Emissions Scenario	63.5 °F	+5.5 °F

Figure 3 Observed and Projected Temperatures for Calistoga
http://cal-adapt.org/tools/factsheet

The Regulatory Context

International Climate Policy

In 1997, international delegates met in Kyoto, Japan to draft the Kyoto Protocol. Under this agreement, industrialized countries (called Annex-1 countries) committed to GHG emissions reduction targets for 2012 set to a certain percentage of the countries' 1990 emissions. These targets represent on average an emissions reduction of 5.2% below 1990 levels (the United States' specific target called for a reduction of 7% below 1990 levels by 2012). 191 states have signed on to the treaty, but the United States has not, and the current Congress is not expected to ratify it. In response to the inaction of the federal government, hundreds of U.S. mayors have signed the U.S. Mayors Climate Protection Agreement, pledging to meet or beat the Kyoto Protocol emissions reduction target in their communities.

[7] San Francisco Bay Conservation and Development Commission, 2011

Federal Climate Policy

There is no federal legislation requiring comprehensive GHG emissions reductions in the United States. However, the U.S. Environmental Protection Agency (EPA) has used the Clean Air Act to regulate certain mobile and stationary sources of GHG emissions since 2010.

The EPA and the United State Department of Transportation (DOT) have established new fuel efficiency standards for passenger cars, medium-duty passenger vehicles and light trucks for model years 2012 through 2016. These standards raise average fleet-wide fuel efficiency from 27.5 mpg to 35.5 miles per gallon. This translates into an average emissions level of 250 grams of CO_2 per mile.

Stronger standards established for model years 2017-2025 will raise average fleet-wide fuel efficiency to 54.5 mpg for cars and light trucks by model year 2025 and limit the average emissions level to no more than 163 grams of CO_2 per mile in model year 2025.

The first-ever fuel standards for heavy-duty trucks and buses have also been established, for vehicle model years 2014-2018. It is estimated that the standards will reduce carbon pollution from tractor-trailers by 20%, medium-duty trucks and vans by 15%, and vocational vehicles (fire trucks, garbage trucks, etc.) by 10%.

Since July 1, 2011, the EPA has also been regulating the greenhouse gas emissions of major stationary sources such as power plants, industrial manufacturers, and solid waste landfills when facilities are newly constructed or substantially modified. A major stationary source of greenhouse gas is defined as a facility that emits 100,000 tons per year or more of CO_2e (EPA, December 2010). No facility in Calistoga has filed a report as a major GHG emitter as of yet.

State Climate Policy

Over the last decade, the State of California has aggressively sought to reduce statewide GHG emissions through legislation and strategies.

Executive Orders

Signed in 2005 by Governor Arnold Schwarzenegger, Executive Order S-03-05 required a reduction in statewide greenhouse gas (GHG) emissions to 80 percent below 1990 levels by 2050, based on achieving atmospheric stabilization by mid-century. In March 2012, Governor Brown signed Executive Order B-16-2012 establishing zero emission vehicle benchmarks and affirming a long-range climate goal for California to reduce greenhouse gases to 80 percent below 1990 levels by 2050.

Assembly Bill 32

In 2006, the State of California adopted the Global Warming Solutions Act (AB32). AB32 created a comprehensive, multi-year program to reduce GHG emissions in California to 1990 levels by 2020, a reduction of approximately 30 percent, and to maintain and continue reductions beyond 2020. The law directs the California Air Resources Board (ARB) to develop a portfolio of mitigation measures to meet the reduction target, called the AB32 Scoping Plan, adopted in December 2008. The Scoping Plan identifies local governments, such as the City of Calistoga, as essential partners in achieving this target, and identifies 15% below 2005–2008 GHG levels as the local government equivalent of 1990 emissions levels, to parallel the State's target.

SB375

Passed in 2008, this law revises the process of regional transportation planning by metropolitan planning organizations (MPOs) in order to address climate change. SB375 requires ARB to establish regional targets for reductions in GHG emissions from passenger vehicles and small trucks for each of the state's 18 MPOs. The MPO of which the City of Calistoga is a part, the Metropolitan Transportation Commission (MTC), has adopted a target of reducing regional per capita vehicle emissions 7 percent below 2005 levels by 2020.

