



GREEN SUNNYVALE



City of Sunnyvale Climate Action Plan – City Operations

FINAL REPORT

Prepared by KEMA Inc.

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1. Executive Summary

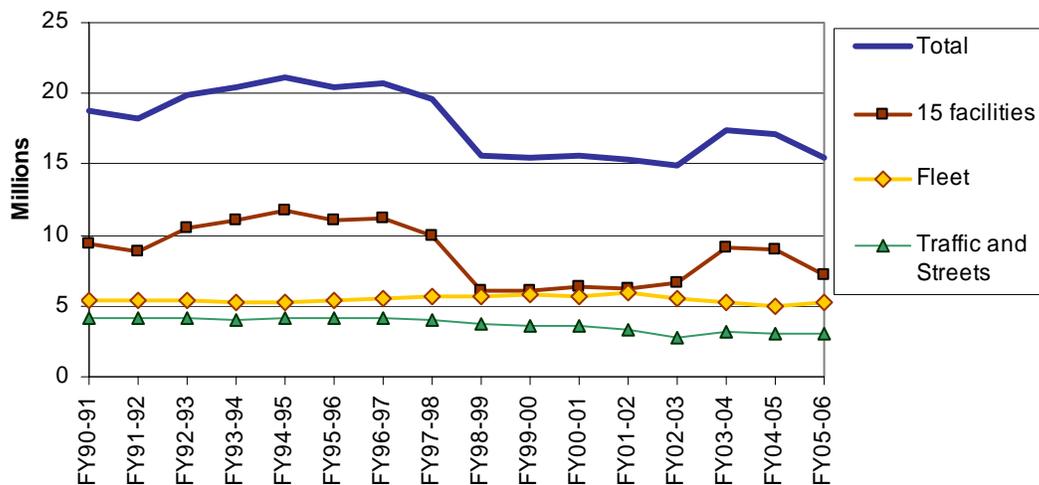
City of Sunnyvale recognizes the natural environment’s role in sustainability and the importance of maintaining a stable climate system for current and future residents. As a pledging partner of Sustainable Silicon Valley, City of Sunnyvale pays annual dues and makes a voluntary commitment to reporting and reducing CO₂ emissions. This report presents the City of Sunnyvale’s historic CO₂ emissions trends related to city operations, opportunities and costs of reducing city emissions and recommended target for future emissions reductions.

1.1 Historic emissions

The results of City of Sunnyvale’s historic emissions trend reflect staff commitment to energy efficiency and resource conservation. Figure 1-1 shows the individual emissions trend related to city facilities, fleet operations and traffic and street lights, with the total city emissions trend shown as a solid line.

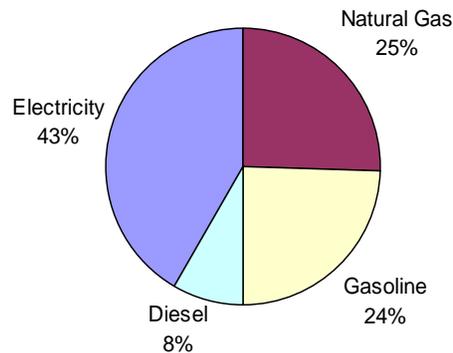
Emissions have already been reduced across all categories of city operations, with the largest reductions apparent within the fifteen city facilities. City facility emissions reductions are primarily due to the cogeneration facility at the Water Pollution Control Plant, which now uses landfill gas to displace purchased natural gas and produces enough electricity to meet the plant’s electricity load. Fleet emissions have also been reduced since around FY01-02, in addition to significant emissions reductions in traffic signals due to LED retrofits in recent years.

Figure 1-1. Total City of Sunnyvale historic emissions from all source categories (lbs of CO₂)



In fiscal year 2005-2006, electricity consumption contributed the largest percentage of emissions by fuel type, at 43% of city emissions. Figure 1-2 shows the relative contribution of other fuel types to the total city inventory. Natural gas, mostly related to building use, and gasoline consumed in fleet vehicles each contributed roughly a quarter of city emissions. Diesel constituted the smallest percent, at 8%.

Figure 1-2. Emissions contribution to total city emissions, by fuel type (FY05-06)

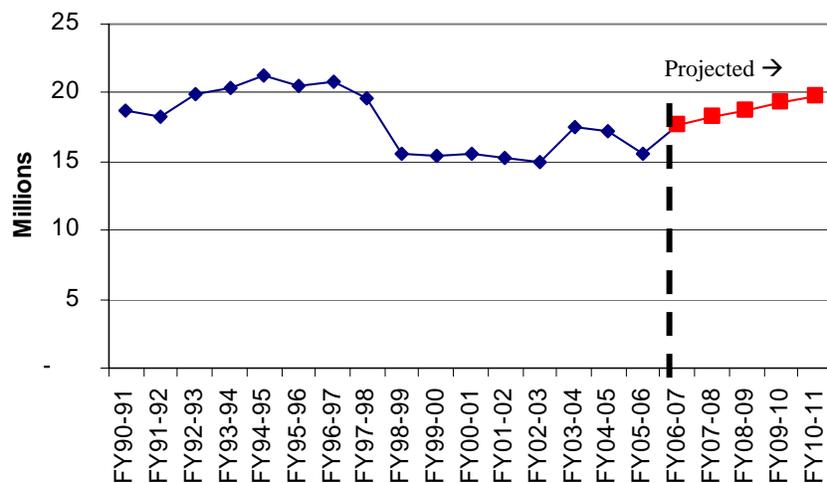


Natural gas and electricity use data was largely available from PG&E for all years back to 1990. Credible fleet size data was also provided by facilities staff from FY89-90. Since 1990 is the base year for Kyoto Protocol, California’s AB 32 Global Warming Solutions Act, and Sustainable Silicon Valley, this year is recommended as the City of Sunnyvale’s baseline year. Since City of Sunnyvale currently monitors fuel use data on a fiscal year basis, FY90-91 was selected as the corresponding to calendar year 1990. Sustainable Silicon Valley allows municipalities to report fiscal year emissions, as long as this is done consistently from year to year.

1.2 Projected emissions

Although City of Sunnyvale has achieved significant emissions reductions since FY90-91, increases in natural gas consumption is predicted to reverse this trend. Landfill gas output is forecasted to diminish in the next five years, which means City of Sunnyvale will purchase more natural gas for the cogeneration facility to make up this difference. Figure 1-3 shows the forecasted CO₂ emissions levels, based on preliminary natural gas consumption data available for 2006.

Figure 1-3. Projected city emission trend (lbs CO₂)



City of Sunnyvale is projected to emit approximately 19,781,000 lbs of CO₂ in FY10-11 under a business as usual scenario. Table 1-1 displays how emissions in FY10-11 are expected to compare with the selected base year, as well as the emissions changes to date (FY05-06).

Table 1-1. Emissions change under business as usual (BAU)

Base year	FY05-06 change in emissions	Projected FY10-11 change in emissions
FY90-91	-17.1%	5.4%

1.3 Costs and carbon impacts of different levels of action

Prospective emissions reduction projects were identified through interviews with facility staff and review of recent facility audits. A wide range of projects were assessed, from T5 fixture retrofits to biodiesel to solar PV installations. These projects were evaluated on the basis of CO₂ emissions reduction potential, initial installed costs and payback period.

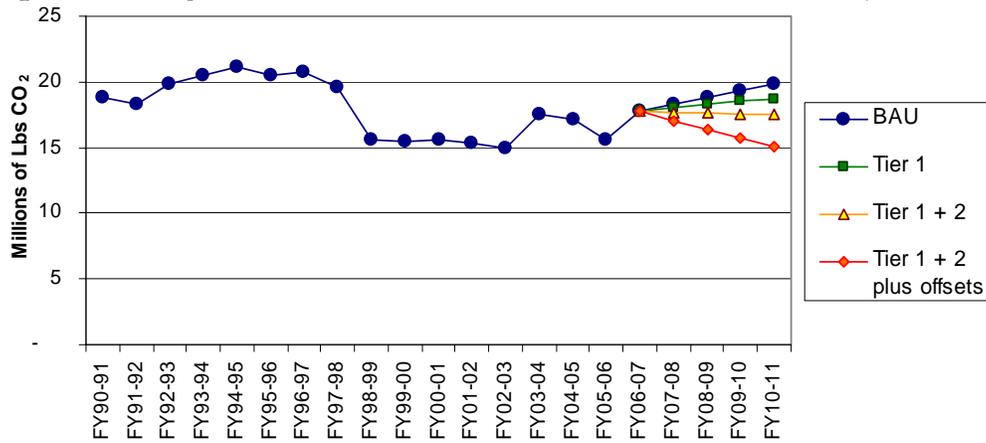
Projects were then grouped according to a low-hanging fruit approach, where Tier 1 projects were deemed to be most favorable, due to economic principles, community interest and momentum. All energy efficiency projects with less than a five year payback were included in this category. Tier 2 projects included additional energy efficiency retrofits with longer payback. Tier 3 projects were primarily carbon offset and off-site renewable energy purchases, such as green tags.

Table 1-2 demonstrates the cost and CO₂ impact of these different levels of action. Tier 1 projects are considered to be most economical, with the most “bang for the buck.” Tier 1 + 2 plus offsets provides insight on what the potential costs for meeting the recommended Sustainable Silicon Valley target of 20% below 1990 levels would be.

Table 1-2. Comparison of cost and carbon impact of different levels of action

FY10-11 scenario	Emissions reduction relative to FY90-91	Lbs of CO ₂ reduced from BAU scenario	Estimated incremental cost to city	Total simple payback
Business as usual (BAU)	5.4%	0	\$ 0	n/a
Tier 1 projects	- 0.1%	1,034,149	\$ 1,034,149	1.5 years
Tier 1 + 2 projects	- 6.8%	2,277,034	\$ 6,608,099	18.3 years
Tier 1 + 2 plus offsets	-20%	4,763,486	\$ 6,618,270	18.4 years

Figure 1-4. Projected emissions trend under different levels of action (lbs of CO₂)



In addition to current facility energy conservation projects, other large emissions reductions are achievable at City of Sunnyvale through such projects as solar PV installations, focused building optimization program, LED street lighting, and process efficiency at the WPCP. There are also many small, yet cost-effective, measures that can continue to be implemented in city buildings including vending misers, additional de-lamping and high performance T8 retrofits for the WPCP.

Based on these results, an emissions reduction goal of 5% below FY90-91 levels is considered reasonably ambitious, with returning to FY90-91 levels being a very achievable goal. Figure 1-4 above shows graphically how different levels of action are likely to affect future city emissions.

2. Introduction

The principle proponents for action to address climate change in the United States have been from state and local governments. California, the 12th largest emitter of greenhouse gases in the world, has adopted a goal of reducing its greenhouse gas emissions to 1990 levels by 2020, per legislation AB 32. The ramification of this legislation for cities is not yet clear, as the implementation plan is under development, but climate change is recognized as a serious environmental issue with potential Bay Area water level rise and ecosystem changes with unknown impacts.