Under SB375, the MTC and other large MPOs are required to develop "Sustainable Communities Strategies" (SCS) to outline how they will meet their GHG reduction targets through actions that integrate land use, housing, and transportation planning. The MPOs must incorporate their SCS into their federally-enforceable regional transportation plans. In addition, funding decisions for regional transportation projects must be consistent with the SCS. Projects that align with the SCS will be given CEQA relief in the form of streamlining and exemptions. The MTC is expected to adopt its SCS, called *Plan Bay Area*, this year.

SB97 & the CA Environmental Quality Act (CEQA)

Enacted in 2007, SB97 directs the Governor's Office of Planning and Research to amend the California Environmental Quality Act (CEQA) to address GHG emissions. In response, the OPR prepared CEQA Guidelines that went into effect March 18, 2010. The City's CEQA checklist has been amended to require an analysis of potential project-related GHG impacts.

In addition, in 2009, the State Attorney General ruled that all land use planning and transportation decisions by local governments, including general plans, must consider GHG emissions reductions in order to comply with CEQA.

City of Calistoga Greenhouse Gas Emissions Policies

The Calistoga General Plan was comprehensively updated in 2003, prior to adoption of the California Global Warming Solutions Act of 2006.

However, the Open Space and Conservation Element includes the following goals, objectives and programs related to minimizing greenhouse gas emissions:

Goal OSC-6	*Protect and improve Calistoga's existing high standard of air quality.*
Objective OSC-6.1	*Minimize air pollution emissions.*
Policy 1	*The City should support efforts to reduce vehicular emissions in the Calistoga Planning area by reducing congestion and dependence on automobile related forms of transportation.*
Policy 4	*The use of alternatively fueled vehicles for City operations shall be explored.*
Goal OSC-7	*Work to preserve the global environment.*
Objective OSC-7.1	*Minimize Calistoga's contribution to impacts on the global environment such as dependence on fossil fuels, consumption of non-renewable resources and discharge of toxins and pollutants.*
Policy 1	*The City shall promote the conservation of non-renewable energy resources and encourage the use of solar energy.*
Policy 2	*The City's own activities should emphasize minimization of impacts to the environment. Examples include wastewater reclamation, use of passive solar energy and use of alternately-fueled City vehicles.*
Policy 3	*The City shall promote decreased reliance on motor vehicle travel through effective land use policies, improved public transit and facilities to accommodate bicycle and pedestrian modes of travel.*
Policy 4	*New building construction to minimize consumption of energy resources shall be encouraged through adoption of energy-efficient building codes and regulations.*

It is intended that the next General Plan update will integrate and reference this plan, but that it will remain a separate document. This will allow the City to update the CCMP as needed to add and amend strategies as new information, policy guidance and regulations regarding greenhouse gases arise and evolve, and new technologies are developed.

In 2009, the Calistoga City Council adopted a greenhouse gas emissions reduction target of 15% below 2005 emission levels by 2020 in order to mitigate the adverse effects of climate change. This Plan is intended to achieve this goal.

The City also supported the Napa Countywide Community Climate Action Plan Framework that was intended to achieve this target. The Framework was adopted by the Napa County Transportation and Planning Agency in 2010.

II. CALISTOGA'S GREENHOUSE GAS EMISSIONS

A Profile of Calistoga

Located in Napa County approximately 25 miles north of the City of Napa, Calistoga is a small city of 2.5 square miles and an estimated population of 5,155 (2010 Census). Calistoga is situated in an inland valley with an elevation of 348 feet above sea level. It is surrounded by agricultural lands and mountains.

Calistoga is a walkable small town, made up of a vibrant main street set within pedestrian-oriented neighborhoods and surrounded by wineries and vineyards. Important visual features include the tree-lined streets found throughout the City, the Napa River, and historic homes and commercial buildings. Most of the community is located on the Napa Valley floor, nestled between the Palisades to the north and the Southern range.