At the municipal level, 514 Mayors from 50 states representing a total population of over 65million citizens committed to the U.S. Mayors Climate Protection Agreement.¹ Under the Agreement, participating cities agree to strive to meet or exceed the Kyoto Protocol goals of taking action in the city's operations and community. The City of Sunnyvale has no established policy on CO₂ emissions reductions so it is not currently listed as an official signatory. Upon completion of this project, much of the initial legwork has been accomplished to inventory historic and current CO₂ emissions in accordance with the U.S. Mayors Climate Protection Agreement.

At the local level, Sustainable Silicon Valley (SSV), a nonprofit organization sponsored by the California Environmental Protection Agency, the Silicon Valley Manufacturing Group and the Silicon Valley Environmental Partnership, identified CO₂ emissions reduction as the foremost environmental goal for the area. SSV was formed in 2001 and began in 2004 working with businesses and municipalities to reduce their CO₂ emissions. It provides educational and networking forums and offers recognition and encouragement to its partners.

SSV offers a default goal for its "pledging partners" to reduce their CO₂ emissions by 2010 to 20% below 1990 levels. Pledging partners, however, may choose the buildings and/or operations that they will measure, the baseline year and percentage reduction goal and goal year. SSV suggests that each pledging partner measure (at a minimum): electricity and natural gas usage from some or all of the organization's buildings, and gasoline and diesel usage of the organization's fleet.

Organizations that join SSV benefit from the support and publicity provided by SSV and from collaboration with colleagues working towards a common goal. SSV includes all pledging partners on its website and publishes an annual report that recognizes partners for their achievements. In July 2006, the City of Sunnyvale City Council directed staff to become a pledging partner of Sustainable Silicon Valley (SSV) and to:

1. Recommend a CO₂ emissions reduction goal
2. Recommend a baseline year for measuring CO₂ emissions
3. Return with a work plan for CO₂ emissions reduction projects and estimated budget for Council consideration.

As a pledging partner of SSV, City of Sunnyvale pays annual dues and makes a voluntary pledge to reduce CO₂ emissions and annually report the results. This report presents the results of City of Sunnyvale's historic CO₂ emissions trend analysis and assessment of reduction opportunities within city government. Consultant recommendations related to CO₂ emissions reduction target, baseline year and attractive mitigation projects are presented.

¹ U.S. Mayors Climate Protection Agreement. <http://www.seattle.gov/mayor/climate/quotes.htm#mayors>

3. Sunnyvale CO₂ emissions inventory

One of the first steps to addressing climate change at the municipal level is to understand the range and magnitude of emissions sources associated with city operations. As a pledging partner of the Sustainable Silicon Valley, City of Sunnyvale has committed to quantifying and reporting its CO₂ emissions annually using the SSV online reporting tool. This chapter examines the relative significance of various city emissions sources to assess which groupings of facilities should continue to be included in future city emissions reporting. The analysis also evaluates the percentage change in city CO₂ emissions against different baseline years.

3.1 Historic emissions

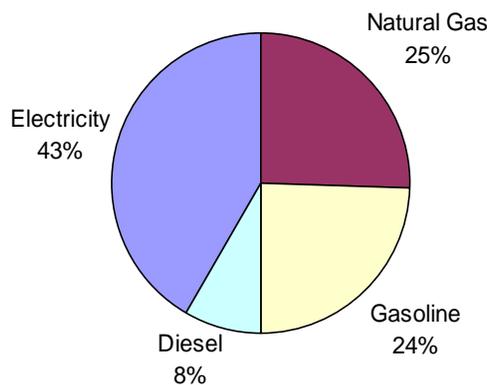
For scoping purposes, city staff decided to inventory CO₂ emissions related to three main areas of City operations: 15 building facilities, fleet vehicles, and traffic/street lighting. To ensure consistency with the Sustainable Silicon Valley (SSV) greenhouse gas goals, the emissions factors used in this report and displayed in Table 3-1 are consistent with the SSV online reporting tool.²

Table 3-1. CO₂ conversion factors

Fuel Type	Emissions factor
Natural Gas	11.64 lbs CO ₂ per therm
Electricity	0.57 lbs CO ₂ per kWh
Gasoline	19.43 lbs CO ₂ per gallon
Diesel	21.05 lbs CO ₂ per gallon

In fiscal year 2005-2006, electricity use contributed the largest percentage of emissions by fuel type, at 43% of city emissions. Figure 3-1 shows the relative contribution of other fuel types to the total city inventory. Natural gas, mostly related to building use, and gasoline consumed in fleet vehicles each contributed roughly a quarter of city emissions. Diesel constituted the smallest percent, at 8%.

Figure 3-1. Emissions contribution to total city emissions, by fuel type (FY05-06)



² The emissions factors are listed in the Sustainable Silicon Valley “CO₂ Emissions Reduction Reporting Tool,” which allows SSV Pledging Partners to report annual energy use. http://cf.valleywater.org/_ssv/

The results of City of Sunnyvale’s historic emissions trend reflect staff commitment to energy efficiency and resource conservation. Figure 3-2 shows the individual emissions trend of each emissions source category related to city operations, with the total city emissions trend shown as a solid line. Table 3-2 displays the total annual emissions since FY90-91.

Figure 3-2. Total City of Sunnyvale historic emissions from all emissions source categories (lbs of CO₂)

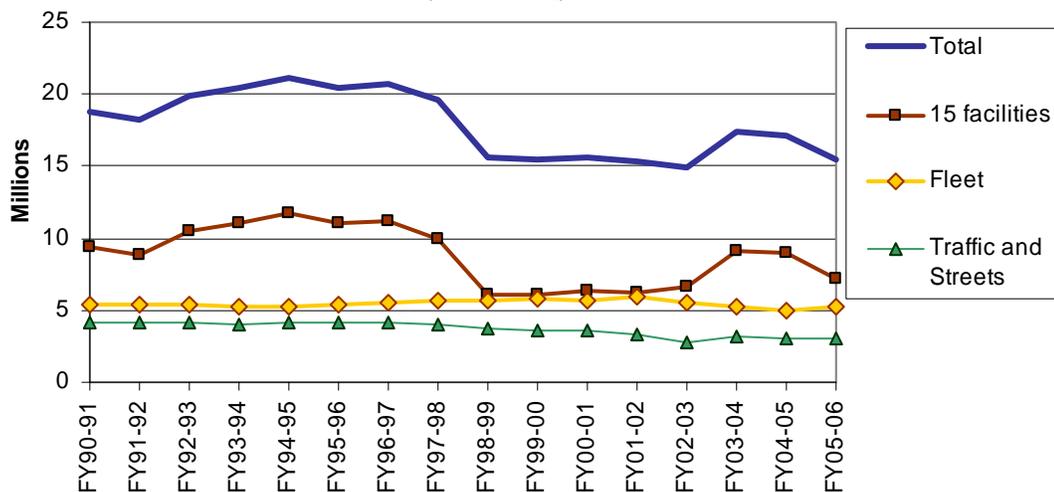


Table 3-2. Total City of Sunnyvale historic emissions
(1 metric tonne is equivalent to 2200 lbs)

	Total city emissions (lbs of CO ₂)	Total city emissions (metric tonnes CO ₂)
FY90-91	18,771,925	8,533
FY91-92	18,243,338	8,292
FY92-93	19,897,196	9,044
FY93-94	20,426,740	9,285
FY94-95	21,193,561	9,633
FY95-96	20,491,494	9,314
FY96-97	20,747,539	9,431
FY97-98	19,598,972	8,909
FY98-99	15,575,061	7,080
FY99-00	15,480,490	7,037
FY00-01	15,556,804	7,071
FY01-02	15,325,792	6,966
FY02-03	14,953,037	6,797
FY03-04	17,521,781	7,964
FY04-05	17,146,421	7,794
FY05-06	15,553,079	7,070

The total CO₂ emissions profile related to City operations is driven by emissions from 15 building facilities. The fifteen city facilities are shown to have significantly fluctuating CO₂ emissions from year to year, primarily due to swings in fuel consumption at the Water Pollution Control Plant (WPCP). Fleet

emissions are estimated to have remained relatively constant, with a small increase around the 2001-2002 timeframe. The combined emissions from traffic signal and streetlight operations have steadily decreased in the past sixteen years, due to LED retrofits of traffic signals. In FY2005-2006, the three emissions sources contributed the following percentages of total city emissions: all 15 facilities were 46%, fleet accounted for 34% and traffic and street lighting were 20%.

The significant fluctuation in emissions from 1990 to 2006 means that the selection of base year makes a big difference in the perceived change in emissions. The following years are selected for purposes of analysis:

- FY 90-91. The year 1990 is the Sustainable Silicon Valley recommended base year. It is also the base year for Kyoto Protocol and California’s AB 32 goal.
- FY 94-95. This is the peak year of City of Sunnyvale emissions
- FY 00-01. The year 2000 is the base year for Governor Schwarzenegger’s Executive Order S-3-05 goal for year 2010.³

Table 3-3 shows the percent change in total city emissions related to the selection of the three different base years. The results indicate that City of Sunnyvale has already significantly reduced emissions since FY90-91, but has maintained a relatively steady greenhouse gas emissions rate since FY00-01.

Table 3-3. Change in total city carbon dioxide emissions over time

Base year	FY05-06 change in emissions	Reason for base year selection for analysis
FY90-91	-17.1%	Kyoto Protocol, CA AB32
FY94-95	-26.6%	Peak year of city emissions
FY00-01	0.0%	Governor’s executive order

Sustainable Silicon Valley allows its pledging partners to normalize its emissions, also known as emissions intensity. Based on information provided by city staff, overall emissions were normalized to population size and operating budget (Figure 3-3 and Figure 3-4) to assess city emission trends against other city trends.⁴

The emissions intensity related to operating budget and population growth have both steadily decreased. These metrics demonstrate that City of Sunnyvale has been able to provide additional services to an increasing population without a corresponding proportional increase in CO₂ emissions.

³ On June 1, 2005, Governor Schwarzenegger signed Executive Order S-3-05 which calls for GHG reductions to 2000 levels by 2010; a reduction of GHG levels to 1990 levels by 2020; and a reduction of GHG emissions to 80% below 1990 levels by 2050. This Executive Order was superseded by the AB 32 California Global Warming Solutions Act of 2006, on September 27, 2006.

⁴ See Appendix A for Sustainable Silicon Valley Reporting Protocols.