Calistoga is located within Climate Zone 2[8], which includes the hilly Coastal Range to the edge of the Northern Central Valley. The zone has a coastal climate influenced by the ocean approximately 85% of the time and by inland air 15% of the time. Heating degree days (HDD)[9] dominate the climate design, although some cooling is necessary in the summer. Calistoga experiences approximately 2,844 HDD (65° F basis) and 456 cooling degree days (CDD) (80° F basis) on an annual basis.

Emissions Inventories

The first step towards reducing emissions is to inventory the GHG emissions for which the community as a whole is responsible for a specific analysis year.

The primary goals of an emissions inventory are to:

- Determine the major sources of emissions within the city as a basis for effective emissions reduction policy,
- Create a base year to set emissions reduction targets, and
- Enable the demonstration of progress over time through re-inventorying across years.

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8 U.S. Department of Energy

9 Heating and cooling degree days are a measurement designed to reflect demand for energy needed to heat or cool a facility, and are calculated as the difference between the average daily temperature for a region and a baseline temperature (usually 65° or 80° F). HDD value is the summation of degrees of the average temperature per day below 65° F for the year. CDD is the summation of degrees of the average temperature per day above 80° F for the year.

Each local community has unique characteristics (e.g., population, housing types, transportation networks, industries, electricity fuel mix) that make its GHG inventory different from other cities or counties.

Inventory Boundaries

One of the challenges in tracking local emissions is establishing the boundaries of the inventory. What is included in the inventory will have important implications on the quantity of emissions the city commits to reducing and the types of mitigation strategies the city adopts.

A community-wide inventory assesses emissions resulting from activities taking place within the City's boundary, consisting of the physical area over which it has jurisdictional authority. Activities that occur within this boundary can be controlled or influenced by the City of Calistoga's policies and educational programs, although the City may have limited influence over the level of emissions from certain activities.

The inventory also includes certain emissions that occur elsewhere but are the result of activities within the city, such as those that occur at landfills and power plants as a result of the solid waste generated and electricity consumed by Calistoga's residents and businesses. The decision to calculate emissions in this manner reflects the general philosophy that a community should take full ownership of the impacts associated with its energy consumption, regardless of whether the generation occurs within the geographical limits of the community.

Units of Measurement

GHG inventories measure three primary greenhouse gases – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_20). These greenhouse gases are converted to carbon dioxide equivalents (CO_2e) based on their relative global warming potentials in order to consider all emissions in comparable terms. Following IPCC guidance, this Plan expresses emissions in metric tons of carbon dioxide equivalent ($MTCO_2e$). One metric ton is equal to approximately 2,204.6 pounds.

Emission Conversion Factors

Data that is collected by an inventory – such as the number of kilowatts of energy consumed, tons of waste generated, and vehicle miles traveled – is multiplied by conversion factors to translate it into greenhouse gas emissions. Conversion factors are calculated ratios – they estimate the amount of CO_2e produced per kilowatt hour, ton of waste, or mile traveled.

Understanding Totals

inventories allow the City to quantitatively track its efforts to mitigate GHG emissions. However, the inventory totals should be viewed with the understanding that there are limitations to their accuracy and inclusiveness. Firstly, they depend on conversion factors rather than direct measurement of emissions. Small errors in these conversion factors can translate into vast differences in GHG estimations, and conversion factors can change over time. For instance, the electricity conversion factor changes each year with fluctuations in the mix of power purchased by the City. Secondly, as discussed earlier, the inventories have narrow boundaries that do not account for all the GHG emissions for which the city is responsible.

2005 Community-wide Emissions

The year 2005 was selected as the base GHG emissions year, since the City's target is to reduce GHG emissions 15% below 2005 levels by 2020. This is also the reference year in both SB 375 and Executive Order S-3-05. Additionally, 2005 is one of the earliest years for which relatively comprehensive data is available.

Calistoga's 2005 emissions were estimated in 2009 using ICLEI's Clean Air and Climate Protection methodology, which is consistent with national and international inventory standards established by the Intergovernmental Panel on Climate Change. The 2005 inventory represents a best estimate based upon accepted methodology in 2009 and data that was available at that time. The model depends upon numerous assumptions, and is limited by the quantity and quality of available data. Therefore, any specific number generated by the model should be thought of as an approximation rather than an exact value.

Emissions Sectors[10]

The 2005 community-wide GHG emissions analysis included the sectors and data/emission sources listed below.

The inventory omitted some smaller sources of emissions, such as emissions from wood-burning appliances and leaked refrigerants. The inventory also did not include the emissions generated by residents' air travel, the energy required to grow and ship food to Calistoga, local agricultural operations or the embedded energy in products bought for the city's residents, businesses and government.

[10] Adapted from Final Napa County Climate Action Plan, March 2012

Table 1 Community-Wide Emissions Sectors - 2005

Sector	Data / Emission Source
Buildings	Electricity consumption Natural gas consumption
Transportation	Vehicles on local roads Vehicles on state highways
Equipment	Lawn and garden equipment Construction equipment Industrial equipment Light commercial equipment
Solid Waste	Methane emissions from landfills Landfill waste Organic alternative daily cover

- Buildings Sector

The use of electricity by residential, commercial and industrial buildings results in the release of GHGs when fossil fuel (either coal or natural gas) is combusted at a power plant servicing Calistoga residents and businesses. Although the combustion of fuel occurs outside of Calistoga, the activities requiring electricity occur within the city's jurisdiction and are thus attributed to it. Natural gas is used in buildings for on-site heating, water heating and household appliances.

Energy used by wastewater treatment facilities was included in electricity and natural gas data provided by PG&E. GHG emissions are the result of two activities in the processing of wastewater: 1) energy use by treatment buildings/facilities, and 2) fugitive emissions associated with the biological and chemical treatment of the waste. The associated GHG emissions are therefore captured in the residential and commercial building energy sector. Similarly, emissions associated with energy used to pump, treat and distribute water (including water transported from water sources outside the city through the State water project) are captured in the buildings sector.

- Transportation Sector

The combustion of gasoline or diesel fuel by on-road vehicles results in the release of GHG emissions. On-road vehicles include passenger vehicles, buses, and medium and heavy duty trucks traveling on roadways within the city limits, whether on local roads or state highways passing through the city.

- Equipment Sector

Equipment run by gasoline or diesel fuel includes lawn and garden, construction, and mobile commercial and industrial equipment.

- Solid Waste Sector

When waste decomposes in a landfill under anaerobic conditions, methane is produced. Methane is a potent GHG, with a warming potential 21 times that of carbon dioxide. The City does not own or operate landfills and is therefore not responsible for the GHG emissions associated with historical waste deposits (i.e., landfill as a stationary source).

2005 GHG Inventory Results

In 2005, the Calistoga community emitted a total of approximately 27,317 metric tons of CO_2e ($MTCO_2e$) within five sectors. Table 2 and Figure 4 illustrate the breakdown of 2005 emissions by sector. The transportation sector is the largest source of emissions, generating nearly one-third of total emissions. The second largest source of emissions is natural gas and electricity use by residences, followed by the commercial and industrial sector.

Table 2 GHG Community-wide Emissions by Sector - 2005

Emission Sector	CO_2e Metric Tons	Share of Total
Transportation	8,704	31.9%
Built Environment		
• Residential	7,758	28.4%
• Commercial/Industrial	7,062	25.8%
Equipment	2,100	7.7%
Solid Waste	1,693	6.2%
Total	**27,317**	