Figure 3-3. Emissions intensity by city operating budget \$

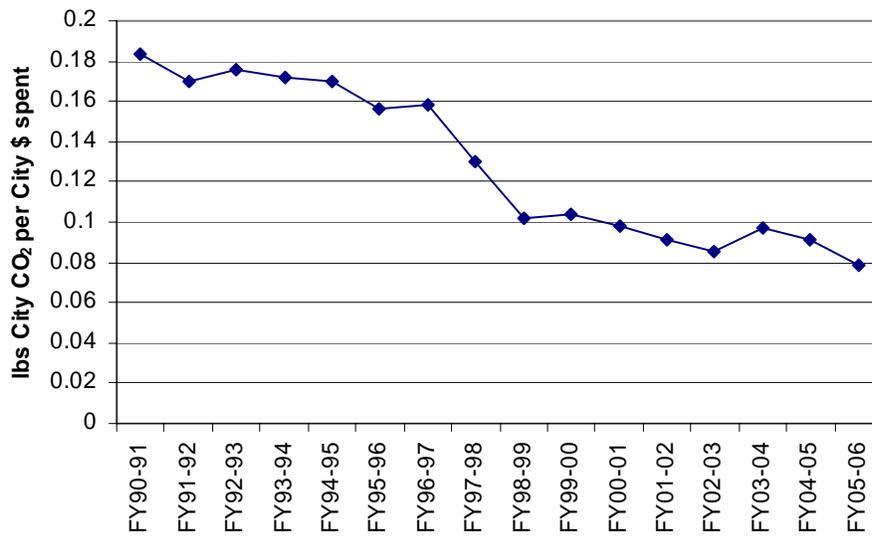
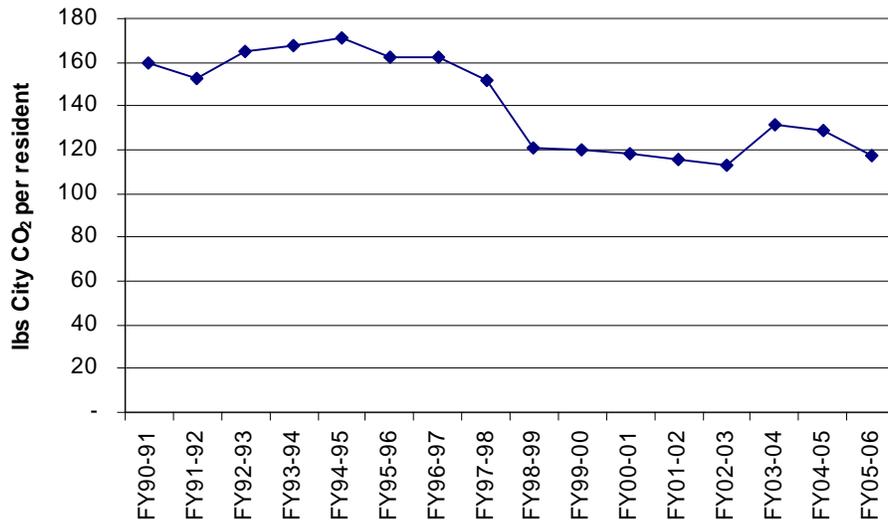


Figure 3-4. Emissions intensity by population



The following sections examine each of the three main emission categories more closely and describe the methodology for calculating CO₂ emissions.

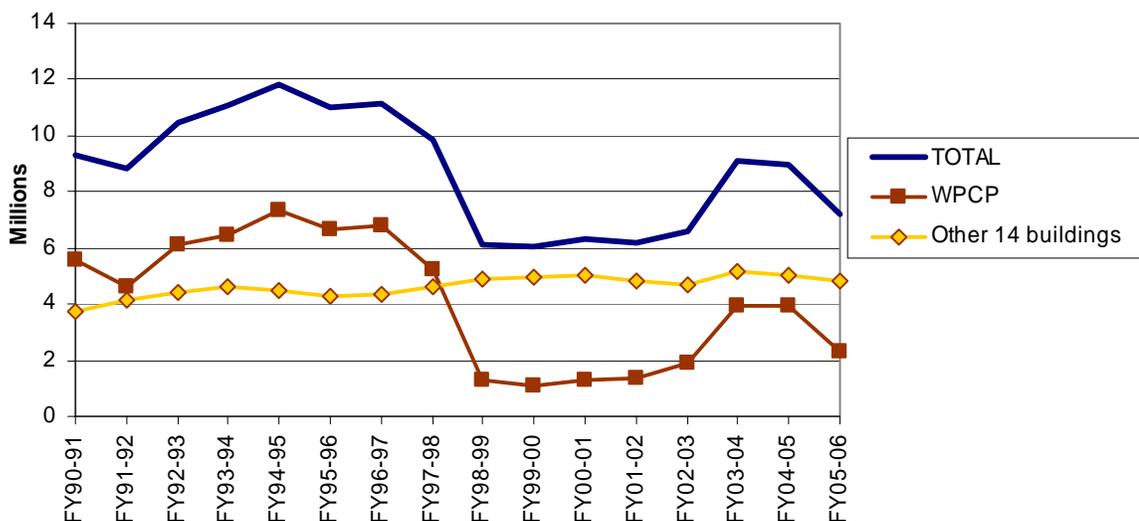
3.1.1 15 city facilities

Almost half of total city CO₂ emissions were related to fifteen city facilities included in the inventory. Although the city owns and operates more than fifteen building facilities within city limits, the facilities below were selected by staff as the main city facilities of interest. Monthly electricity and natural gas consumption data provided by PG&E were aggregated on a fiscal year basis, July through June. The Water Pollution Control Plant (WPCP) was the only facility whose energy data was provided on a

calendar year basis, which was then assigned to fiscal years (e.g. 1990 calendar year data was attributed to FY1990-1991).⁵

CO₂ emissions related to WPCP on-site processes were on the same order of magnitude as all other 14 building facilities combined. Figure 3-5 shows how the shape of WPCP emissions trend, with exported electricity emissions netted out, drives the overall CO₂ emissions trend related to all 15 facilities from FY1990-2006. While other city buildings aggregated together have a small, but steady increase in CO₂ emissions since 1990, the WPCP facility has significant variation from year to year.

Figure 3-5. Historic CO₂ emissions trend for 15 city facilities



Much of the observable variation in WPCP CO₂ emissions from year to year is due to the plant’s cogeneration installations. In 1997, the City began using a portion of the landfill gas (LFG) from the Sunnyvale Landfill (which closed in 1993) to generate heat and power for on-site processes. From 1997 to 1992 this mode of operation reduced, but did not eliminate, routine purchases of electricity from PG&E. Since LFG as a biogenic gas was now displacing fossil fuel-based electricity and natural gas, the city reduced its CO₂ emissions related to WPCP operations.⁶

In 2002, the City began using the entire LFG stream plus a portion of the digester gas produced at the WPCP, supplementing the fuel with purchased natural gas to eliminate routine purchases of electricity from PG&E and to begin exporting electricity. The observable drop in electricity purchased in 2003 corresponds with an increase in natural gas purchased in that same year. Subsequent changes in the

⁵ FY90-91 was the earliest fiscal year data provided by PG&E. Therefore, calendar year 1990 (rather than half calendar year 1990 and half calendar year 1991) was selected to correspond to this fiscal year, in order to correlate with Kyoto Protocol and California AB 32 calendar year reporting requirements. This was mutually agreed upon during the kick-off meeting.

⁶ The carbon content of landfill and digester gas is due to organic decomposition of “recently sequestered” carbon. Therefore, when the carbon is combusted and released back into the atmosphere, it is not considered additional atmospheric carbon (compared to fossil fuel carbon, which has been sequestered for millennia). The CO₂ will be reabsorbed and sequestered during the next crop of biomass. Consistent with the Intergovernmental Panel on Climate Change, World Resources Institute and U.S. EPA Climate Leaders, the CO₂ from landfill gas combustion is not included in the city inventory of anthropogenic CO₂ emissions.

amount of natural gas purchased correlate to changes in how the PGF is managed in response to air quality emissions requirements and changes in the prices of natural gas and electricity. Recent improvements to the engine control systems allow the engine-generators to meet emissions requirements in a wider range of operating conditions. At the present time, the PGF is being operated so as to provide (and export to the grid) a “buffer” of 100 kW over the load required to power the WPCP.

Because the Sunnyvale Landfill has not accepted any new garbage for over 13 years, the anaerobic organisms that convert the garbage to methane are gradually running out of food to “eat.” In the long term, WPCP consumption of natural gas is expected to increase at the same rate that landfill gas production declines. Based on the rate of decline from 2000-2005, this factor is expected to increase annual WPCP natural gas purchases by approximately 17,500 million Btu (175,000 therms) in 2010 compared to 2005. This equates to emissions of an additional 2,037,000 pounds of CO₂ per year in 2010 to replace the declining flow of biogenic gas from the landfill.

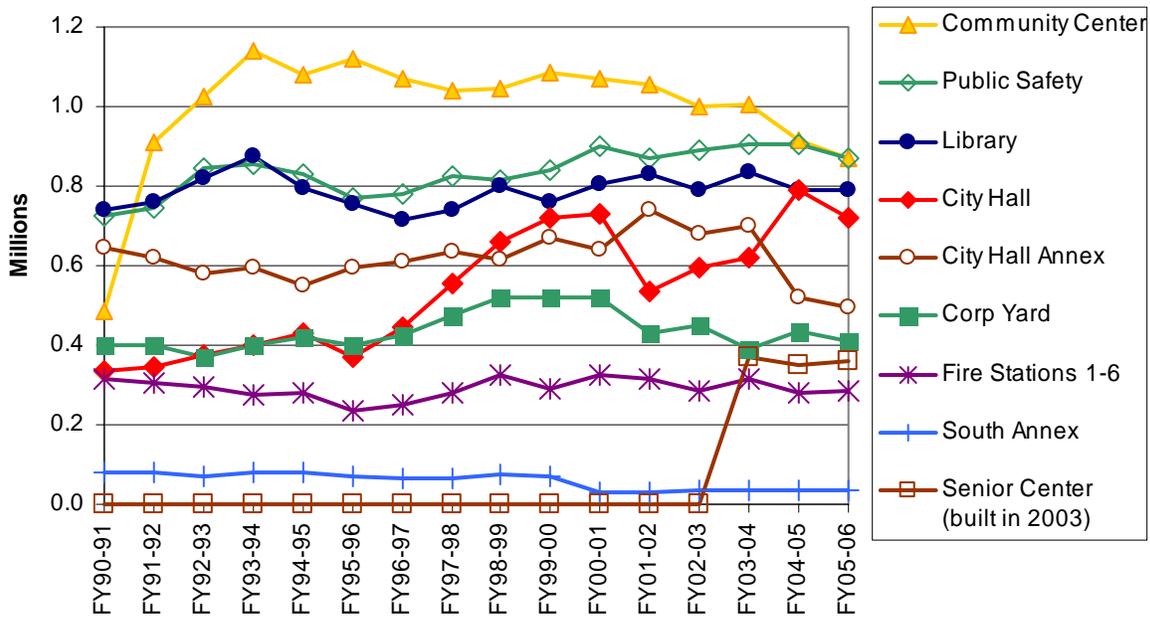
Apart from the WPCP, Figure 3-6 shows the emissions trends related to each of the other 14 building facilities. Although the overall CO₂ emissions trend is steadily increasing from 1990 (as seen in the previous graph), some of the individual building trends are quite dissimilar from each other. The CO₂ emissions trends fall into three general categories:

- *Generally flat* – Emissions related to some facilities have mostly remained the same (Public Safety, Library, Fire Stations 1-6, Corp Yard, Community Center, Senior Center).
- *Decreasing* – Other facilities have decreased their CO₂ emissions since 1990 (South Annex, City Hall Annex).
- *Increasing* – Only one facility, City Hall, has experienced a significant increase in energy consumption and thus, CO₂ emissions, since 1990.