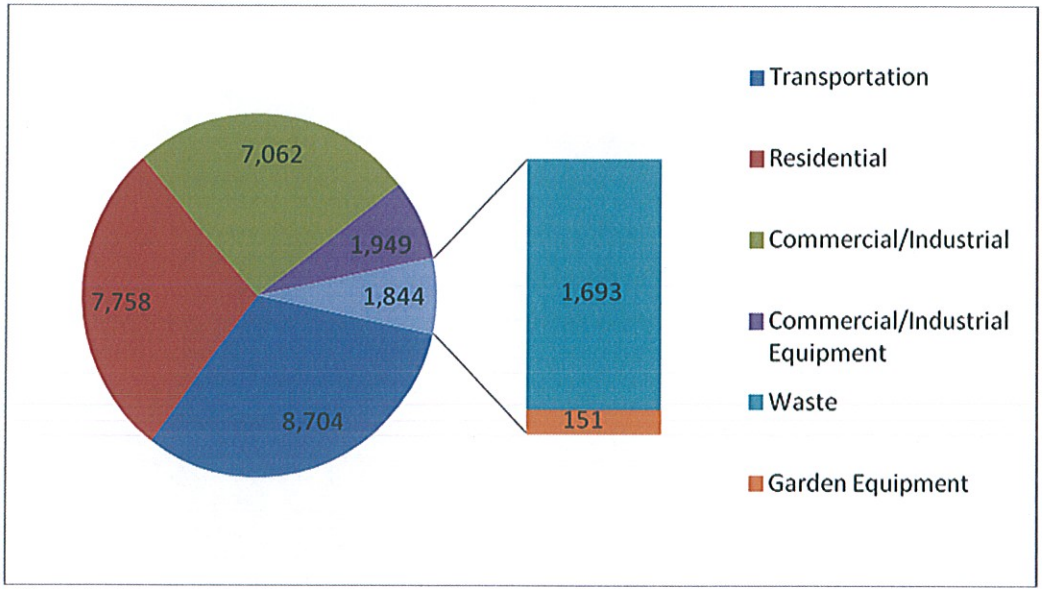

Figure 4 GHG Emissions by Sector - 2005

2010 Community-Wide and Local Government Emissions

Estimates of community-wide and local government GHG emissions during 2010 were made in 2012, using the International Local Government GHG Emissions Analysis Protocol (IEAP) to inventory the City's community emissions[11].

Emission Scopes

In many sectors of a GHG emissions inventory, the science, models, and data infrastructure behind available data are continually evolving. For this reason, available data and emissions factors are continually being refined and made more accurate.

As a refinement of the 2005 estimates, emissions sources were categorized as one of the following three scopes for the 2010 estimates, to prevent double counting prevent double counting of emissions for major categories such as electricity use and waste disposal.

- Scope 1: Direct emissions from sources located within the city.
- Scope 2: Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, and cooling. Scope 2 emissions occur as a result of activities that take place within the geopolitical boundary of the local

[11] City of Calistoga 2010 Community-Wide Greenhouse Gas Emissions Inventory, produced by Zohreh Khodabandelu and Pacific Gas and Electric Company with assistance from Association of Bay Area Governments and Local Governments for Sustainability USA. September, 2012.

government, but that rely upon emissions-producing processes located outside of the city.

- Scope 3: Other indirect or embodied emissions not covered in Scope 2 that occur as a result of activity within the city.

Scope 1 and Scope 2 sources are the most essential components of a community greenhouse gas analysis as these sources are typically the most significant in scale, and are most easily affected by local policy making.

For the 2010 estimates, a Water/Wastewater sector was added to the emissions inventory to reflect fuel and electricity used in the transport of water and wastewater, as well as the emissions generated during the wastewater treatment process.

2010 GHG Inventory Results – Community-Wide

Total community-wide emissions for Calistoga, consisting of all scopes and all sectors, were approximately 22,265 metric tons of CO_2e in the year 2010. (Because the sources that go into an inventory vary from community to community, this number should not be used for comparison purposes without a careful analysis of the basis of the number.) Table 3 presents the emissions calculations by scope and sector.