The emissions related to the 14 facilities appear to have increased due to the addition of the Senior Center in 2002, and increased emissions from City Hall. The emissions trends for the different facilities show annual fluctuations, presumably due to weather impacts on electricity and natural gas consumption. HVAC replacement projects for City Hall (completed in 2000) and City Hall Annex (completed in 2004) appear to have had a demonstrable impact on the CO₂ emissions trends for those facilities.⁷

⁷ See Appendix C for detailed examination of each of the 15 facilities

Figure 3-6. Historic CO₂ emissions trend for 14 city facilities, excluding the WPCP (lbs CO₂)



The underlying data for City Hall indicates that both electricity and natural gas use dropped significantly in FY01-02. This is most likely due to the HVAC retrofit completed around year 2000. In recent years, however, the energy consumption has increased substantially, suggesting that a building tune-up may be due for City Hall to ensure that the system is operating according to the original design.

City Hall Annex also shows an appreciable drop in CO₂ emissions around the time of its HVAC retrofit in 2004. The energy conservation effects of this retrofit appear to have been maintained and the CO₂ emissions from City Hall Annex continued to drop in FY05-06. In the future, the CO₂ emissions related to the Library is also expected to decrease since its HVAC system was replaced in 2006, and the contractor recently performed a tune-up of the system in early 2007. The low amount of CO₂ emissions for the Community Center in FY90-91 are related to the complete closure of that facility for a major renovation project.

A few data quality issues were encountered while compiling the CO₂ inventory related to the 14 facilities. Two facilities had missing data for some months, but this was resolved by using an average of the prior year and next year’s energy use for those months. The missing months were in the 2000 and 2001 time frame for the Library (natural gas) and Community Center (electricity).

Overall, Table 3-4 lists the 15 facilities in order of CO₂ emissions contributions in FY05-06 from largest to smallest. In FY2005-2006, WPCP emissions accounted for a third of CO₂ emissions associated with city facility operations. For the purposes of the city CO₂ inventory, WPCP emissions related to exported electricity were excluded.

Table 3-4. Comparison of CO₂ emissions contributions of all 15 facilities

	FY05-06 (lbs CO₂)	Percent of Total
WPCP	2,357,625	33%
Public Safety	872,356	12%
Community Center	871,945	12%
Library	788,206	11%
City Hall	719,476	10%
City Hall Annex	494,725	7%
Corporate Yard	410,194	6%
Senior Center	361,246	5%
Fire Station 2	88,023	1%
Fire Station 6	49,002	1%
Fire Station 1	46,779	1%
Fire Station 3	39,186	1%
South Annex	33,972	0%
Fire Station 4	32,839	0%
Fire Station 5	30,774	0%
TOTAL	7,173,758	100%

Table 3-5 compares the change in CO₂ emissions from three possible baseline years for three groupings of city facilities. While the emissions trend from WPCP is quite different from the rest of the city facilities, the size of its emissions contribution affects the overall facility trend significantly.

Table 3-5. Change in CO₂ emissions from city facilities

Base year	FY05-06 change in emissions		
	All 15 facilities	5 largest facilities	14 facilities w/o WPCP
FY90-91	-22.9%	-28.9%	29.7%
FY94-95	-39.0%	-46.4%	8.5%
FY00-01	13.4%	16.1%	-3.7%

3.1.2 City fleet

Carbon dioxide emissions related to fleet operations were the second largest source of city emissions. In FY2005-2006, the city owned and operated 534 fleet vehicles.⁸ Gasoline and diesel consumption data was provided by Edith Alanis, fleet senior office assistant, and was only available from FY2000-2001 onwards. Fleet natural gas consumption data was provided by PG&E on a monthly basis and aggregated on a fiscal year basis.

⁸ Per email from Tony Vargas, Fleet Manager. 1-10-07.

For comparison purposes with other city emission sources spanning back to FY1990-1991, gasoline and diesel consumption related to fleet operations was estimated for the missing years from 1990 to 2000. City provided fleet size data for prior years back to FY90-91, which was used to extrapolate historic gasoline and diesel use by multiplying each year’s fleet size by the average fuel consumption/vehicle from FY00-06.⁹ Figure 3-7 shows the results of the extrapolation and the overall estimated fleet CO₂ emissions trend. Gasoline consumption is the dominant source of fleet emissions, as shown in Table 3-6.

Figure 3-7. Historic CO₂ emissions trend for city fleet (lbs CO₂)

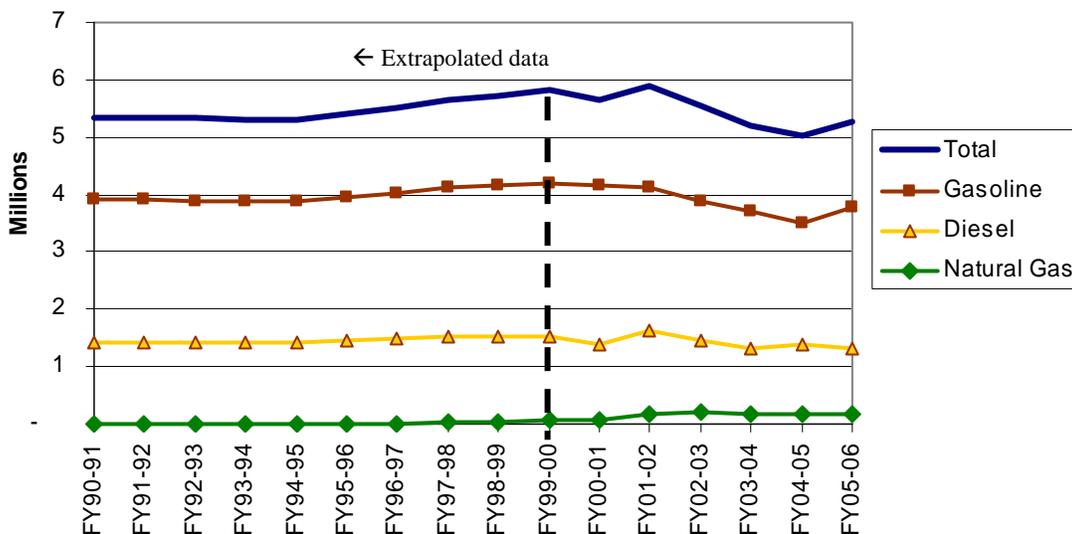


Table 3-6. Comparison of CO₂ emissions contributions of fleet fuel use

	FY05-06 (lbs CO ₂)	Percent of Total
Gasoline	3,788,539	72%
Diesel	1,317,267	25%
Natural gas	178,744	3%

Largely due to city efforts to reduce fleet size starting around 2001 and associated staff and budget reductions (Figure 3-8), total emissions related to fleet operations have decreased in the last the last five years. Gasoline consumption is observed to have dipped in FY04-05 with substantially increased levels in FY05-06. It is unclear what accounts for the recent apparent increase in gasoline use, including whether this data point is an anomaly or part of a trend. Diesel consumption is estimated to have remained relatively steady, with a slight observable bump in FY01-02. Natural gas remains a small portion of fleet fuel use, with minimal consumption recorded since FY97-98. Table 3-7 shows a comparison of percentage change in total fleet emissions compared to three possible baseline years.

⁹ This calculation was also performed by using the fuel consumption/fleet vehicle average of FY00-01 alone, but using the fuel consumption/fleet vehicle average of FY00-06 turned out to be the more conservative approach (i.e. average fuel consumption/vehicle FY00-06 was greater than average fuel consumption/fleet vehicle FY00 alone).

Figure 3-8. Fleet size from FY90-91 through FY05-06

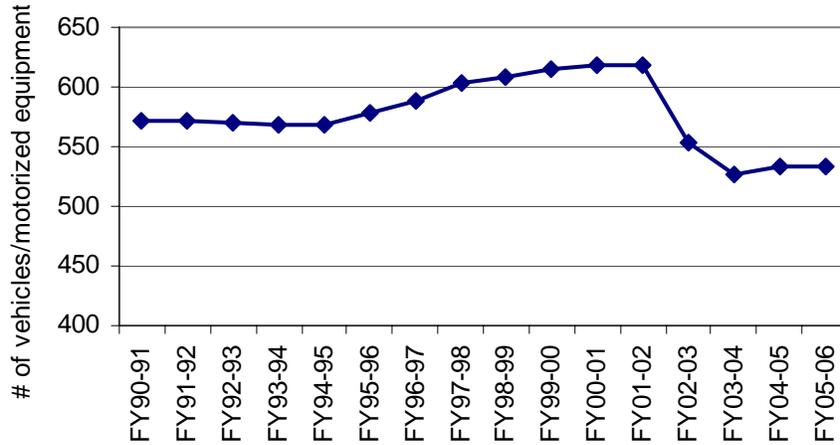


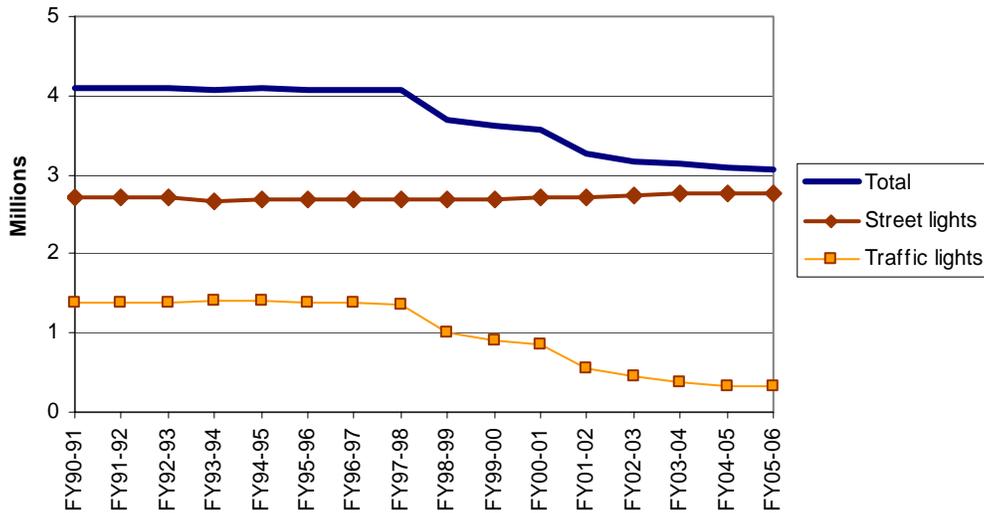
Table 3-7. Change in estimated CO₂ emissions from city fleet

Base year	Estimated FY05-06 change in emissions
FY90-91	-1.2%
FY94-95	-0.4%
FY00-01	-6.3%

3.1.3 City-owned street lights and traffic signals

Electricity use for city street lights and traffic signals is the third category of emissions examined as part of this study and accounts for 18% of total municipal emissions in FY05-06. Figure 3-9 shows the historic emissions trends associated with traffic and streetlights from FY1990-2006. All traffic signal and street lighting electricity use data was provided by PG&E on a calendar year basis. Therefore, the data presented below was allocated from calendar year to fiscal year (e.g. 1990 data was allocated to FY90-91).