Table 3 Community-Wide GHG Emissions by Sector and Scope - 2010

Sector	Metric tons CO_2e				Share of Total
	Scope 1	Scope 2	Scope 3	**Totals**	
Residential	5,119	2,480	0	**7,599**	34.1%
Transportation	6,981	0	0	**6,981**	31.3%
Commercial/Industrial	3,470	3,158	0	**6,628**	29.8%
Solid Waste	0	0	706	**706**	3.2%
Water/Wastewater	55	266[12]	30	**351**	1.6%
Totals	15,625	5,904	736	**22,265**	
Percentage of Total CO_{2e}	70.2%	26.5%	3.3%		

[12] To avoid double counting, Scope 2 Water/Wastewater Sector emissions, which are emissions from electricity consumption by the subsectors located inside the City's boundaries, were subtracted from Scope 2 emissions in the Commercial Sector

Some of the differences between the 2005 and 2010 community-wide emissions estimates are attributable to revised methodology. Additionally, solid waste emissions estimates for 2010 exclude the Scope 1 emissions included in the base year (2005) estimates, which include fugitive emissions (i.e., not captured by methane recovery facilities) from all decomposing organic waste-in-place since the landfill's opening.

Despite the differences, 2010 emissions related to the transportation, residential and commercial/industrial sectors continued to be the top emissions sources.

Per capita GHG emissions in 2010 were 4.32 metric tons CO_2e. Due to differences in emission inventory methods, it can be difficult to get a directly comparable per capita emissions number, and one must be cognizant of this margin of error when comparing figures. This number is not the same as the carbon footprint of the average individual living in the city of Calistoga (which would include emissions from production of goods purchased from outside the community, emissions resulting from air travel, etc.).

2010 GHG Inventory Results – Local Government Operations

Analyzing the City government's emissions profile can help it tailor strategies to achieve the most effective GHG emissions reductions within its control. Therefore, in addition to estimating the community-wide emissions in 2010, the Local Government Operations Protocol was used to estimate emissions from the city's government operations as a subset of the community's emissions[13].

The City of Calistoga operates buildings, vehicles, street lights, water systems, and wastewater plants; city employees consume resources commuting to work and generate solid waste which is sent for disposal. All of these activities directly or indirectly cause the release of carbon dioxide and other greenhouse gases into the atmosphere.

Local government emissions by sector and scope are summarized in Table 4 and described below. However, they represent only a very small share – four percent – of total community-wide emissions.

[13] City of Calistoga 2010 Government Operations Greenhouse Gas Emissions Inventory, produced by Zohreh Khodabandelu and Pacific Gas and Electric Company with assistance from Association of Bay Area Governments and Local Governments for Sustainability USA. September 2012.

Table 4 Government Operations GHG Emissions - 2010

Sector	Metric tons CO_2e				Share of Total
	Scope 1	Scope 2	Scope 3	Totals	
Wastewater Treatment	55	204	0	259	29%
Employee Commute	0	0	183	183	20%
Vehicle Fleet	168	0	0	167	19%
Buildings/Facilities	55	86	0	141	16%
Water Treatment/Delivery	<1	93	0	93	11%
Public Lighting	0	28	0	28	3%
Solid Waste	0	0	21	21	2%
Totals	278	411	204	**893**	
Percentage of Total CO_2e	31.2%	46.0%	22.8%		

- Wastewater Treatment

Wastewater coming from homes and businesses is rich in organic matter and has a high concentration of carbon and nitrogen (along with other organic elements). As wastewater is collected, treated, and discharged, chemical processes in aerobic and anaerobic conditions lead to the creation and emission of two greenhouse gases: methane and nitrous oxide. The City owns and operates the Dunaweal Wastewater Treatment Plant, which serves residents and businesses of Calistoga. The treatment facility's energy use is responsible for 72 percent of emissions in this sector; fugitive nitrous oxide emissions from nitrification and/or denitrification are responsible for 20 percent.

- Buildings and Other Facilities

City-operated buildings and facilities generate the largest share of emissions (29%) related to government operations. Such facilities as City Hall, the fire and police stations, corporation yard, community center, Monhoff Recreation Center, community pool, Sharpsteen Museum and Calistoga Library contribute to greenhouse gas emissions in two major ways. Primarily, facilities consume electricity and fuels such as natural gas. In addition, fire suppression, air conditioning and refrigeration equipment in buildings can emit hydrofluorocarbons and other greenhouse gases when these systems leak refrigerants or fire suppressants. Refrigerants and fire suppressants are very potent greenhouse gases, and have a global warming potential many thousand times that of CO_2. Therefore, even small amounts of leaked refrigerants can have a significant effect on greenhouse gas emissions.