Figure 3-9. Historic CO₂ emissions trend for city traffic signals and street lights (lbs of CO₂)



Most traffic signal electricity consumption data was missing for calendar years 1990 and 1991. Since traffic signal energy use is very steady for years 1992 through 1997, the 1990 and 1991 data was revised to equal the kWh consumed in 1992 for traffic signals.

Starting in 1998, the city began to retrofit all traffic signals with energy efficient light-emitting diode (LED) technology. The energy savings associated with the LED retrofits is clearly visible in the graph, shown by the steady decrease in CO₂ emissions starting in FY1997-1998 and again in FY00-01. In addition to traffic signals, all pedestrian walk/don't walk signals were also converted to LEDs. Table 3-8 shows the overall percent change in emissions related to traffic signals and streetlights against the different possible base years.

Table 3-8. Change in CO₂ emissions from city traffic signals and street lights

Base year	FY05-06 change in emissions
FY90-91	-24.9% (estimated)
FY94-95	-24.8%
FY00-01	-13.9%

3.2 Projected emissions

City of Sunnyvale's CO₂ emissions are projected for the future years leading up to FY10-11, which is assumed to be the equivalent to a calendar 2010 target year. In general, WPCP natural gas consumption has a large impact on overall City emissions and is the largest source of uncertainty related to the projected emissions trend. The projected increase in emissions is primarily due to expected increases in natural gas consumption at WPCP, due to decreased landfill gas production. Based on the rate of landfill gas decline from 2000-2005, this factor is expected to increase annual WPCP natural gas purchases by approximately 17,500 million Btu (175,000 therms) in 2010 compared to 2005. This equates to emissions

of an additional 2,037,000 pounds of CO₂ per year in 2010 to replace the declining flow of biogenic gas from the landfill.

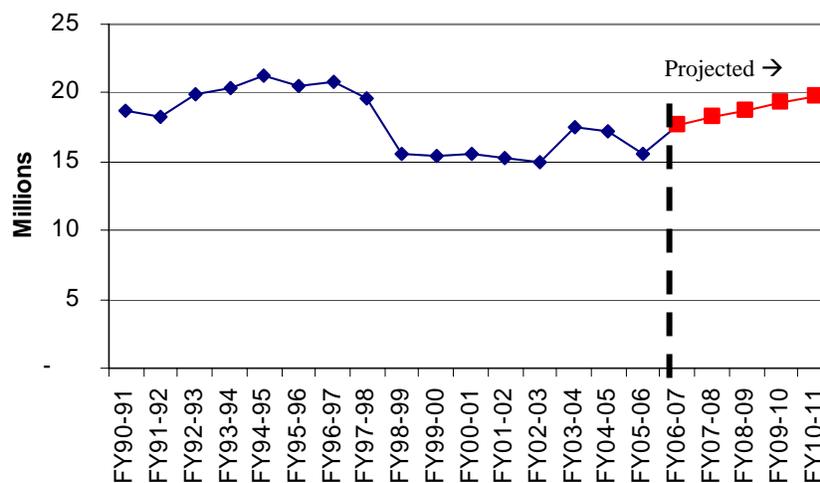
Emissions related to most city operations are expected to remain relatively flat from 2006 through 2010 due to normal operations related to energy efficiency and conservation efforts, including the following activities being undertaken by city staff:

- Library – HVAC replacement completed in late 2006
- Public Safety building – HVAC replacement to be completed in 2007-2008
- City Hall – New energy management system (EMS) to be completed in 2007-2008
- City Hall – Convert multi-zone (constant volume) HVAC system to variable air volume
- Community Center – Scheduled roof replacement will include cool roof application
- City-wide computer monitor replacement of CRT with higher efficiency flat panel LCD

Furthermore, there are no expected changes in square footage of city facilities, fleet size or general number of street lights and traffic signals. Therefore, it appears reasonable that emissions may remain more or less constant for the next four to five years related to City facilities, fleet operations and traffic infrastructure, with the exception of the increased WPCP natural gas purchases discussed previously.

Figure 3-10 shows the forecasted CO₂ emissions levels, in comparison with the historic trend.

Figure 3-10. Projected city emission trend (lbs CO₂)



Based on continued staff commitment to energy efficiency and environmental stewardship, City of Sunnyvale is projected to emit approximately 19,781,000 lbs of CO₂ in FY10-11 under a business as usual scenario. Table 3-9 displays how this amount compares to several potential baseline years.

Table 3-9. Projected emissions change under business as usual (BAU)

Base year	FY10-11 change in emissions
FY90-91	5.4%
FY94-95	-6.7%
FY00-01	27.2%

City of Sunnyvale has shown remarkable success in reducing energy use during the 1998 through 2005 time frame, but city-wide CO₂ emissions have begun to increase again in recent years. For a target year of 2010 (FY10-11), it is estimated that city emissions may be 27.2% above year 2000 levels, while remaining 5% below 1990 levels. The following chapters in this report will examine how city staff may take actions to reverse the recent increase in CO₂ emissions.

4. Potential CO₂ emissions reduction projects

There is a wide variety of CO₂ emissions reduction options available to municipalities wishing to reduce their climate footprints. The three main strategies for all emissions sources include energy efficiency, renewable energy and purchasing emissions offsets. This chapter will discuss the types of options available for each category of emissions and offer some cost-benefit analysis for evaluating different approaches. All calculations in this section are approximations, and actual costs and savings may differ. Best available information was used for estimating future energy costs, current PG&E rebate levels and achievable energy savings.

The assumed cost of electricity and natural gas is based on the previous two years of billing data received from PG&E.¹⁰

- Electricity rates for the past two years ranged from an average \$0.116/kWh (Public Safety) to \$0.162/kWh (South Annex). Therefore, an average rate of \$0.14/kWh was used to estimate cost savings per kWh saved. This is a somewhat conservative value, as electricity rates will likely escalate in future years.¹¹
- Natural gas rates for the past two years ranged from an average \$1.16/therm (Public Safety) to \$1.32/therm (City Hall). Therefore, an average rate of \$1.20/therm was used to estimate cost savings per therm saved.

In general, project costs are estimated from PG&E audit reports, California Energy Commission DEER database and City of Sunnyvale staff interviews. PG&E rebates that are currently available were included in project cost estimations.

4.1 15 City facilities

This section focuses on on-site projects at Sunnyvale facilities related to efficiency/conservation and renewable energy. City staff has shown a commendable commitment to energy efficiency and smart energy management practices. The new Senior Center solar panels and WPCP landfill gas cogeneration plant are projects that significantly reduce the use of fossil-fuel based energy. A few additional energy efficiency and renewable energy projects are assessed below based upon PG&E and ABAG facility audits and other on-going city initiatives.

Energy efficiency

In general, WPCP natural gas consumption is a significant source of city facility emissions. The City has already significantly reduced CO₂ emissions at the WPCP with the installation of the cogeneration facility that uses mainly landfill gas and digester gas. Since the WPCP constitutes such a large portion of the city's CO₂ inventory, further efforts to reduce energy use at the plant can yield large emissions reductions. Based on data from the Wastewater Treatment Plants Improvement Program (WTPIP) implemented in 2002-2004 by PG&E and Southern California Edison (SCE), the average plant was able to reduce its

¹⁰ Total costs \$ (including tax and demand charges for previous two years) were divided by total kWh or therms to calculate the average cost per facility.

¹¹ PG&E electricity rates have increased an average of 2.3% each year since 1990. Source: California Energy Commission website http://www.energy.ca.gov/electricity/weighted_avg_retail_prices.html

electricity consumption by 344,896 kWh/year by implementing process efficiency improvements.¹² The 2002-2004 program had five wastewater treatment plant participants, with average daily flows ranging from four to 72 million gallons per day (MGD). PG&E is currently running a Wastewater Process Efficiency Initiative (WPEI) to provide cash incentives to offset the cost of implementing energy saving investments.¹³ In general, these programs look for efficiency opportunities related to pumps, compressed air systems, premium motors, reducing the need for pumping related to the auxiliary water system and examining how controls are set up, including wet well levels. City of Sunnyvale may wish to continue to implement targeted efforts to improve process efficiency at the WPCP.

Table 4-1 below shows the energy savings and cost data for potential energy efficiency projects that have been identified for the 15 city facilities, based on facility energy audits, benchmarking studies and interviews with facility engineers. According to Energy Solutions and the ABAG Energy Watch program, some City building facilities consume more energy per square foot than other comparable facilities in the Bay Area.¹⁴ Based on this study, KEMA has identified ten City facilities as having potential for building optimization, including City Hall, Library, Community Center, Public Safety, City Hall Annex, Corporation Yard, Senior Center, and Fire Stations 1, 2 and 6. Building optimization includes a traditional audit, targeted functional testing of equipment and recommendations for additional low cost or no cost measures.

KEMA's cost and savings estimates related to Building Optimization are based on the Nevada Building Optimization program 2004 and 2005 results. Many highly cost-effective measures were identified at participating facilities, including no cost measures such as adjusting economizers which had been found to be stuck open. The Nevada Building Optimization program realized average no cost or low cost electricity savings of 2.47 and 1.36 kWh/square foot in 2006 and 2005. KEMA estimates that a similar study could be conducted for City of Sunnyvale at a cost of \$76,000.

Additional energy efficiency projects listed in the table below are based on PG&E and ABAG facility audits. Unless otherwise noted, costs were estimated using the Database for Energy Efficient Resources (DEER) database. DEER is a California Energy Commission and California Public Utilities Commission (CPUC) sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source. DEER project cost and energy savings values are commonly used for energy efficiency program planning purposes and is updated frequently. Costs used below are full cost of the project, including installation costs.

In response to City of Sunnyvale staff comments, an additional column was added to the table to reflect Sunnyvale estimated project costs for the identified measures. These project costs were provided by facilities staff based on previous project experience. In some cases, Sunnyvale estimated costs are very similar to the DEER estimated costs, but this is not true for all measures.

See Appendix B for a detailed assessment of each facility and data sources used for the DEER analysis.

¹² Final Evaluation Report "Energy Efficient Local Government Program: 2003 Evaluation Report" by Quantec

¹³ Visit the program website at <http://websafe.kemainc.com/projectcenter/wpei>

¹⁴ See Appendix F, for Energy Solutions benchmarking study (1/12/07) performed under Association of Bay Area Governments Energy Watch program. The benchmarking is originally developed to inform the prioritization of facilities for energy efficiency projects.