The community pool, which is heated by natural gas, contributes the greatest share of emissions, accounting for more than 45 percent of the 141 metric tons of CO_2e generated by this sector. Emissions from the Police Department account for approximately 22 percent of the total.

- Employee Commute

Emissions in the Employee Commute Sector represent the second largest source of City operations-related emissions (20 percent), and are due to combustion of fuels in vehicles used by commuting employees. They are considered Scope 3 emissions because the vehicles used are not owned and operated by the City. However, the City can influence these emissions through various programs (e.g., carpools, telecommute options, flex schedule options) despite not having direct control over them. A survey designed by ICLEI and administered by the City revealed that 80 percent of the responding employees drove to work alone. The types of commute vehicles were equally distributed between passenger cars and light trucks/SUVs/pickups/vans.

- Vehicle Fleet and Mobile Equipment

Vehicles associated with the City's daily municipal operations range from maintenance trucks used for parks and recreation, to police cruisers and fire trucks. In 2010, the City operated a vehicle fleet with 38 vehicles, 37 percent of which were used by the Public Works Department. The City also operated mobile equipment, including construction equipment and an assortment of small equipment such as weed trimmers and other maintenance tools. Fuel burned by vehicles, mostly gasoline, accounts for 93 percent of sector emissions.

In addition to burning fuels such as gasoline and diesel, the vehicle fleet contributes greenhouse gas emissions in the form of fugitive emissions (leakage) of refrigerants used for vehicle air conditioning. Because of data limitations, default refrigerant leakage estimates were used for all vehicles[14]. Fugitive emissions of refrigerants from vehicle air conditioning accounts for the remaining seven percent.

- Water Treatment and Delivery Facilities

Emissions associated with this sector of government operations are generated by equipment used for the treatment, transport and distribution of water that serves primarily the City's residents and businesses. The City operates a water treatment plant, water pumps and irrigation systems that disperse recycled water. Electricity consumption is a significant source of

[14] This method of estimating leaked refrigerants tends towards a significant overestimate, but is in line with ICLEI's LGO Protocol methods and represents the best methodology available.

greenhouse gas emissions from the operation of Calistoga's water treatment and transport system. Water pumps are responsible for 81 percent of this sector's emissions; water treatment is responsible for 19 percent.

- Public Lighting

The City of Calistoga operates public lighting that consumes electricity, including lighting at public facilities, streetlights and a traffic signal.

- Solid Waste

Sources of solid waste in local government operations include paper and food waste from offices and facilities, construction waste and plant debris. Emissions from the Solid Waste Sector are an estimate of methane generation that will result from the anaerobic decomposition of all organic waste sent to the landfill in the base year. It is important to note that although these emissions are attributed to the inventory year in which the waste is generated, the emissions themselves will occur over the 100+ year timeframe that the waste will decompose. Although the data on waste attributed to government operations included a 20-yard trash bin for all the departments; a 10-yard trash bin for the street sweeper, water line breaks, etc.; the trash cans on Lincoln Avenue and Logvy Park; and the waste related to the wastewater treatment plant, only data for the 20-yard bin could be considered government-generated waste, since the community is the main source of all other waste mentioned above.

Emissions Projections

Business as Usual Emissions Projection

As population and the economy grow, the activities that produce GHGs also increase. These activities generally increase at the same rate as population and job growth. Therefore, population and economic growth can be used to estimate the rate at which GHG emissions from each sector will increase in the future, assuming that the emissions per person are the same as they are now.

A "business-as-usual" (BAU) projection estimates how emissions will grow if consumption trends and efficiencies remain at their current levels while the numbers of Calistoga residents and jobs continue to increase. It is the status quo scenario before state and local mitigation measures are taken into consideration. Consequently, the BAU forecast is an overestimate of the City's future GHG emissions.

The BAU projection for city emissions in 2020 is based on the growth assumptions in population, housing and employment shown in Table 5, which is derived from the Association of Bay Area Government's *Projections 2005*.