Table 4-1. Potential energy efficiency projects in building facilities

Building facility	Project description	Annual electricity savings	Annual natural gas savings	Annual CO ₂ benefit	Annual PG&E bill savings	DEER estimated project cost	Sunnyvale estimated cost
		(kWh)	(therms)	(lbs)	(\$)	(\$)	(\$)
All facilities	Vending misers (12)	19,344		11,026	\$ 2,708	\$ - ¹⁵	\$ -
10 facilities	Building optimization	595,419		339,389	\$ 83,359	\$ 76,000 ¹⁶	\$ 76,000
City Annex	VFD on HVAC fan motors (30 hp fan)	29,340		16,724	\$ 4,108	\$ 6,660	\$ 12,000
City Hall	VFD on VAV AHU (7.5 hp fan)	7,335		4,181	\$ 1,027	\$ 1,665	\$ 12,000
Community Center	Metal halide to T5 retrofit (6)	2,820		1,608	\$ 395	\$ 2,370	\$ 7,500
Corp Yard	Metal halide to T5 retrofit (6)	5,062		2,886	\$ 709	\$ 2,370	\$ 25,000
Fire stations 1-6	2 occupancy sensors	33,272		18,965	\$ 4,658	\$ 1,547	\$ 3,000
Fire stations 1-6	Insulate water heater pipes (54 feet)	-	108	1,257	\$ 130	\$ 54 ¹⁷	\$ 6,000
Fire stations 1-6	Double Pane Windows	1,250	197	3,005	\$ 411	\$ 24,708	\$ 25,000
Fire stations 1-6	Window with sunscreen	3,263		1,860	\$ 457	\$ 1,697	\$ 10,000
Library	VFD on AHU (20 hp fan)	19,560		11,149	\$ 2,738	\$ 4,440	\$ 12,000
WPCP	Process optimization	344,896		196,591	\$ 48,285	\$ 113,304 ¹⁸	\$ 113,304
WPCP	Lighting retrofit	131,361		4,179	\$ 12,248	\$ 14,028 ¹⁹	\$ 20,000
WPCP	Delamping	32,840		1,045	\$ 3,087	\$ -	\$ -

Renewable energy (solar photovoltaic)

At the present time, only solar photovoltaic (PV) technology is considered at City facilities. Other technologies such as wind energy, biomass or hydrogen fuel cells may be feasible in the future, but no studies for Sunnyvale have been provided. City staff recently met with a hydrogen fuel cell company located in Sunnyvale. Although the hydrogen fuel cell company claims its technology is “affordable,” no cost or payback data was available.

The Community Development Department’s Sustainable SUNNYvale Initiative is seeking funding to establish the City of Sunnyvale as a leader in solar energy installations. City Council has established new policy studies “Citywide Solar Energy Plan Including Solar Cell Parking Areas” and “Bringing Solar Power to City of Sunnyvale Buildings” as two of the top policy priorities for 2007. The Senior Center is already equipped with two sets of photovoltaic solar panels. Solar panels are also used to power a number of small, remotely located devices such as irrigation controllers and speed warning signs. SPG

¹⁵ Although DEER estimated project cost for Vending Miser is \$179 per unit, Julie Benabente provided email documentation that Cliff Kramer from Ecology Action could provide Vending Misers at no cost to the City.

¹⁶ This was a KEMA provided estimate.

¹⁷ This installed project cost was estimated at \$1.00/ft, based on Iowa Energy Center cost estimates per foot. <http://www.energy.iastate.edu/news/pr/pr-hotwater.html>

¹⁸ This project cost is estimated from actual projects implemented under the 2002-2004 Wastewater Treatment Plants Improvement Program (WTPIP).

¹⁹ This project estimate was provided by Energy Solutions, as part of the ABAG Energy Watch facility audit and recommendations.

Solar was contracted to provide a preliminary feasibility analysis for solar PV installations on other city facilities, including estimates on PV system size and cost.²⁰

State provided California Solar Initiative (CSI) rebate levels continue to decrease as more PV projects are being implemented. If City of Sunnyvale decides to advance its PV installation plans, staff should submit an application immediately to reserve funds. Municipalities have 12 months from the time of the CSI application to demonstrate progress towards installation of a PV system. In addition to the 12 months, there are two 90-day extensions available, which means that City of Sunnyvale can reserve CSI rebates at the current level and take up to 18 months to begin project work.²¹

In general, there are two main approaches to financing PV systems:

1. City-owned and operated PV system, where the city would bid the design/build PV systems to qualified contractors and purchase the system outright.
2. Third-party owned and leased to city, where a financing entity purchases the system and sells the electricity to the city under a long-term power purchase agreement (PPA).

The SPG Solar study states that third-party PPA's "are quite competitive for large >500 kW PV systems. For smaller systems, <100 kW, the administrative and financing costs often outweigh the added benefits afforded by the tax advantages and it most likely is a better value proposition for the public entity to just purchase the PV systems outright from a qualified PV contractor." SPG Solar recommended 18 and 35 kW systems for various City facilities. With an aggregate size of 442 kW, these systems may be an attractive third-party PPA project. Table 4-2 shows the recommended PV system sizes for City of Sunnyvale facilities and the costs related to city-owned and operated PV panels. The calculations below assume a \$0.14/kWh PG&E cost avoided. Without rebates, the payback period is on the range of 34 – 36 years. If the PG&E rate increases, then the payback period will be shorter (the SPG Solar Study assumed a PG&E rate cost of \$0.15/kWh).

Table 4-2. City-owned on-site solar PV

Building facility	Project description	Annual electricity savings	Annual CO ₂ benefit	Annual PG&E bill savings	Project cost	CSI rebate in Feb.2007	Simple payback without rebate/ with rebate
		(kWh)	(lbs)	(\$)		(\$)	(years)
City Hall	35 kW solar panel	50,778	28,943	\$ 7,109	\$ 245,000	\$ 125,000	35/17
City Hall Annex	35 kW solar panel	50,778	28,943	\$ 7,109	\$ 245,000	\$ 125,000	35/17
South Annex	18 kW solar panel	25,000	14,250	\$ 3,500	\$ 126,000	\$ 62,500	36/18
Public Safety	35 kW solar panel	50,778	28,943	\$ 7,109	\$ 245,000	\$ 125,000	35/17
Library	35 kW solar panel	50,778	28,943	\$ 7,109	\$ 245,000	\$ 125,000	35/17
Corp Yard	35 kW solar panel	50,778	28,943	\$ 7,109	\$ 245,000	\$ 125,000	35/17
	18 kW solar panel	25,000	14,250	\$ 3,500	\$ 126,000	\$ 62,500	36/18
Fire Stations	18 kW solar panels (6)	150,000	85,500	\$ 21,000	\$ 756,000	\$ 375,000	36/18

²⁰ See Appendix F for SPG Solar Feasibility Study (February 5, 2007)

²¹ For more information, visit the California Solar Initiative homepage: <http://www.gosolarcalifornia.ca.gov/>

Community Center	35 kW solar panels (3) 18 kW solar panel	50,778 25,000	28,943 14,250	\$ 7,109 \$ 3,500	\$ 245,000 \$ 126,000	\$ 125,000 \$ 62,500	35/17 36/18
TOTAL	442 kW solar PV system	884,336	504,336	\$ 123,807	\$ 3,094,500	\$1,562,500	35/17

If the city-owned and operated financing model is deemed too costly upfront or risky, then third-party financing companies can combine the systems to an aggregate 442 kW project. From the City’s point of view, this third-party owned and operated arrangement can be a very streamlined project, with electricity generated from the systems on different buildings being aggregated monthly and sold to the City at a uniform rate.

The initial contract rate for solar energy is often available at approximately the retail rate paid to PG&E, with a set annual escalator in price in the 4-5% range. Recent conversations with GreenLight Solar confirm that a rate equal to the current PG&E rate would be possible, with an escalator less than 4%. In the past 25 years, PG&E electricity rates have increased an average of 4.1% each year.²² The fixed price contract can serve as a hedge against future electricity price increases as California depends increasingly on natural gas as a “clean fuel” over coal. This agreement is generally for a 20 – 25 year period, with the third-party financier assuming all maintenance and operating costs, and insurance premiums.²³ The City only pays for the solar power generated; therefore, if the PV panels go off-line, then city facilities do not pay anything to the solar provider. Although these third-party financed PV projects are generally very cost-competitive with PG&E electric rates, KEMA assumes a \$0.01/kWh premium as a conservative estimate.

Table 4-3. Third-party owned on-site solar PV
(assume a solar rate of \$0.15/kWh compared with PG&E rate of \$0.14/kWh)

Building facility	Project description	Annual electricity savings	Annual CO ₂ benefit	Annual PG&E bill savings	Annual solar kWh payment	Annual difference
		(kWh)	(lbs)	(\$)	(\$)	(\$)
TOTAL	442 kW solar PV system	631,224	359,798	\$ 88,371	\$ 94,684	\$ 6,312

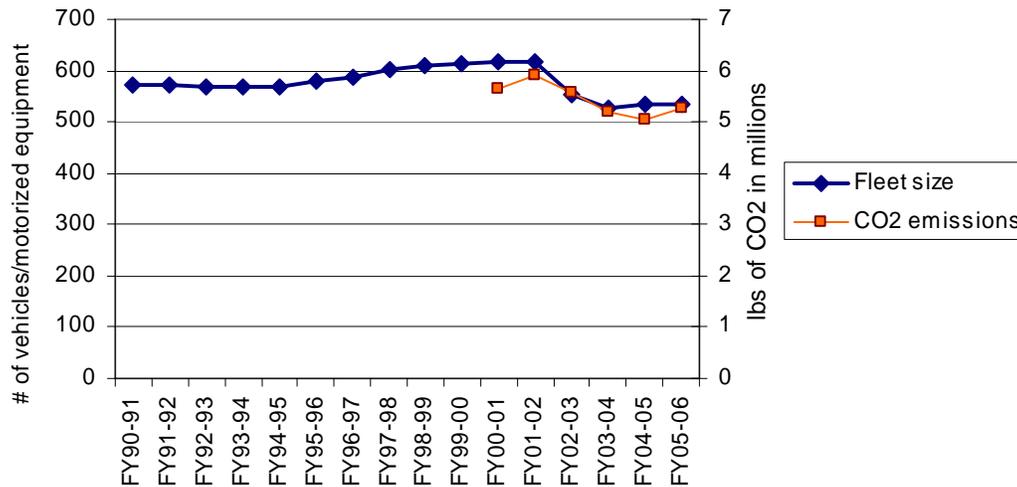
4.2 City fleet

Emissions from vehicle travel is a well-recognized source of anthropogenic CO₂. In FY05-06, fleet emissions were similar in magnitude to emissions from city facilities. Figure 4-1 shows the change in fleet size from FY90-91, compared with CO₂ emissions calculated for years for which we had data. During the years FY00-01 through FY05-06 for which there was both fuel use and fleet size data, the fuel use appeared to generally correlate with fleet size.