Table 5 Projected Growth, 2005–2020

Sector	2005	2020
Population	5,200	5,300
Households	2,060	2,130
Jobs	2,830	3,000

Source: Association of Bay Area Governments, Projections 2005

For the purposes of GHG emissions forecasting, BAU assumes that the per capita GHG emissions in 2005 will remain essentially unchanged. Calistoga's share of countywide greenhouse gas emissions is expected to remain stable at two percent, and its emissions growth rate is expected to be significantly lower than the county's.

The total GHG emissions under the BAU 2020 scenario are 30,351 $MTCO_2e$, which is an 11.1 percent increase from the 27,317 $MTCO_2e$ emitted in 2005.

Table 6 BAU Emissions Projections - 2020

	CO_2e Metric Tons		
Emission Sector	2005	2020	**Increase**
Transportation	8,704	10,896	25.2%
Built Environment			
• Residential	7,758	8,022	3.4%
• Commercial/Industrial	7,062	7,486	6.0%
Equipment – Garden	151	156	3.4%
Equipment – Comm./Ind.	1,949	2,066	6.0%
Solid Waste	1,693	1,726	1.9%
Totals	**27,317**	**30,351**	**11.1%**

The greatest emissions increase under the BAU scenario would come in the On-Road Transportation Sector, which would grow by 25.2 percent. Emissions growth in the other sectors would be much less, ranging from 1.9 to 6 percent.

Adjusted Emissions Forecast

The great majority of GHG reductions that will occur between 2005 and 2020 are outside of local control. Aggressive State regulations included in the AB32 Scoping Plan – which affect vehicle standards, building standards and the renewable energy content of electricity – will significantly reduce GHG levels in the city.

The State actions summarized below have been incorporated into the city's BAU forecast to create a more realistic estimate of the city's future emissions. The majority of these reductions are from more stringent vehicle emissions standards and the cleaner energy production standards that PG&E is implementing pursuant to the statewide Renewables Portfolio Program.

Table 7 Applicable State GHG Reduction Measures

Measure	Description
S1 Emissions Standards for Passenger Vehicles (AB1493)	Vehicle standards that lower GHG emissions from passenger cars and light-duty trucks to the maximum extent technologically feasible, beginning with model year 2009.
S2 Low-Carbon Fuel Standard (EO S-01-07)	Requires fuel providers to ensure that the mix of fuel they sell in California meets, on average, a declining standard of carbon intensity. Fuel providers must reduce the carbon intensity of all passenger vehicle fuels at least 10% by 2020. Potential low carbon fuel technologies include biofuels from waste and cellulosic materials, natural gas, electricity used in plug-in vehicles, and hydrogen used in fuel cell vehicles.
S3 Other Vehicle Efficiency Measures	Proper tire pressure maintenance, low friction engine oils, heavy-duty vehicle aerodynamic/rolling resistance improvements
S4 Renewables Portfolio Standard (SB1078 & SB107)	Requires electric utilities to meet 20% of their retail sales with renewable power - like solar, wind, and geothermal - by 2010 and 33% by 2020.
S5 CAL Green	Updates to Title 24 of the California Code of Regulations require electricity, natural gas and water savings for every new home or business built in California.
S6 Landfill Methane Regulation	Capture of methane escaping from landfill
S7 Commercial Recycling	Mandatory recycling of waste generated by businesses

Source: CAPCOA AB32 Scoping Plan, 2008

The adjusted business-as-usual (ABAU) forecast is detailed in Table 8. In comparison to the BAU scenario, 2020 emissions with state reduction measures are __% below baseline 2005 levels rather than 11.1% above. Additional details on the adjusted forecast are provided in Appendix __.

Table 8 ABAU Emissions Projections - 2020

Emission Sector	CO_2e Metric Tons
Business-As-Usual Projected Emissions	**30,351**
State Actions S1 Vehicle emissions reductions S2 Low Carbon Fuel Standard S3 Other Vehicle Efficiency Measures S4 Renewables Portfolio Standard S5 CAL Green S6 Landfill Methane Regulation S7 Commercial Recycling	
Total State Reductions	-_____
Net Emissions (Adjusted BAU)	_____
Reduction from 2005	___%