²² Source: California Energy Commission. http://www.energy.ca.gov/electricity/weighted_avg_retail_prices.html

²³ Per discussions with David Felix and Joseph Kastner, MMA Renewable Ventures, prices may range from \$0.14 - \$0.18/kWh, with a 4-5% escalator each year. A lower initial price may be possible with larger escalators in price in future years. Or, a slightly higher price now may enable a lower percent escalator for future years.

Figure 4-1. Historic change in fleet size



Similar to city building facilities, reducing CO₂ emissions related to fleet vehicles can be done through greater energy efficiency and renewable energy sources to displace fossil-fuel based energy.

Energy efficiency

Although fleet size reduction while meeting city needs has been shown to be highly effective since 2001, additional reductions in fleet size are expected to be difficult. Discussions with staff also indicate that policies to reduce vehicle miles traveled (VMT) may be challenging, with police vehicles and maintenance vehicles necessary to provide basic services to residents. Therefore, no projects to reduce fleet size or VMT are assessed at this time. Two realistic projects may be to promote the purchase of hybrid vehicle technology and set in place a replacement policy mandating new vehicles with higher miles per gallon efficiency.

Hybrid vehicles have a positive appearance and can be a visible demonstration of the City’s commitment to environmental stewardship. In this analysis, it is assumed that approximately 4 vehicles that are good candidates for hybrid vehicle replacement are retired each year. The costs summarized in Table 4-4 represent the incremental cost of purchasing 4 hybrid vehicles over conventional vehicles each year.

City of Sunnyvale may also consider a policy that mandates that each vehicle retired be replaced with a more fuel efficient model, or perhaps any new vehicle purchased should meet or exceed the current average city-wide fleet fuel efficiency. The table below assumes that 4 vehicles are replaced each year with new vehicles that are 2 mpg more efficient than the old vehicles. See Appendix C for the detailed savings calculation methodology and assumptions.

Table 4-4. Energy efficiency options for city fleet operations

Specific target	Project description	Annual gasoline saved (gallons)	Annual diesel saving (gallons)	Annual CO ₂ benefit (lbs)	Annual fuel savings (\$)	Initial project cost (\$)
Gasoline vehicles	4 vehicles hybrid vehicles	409		7948	\$ 1248	\$ 19,800
Gasoline vehicles	Replace vehicles only with more efficient models	76		1472	\$ 231	\$ -

Renewable energy

The City of Sunnyvale fleet manager has already begun evaluating the use of biodiesel in fleet vehicles. Biodiesel is an alternative fuel produced from renewable resources such as soybean, rapeseed or other oilseed crops. Biodiesel may be blended with petroleum diesel at any percentage to create a biodiesel blend that displaces fossil fuel use. Biodiesel works in any diesel engine with few or no modifications. The State of Minnesota is currently requiring all diesel in the state to contain 2% biodiesel (B2), while most of Europe already uses 5% biodiesel (B5) in all diesel.

In general, using biodiesel blends of 20% or lower has demonstrated significant environmental benefits with minimum increases in costs for fleet operations.²⁴ Many manufacturers, including Volkswagen and Chrysler, have approved 5% biodiesel blend (B5) to be used in their vehicles and offer corresponding warranty protection. The Sunnyvale fleet manager has begun a pilot demonstration of 5% biodiesel with a few fleet vehicles.

Upon successful implementation of the pilot program, City of Sunnyvale may consider using B5 (5% biodiesel, and 95% petroleum diesel) in place of regular 100% diesel in all fleet vehicles. The most likely problem or issue to arise is generally related to the solvent effect of biodiesel that releases deposits accumulated on tank walls and pipes from previous diesel fuel use. Therefore, fuel filters should be checked and changed more frequently during initial biodiesel use. Fleet manager Tony Vargas, indicates that the cost of B5 is currently the same as petroleum diesel per gallon, if not a few cents cheaper.

City of Sunnyvale may also consider using 20% biodiesel (B20), which is another common level of biodiesel blend. Cummins Engine Co., Inc. recently approved B20 biodiesel blends for use in its 2002 and later models. Use of B20 will enable City of Sunnyvale to reduce petroleum diesel consumption by 20%. Aside from some minimal expenses related to fuel filters and storage tanks (estimated at \$5000 in initial project costs for 100 units), B20 itself is expected to be price competitive with diesel fuel per gallon.

Table 4-5. Renewable energy projects for city fleet operations

Specific target	Project description	Annual gasoline saved	Annual diesel saving	Annual CO₂ benefit	Annual fuel savings	Initial project cost
		(gallons)	(gallons)	(lbs)	(\$)	(\$)
Diesel vehicles	5% biodiesel (B5)		3,115.74	65,586	\$ -	\$ 5000
Diesel vehicles	20% biodiesel (B20)		12,462.96	262,345	\$ -	\$ 5000

4.3 City-owned street lights and traffic signals

Electricity consumption related to 8862 City street lights is metered on 9 individual accounts.²⁵ According to Dennis Ng, Traffic Engineering, approximately 40% of street lighting is 200 watt high

²⁴ http://www.biodiesel.org/pdf_files/fuelfactsheets/CommonlyAsked.PDF

²⁵ Data received from Julie Benabente.

pressure sodium (HPS) lamps, 20% are 150 watt HPS, and 40% are 75 watt HPS. Using low pressure sodium lamps is one way to reduce energy consumption, but these lamps produce an undesirable yellow-tinted light that can raise safety and aesthetic concerns. Therefore, city staff is beginning to investigate light-emitting diode (LED) streetlights as an option to replace the current HPS technologies. Dennis Ng indicated that the new LED street lighting can reduce wattages as follows:

- 200 watt HPS, replaced with 125 watt LED
- 150 watt HPS, replaced with 75 watt LED
- 70 watt HPS, replaced with 48 watt LED

The LED retrofit would require replacing the entire head of each street light, to replace the HPS lamp and ballast. Each replacement is expected to cost approximately \$200 per street light for materials. Total cost for replacing all street lighting with LED fixtures would be \$6.20 million before PG&E rebates, with an average simple payback of 24.4 years. Dennis Ng estimates that PG&E would rebate approximately \$50 per unit, bringing total cost down to \$5.8 million for replacing all street lights. The average simple payback with PG&E rebate would be 22.7 years. In addition to energy savings, LEDs also last longer than conventional lighting technology and need only be replaced every five to twelve years, resulting in reduced maintenance costs, which have not been quantified here.

Table 4-6 summarizes the estimated costs and CO₂ emissions savings related to retrofitting all city street lights with LEDs. In addition to energy savings, LEDs also last longer than conventional lighting technology and need only be replaced every five to twelve years, resulting in reduced maintenance costs, which have not been quantified here.

Table 4-6. CO₂ emissions reduction potential for LED street lighting

Specific target	Project description	Annual electricity saved	Annual CO ₂ benefit	Annual PG&E bill savings	Initial project cost without rebate	Simple payback without rebate/with rebate
		(kWh)	(lbs)	(\$)	(\$)	(yrs)
All 200 watt HPS	Replace with 125 watt LED	1,196,370	681,931	\$ 167,492	\$ 3,190,320	19/18
All 150 watt HPS	Replace with 75 watt LED	265,860	151,540	\$ 37,220	\$ 620,340	17/15
All 70 watt HPS	Replace with 48 watt LED	350,935	200,033	\$ 49,131	\$ 2,392,740	49/45
TOTAL		1,813,165	1,033,504	\$ 253,843	\$ 6,203,400	24/23

All traffic signals in City of Sunnyvale are LED, as well as all pedestrian signals. Therefore, no additional energy conservation measures have been identified for traffic signals.

4.4 Other emissions reduction opportunities

In general, most of the CO₂ emissions reduction projects are being evaluated at the emission source level (city facilities, city fleet, and city traffic signals/street lights). Since CO₂ emissions have a climate change impact regardless of where they are emitted, City of Sunnyvale may also choose to invest in projects that occur beyond city boundaries. In this section, we assess three potential approaches to investing in emissions reductions occurring elsewhere, which City of Sunnyvale may then apply to its own CO₂ emissions footprint: PG&E ClimateSmart program, carbon offsets and renewable energy credits.

PG&E was recently approved by the California Public Utilities Commission to offer a voluntary program for its customers to reduce greenhouse gas emissions. The PG&E ClimateSmart program calculates the greenhouse gas emissions related to its electricity and natural gas products sold and purchases carbon

offsets on behalf of participating customers. The amount of carbon offsets purchased will match the customer’s actual energy usage. The projects that PG&E plans to invest in will be approved by the California Climate Action Registry and will be independently verified and audited. PG&E is targeting a spring to summer 2007 program launch. The operating cost calculated below reflects the estimated 3% premium of participating in the program. The advantages of this approach are that the certification process for offset projects will likely be quite rigorous and emissions reductions will probably occur within California.

The city may also choose to purchase carbon offsets from a myriad of other offset brokers and providers, not just from PG&E. CO₂ offsets represent the emissions reduction achieved at a project implemented elsewhere (e.g. planting trees, energy conservation projects, methane capture). The amount of offsets purchased is directly correlated to emissions reductions from city operations (e.g. buying an amount of offsets equivalent to 100% of city emissions would reduce Sunnyvale emissions by 100%.) The advantage is that the city may select specific projects that align with city priorities and choose a least cost option. The disadvantages include the lack of certification standards for offsets and the difficulty of verifying CO₂ savings claims.²⁶ Table 4-7 provides a cost estimate of different levels of offset purchases.²⁷

Table 4-7. Annual cost and emissions impact of purchasing CO₂ offsets

Specific target	Project description	Annual CO ₂ benefit	Annual operating cost	\$ cost per lb of CO ₂ reduced
All sources	PG&E ClimateSmart (offsets all electricity and natural gas, 67% of City emissions)	10,447,273	\$ 42,710	\$ 0.004/lb CO ₂
All sources	100% of City CO ₂ offset	15,553,086	\$ 63,626	\$ 0.004/lb CO ₂
All sources	50% of City CO ₂ offset	7,776,540	\$ 31,813	\$ 0.004/lb CO ₂
All sources	25% of City CO ₂ offset	3,888,270	\$ 15,907	\$ 0.004/lb CO ₂

Another City-wide approach is to purchase renewable energy credits (RECs) from third-party brokers, such as Sterling Planet or 3 Phases. Reputable REC products are third-party certified by the Center for Resource Solutions e-certification scheme, which provides confidence that the REC accurately represents real renewable electricity that is generated and delivered to customers. Table 4-8 displays the estimated cost of different amounts of renewable energy purchases.

The estimated REC price of \$21/MWh used in the below analysis is based on an average of prices listed on the U.S. Department of Energy website.²⁸ Prices may vary depending on the renewable technology. Solar PV generally will be more expensive than wind or biomass. Additionally, RECs may also be priced

²⁶ Clean Air-Cool Planet has released a guide to help organizations and consumers to purchase high quality carbon offsets. <http://www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf>

²⁷ Assume a cost of \$9.00/metric tonne CO₂ (\$0.004/lb CO₂) based on 2006 Rocky Mountain Institute survey of CO₂ emissions offset products available. Note that there is no initial project cost, because the purchase cost may be considered an annual expenditure. (Source: Rocky Mountain Institute, Fall 2006. RMI Solutions Newsletter. <http://www.rmi.org/sitepages/pid1211.php>, p. 5)

²⁸ Assume an average cost of \$21/MWh REC, per U.S. Department of Energy website: <http://www.eere.energy.gov/greenpower/markets/certificates.shtml?page=1>

according to geographic region of the renewable energy project. For example, RECs from the Southeast may be cheaper than from the West Coast.

Table 4-8. Annual cost and emissions impact of purchasing renewable energy credits (RECs)

Specific target	Project description	Annual CO ₂ benefit	Annual operating cost	\$ cost per lb of CO ₂ reduced
Electricity	100% green power	6,539,764	\$ 234,302	\$ 0.036/lb CO ₂
Electricity	50% green power	3,269,882	\$ 117,151	\$ 0.036/lb CO ₂
Electricity	25% green power	1,634,941	\$ 58,575	\$ 0.036/lb CO ₂

If these types of purchases are accompanied by energy efficiency projects on city facilities, then fewer CO₂ offsets or RECs may need to be purchased to meet the same levels of CO₂ reduction. The advantages of these offset or REC purchases is that these products are easy to purchase (i.e. low transaction cost), relatively inexpensive and may have positive public relations benefits. The disadvantage is that they do not represent investments in city property, and are annual expenditures. While Green-e certified RECs are quite credible, carbon offsets are sometimes viewed as a “buying your way out of the problem.”

5. Cost and carbon impact of different levels of action

Given the wide variety of emission reduction opportunities, the projects presented in the previous section are now grouped together to assess the financial and carbon impact of different levels of action by City of Sunnyvale. The projects are grouped into three tiers: Most favorable, moderately attractive and potentially appropriate projects.

Once again, the aggregation of costs represents a back-of-the-envelope estimation of emissions savings and project costs. Actual savings and financial impact may vary. To compare many different types of projects, all financial data in tables are shown as a cost. Therefore, any cost savings related to reduced electricity, natural gas or other fuel consumption is displayed as a negative, with parentheses.

In this chapter, Sunnyvale facility estimated costs are used, in order to be presented to City Council.

5.1 Tier 1: Most favorable

Projects classified as Tier 1 have large CO₂ reduction opportunities and are considered attractive projects for City of Sunnyvale to implement. Although these projects may have some initial costs, they are accompanied by energy savings that quickly recoup expenses and yield annual cost savings. All energy efficiency projects with less than a 5 year simple payback were included in this group.

Some projects with longer payback periods are included if there is significant public interest or if the project meets broader city goals, including establishing City of Sunnyvale as a leader in solar energy. The solar PV installations fall in this category, as well as hybrid vehicle installations. Hybrid vehicles have a positive appearance and can serve as a visible demonstration of the City's commitment to sustainable practices.

Tier 1 projects are considered "low-hanging fruit" projects for City of Sunnyvale staff to implement. Since WPCP emissions constitute such a large portion of city emissions, and a source of uncertainty in projected emissions, it is also deemed important to address energy use at this facility. Recommended projects include process optimization, lighting retrofit and delamping. Table 5-1 below displays the current group of projects that are deemed to qualify as Tier 1 projects, listed in order of payback period.

Table 5-1. Emission reduction projects classified as Tier 1

Specific target	Project description	Annual CO ₂ benefit	Annual operating cost	Sunnyvale estimated project cost	Simple payback
		(lbs)	(\$)	(\$)	(yrs)
All facilities	Vending misers (12)	11,026	\$ (2,708)	\$ -	-
Fleet	Policy to replace with higher mpg	1,472	\$ (231)	\$ -	-
WPCP	Delamping	1,045	\$ (3,087)	\$ -	-
Fire stations 1-6	2 occupancy sensors	18,965	\$ (4,658)	\$ 3,000	0.64
10 facilities	Building optimization	339,389	\$ (83,359)	\$ 76,000	0.91
WPCP	Lighting retrofit	4,179	\$ (12,248)	\$ 20,000	1.63
WPCP	Process optimization	196,591	\$ (48,285)	\$ 113,304	2.35
City Annex	VFD on HVAC fan motors	16,724	\$ (4,108)	\$ 12,000	2.92
Library	VFD on AHU	11,149	\$ (2,738)	\$ 12,000	4.38
Fleet	4 hybrid vehicles	7,949	\$ (1,248)	\$ 19,800	15.87
13 facilities	*442 solar PV system (purchase outright)	7,949	\$ (88,371)	\$ 3,094,000	35.01
13 facilities	*442 solar PV system (PPA)	359,798	\$ (6,312)	\$ -	none
Fleet	5% biodiesel	65,863	\$ -	\$ 5,000	none
TOTAL (with solar PPA)		1,034,149	\$ (168,982)	\$ 261,104	2

Some projects assessed are mutually exclusive, meaning that the implementation of one project excludes the implementation of another project (e.g. 442 solar PV system PPA or purchased outright). These projects are indicated in the table with asterisks.

If Tier 1 projects are implemented (with solar PPA), then emissions are estimated to be reduced by approximately 1,034,149 lbs of CO₂. The total city emissions by FY10-11 are estimated to be reduced to 18,746,878 lbs CO₂, which is a 0.1% decrease in emissions compared to FY90-91.

5.2 Tier 2: Moderately attractive

Tier 2 projects are generally more ambitious than Tier 1 projects. Some projects may be more ambitious due to less favorable economics (e.g. LED retrofits for street lights) or uncertain technology performance (e.g. 20% biodiesel). Tier 2 projects have a greater than 5 year simple payback. Some projects within Tier 2 are mutually exclusive, in that more than one project idea is presented to address the same energy consumption source (e.g. window sunscreen or double-pane window installation). These projects are indicated by asterisks and only one project would be implemented of the two.

Table 5-2 shows the projects that are considered Tier 2. If Tier 2 projects are implemented alone (separately from Tier 1 projects), then Tier 2 projects alone would reduce emissions by 1,308,749 lbs of CO₂ by 2010. Tier 2 projects alone would reduce city-wide emissions to 18,472,278 lbs of CO₂ by 2010, which is a 1.6% decrease in total emissions. This assumes the implementation of sunscreens on windows (rather than the double-pane window retrofit).

Table 5-2. Emission reduction projects classified as Tier 2

Specific target	Project description	Annual CO ₂ benefit	Annual operating cost	Sunnyvale estimated project cost	Simple payback
		(lbs)	(\$)	(\$)	(yrs)
City Hall	VFD on VAV AHU	4,181	\$ (1,027)	\$ 12,000	11.69
Street lighting	Replace 150 watt HPS with LED	151,540	\$ (37,220)	\$ 576,030	15.48
Street lighting	Replace 200 watt HPS with LED	681,931	\$ (167,492)	\$ 2,990,925	17.86
Community Center	Metal halide to T5 retrofit	1,608	\$ (395)	\$ 7,500	18.99
Fire stations 1-6	Window with sunscreen	1,860	\$ (457)	\$ 10,000	21.89
Corp Yard	Metal halide to T5 retrofit	2,886	\$ (709)	\$ 25,000	35.27
Street lighting	Replace 70 watt HPS with LED	200,033	\$ (49,131)	\$ 2,193,345	44.64
Fire stations 1-6	Insulate water heater pipes	1,257	\$ (130)	\$ 6,000	46.30
Fire stations 1-6	Double Pane Windows	3,005	\$ (411)	\$ 125,000	303.91
Fleet	20% biodiesel	263,453	\$ -	\$ 5,000	none
TOTAL (select sunscreen over double-paned windows)		1,308,749	\$ (256,560)	\$ 1,342,456	23

5.3 Tier 3: Potentially appropriate

The project categorized as Tier 3 mostly involve the purchase of third-party offset projects, or renewable energy certificate purchases that are annual expenditures for emissions reductions to occur elsewhere. These are generally considered measures of last resort, after all cost-effective emissions reduction projects within an organization’s boundaries have been implemented.

Table 5-3 summarizes the last group of emission reduction projects. No summation of emissions reduction potential is calculated here, since the purchase of offsets and RECs can be at any amount. Carbon offsets are relatively inexpensive, and City of Sunnyvale could theoretically invest \$63,626 to offset all FY05-06 emissions related to government activities, without implementing any energy efficiency or renewable projects on-site.²⁹

Table 5-3. Emission reduction projects classified as Tier 3

Specific target	Project description	Annual CO ₂ benefit	Annual operating cost	Relative cost per lb CO ₂ reduced
		(lbs)	(\$)	
Electricity & NG	100% PG&E ClimateSmart	10,447,273	\$ 42,710	\$ 0.004/lb CO ₂
All sources	100% of city CO ₂ offset	15,553,079	\$ 63,626	\$ 0.004/lb CO ₂
All sources	50% of city CO ₂ offset	7,776,540	\$ 31,813	\$ 0.004/lb CO ₂
All sources	25% of city CO ₂ offset	3,888,270	\$ 15,907	\$ 0.004/lb CO ₂
Electricity	100% green power RECs	6,500,312	\$ 234,302	\$ 0.036/lb CO ₂
Electricity	50% green power RECs	3,250,156	\$ 117,151	\$ 0.036/lb CO ₂
Electricity	25% green power RECs	1,625,078	\$ 58,575	\$ 0.036/lb CO ₂

²⁹ Assumes a cost of \$9.00 per metric tonne CO₂

Another potential option is to join the PG&E ClimateSmart program to purchase electricity and natural gas that is essentially “carbon neutral.” This means that all CO₂ emissions related to the purchased electricity and natural gas is matched by PG&E investments in carbon offset projects. City of Sunnyvale could then purchase carbon offsets only for fleet vehicle operations that consume diesel and gasoline to achieve zero net CO₂ emissions related to city government.

6. Conclusion and Recommendations

Overall, City of Sunnyvale has very effectively managed its energy and carbon footprint for the past 16 years. The results of the CO₂ emissions inventory, along with third-party facility energy audits, demonstrate that city staff has been successful in reducing energy use related to city operations. Recommendations to City of Sunnyvale are detailed below, to assist staff in defining the organizational boundary, base year and target reductions for continued management of CO₂ emissions related to city operations.

6.1 Group of City facilities to measure

Recommendation: Include all 15 City facilities

Energy usage data was found to be mostly available for all 15 city facilities, representing 33 PG&E accounts. Since CO₂ emissions data has been collected for all facilities thus far, it is recommended that City of Sunnyvale continue to include all 15 city facilities in its CO₂ inventory. This will also ensure greater flexibility in meeting a city CO₂ emission reduction goal.

6.2 CO₂ emission reduction baseline year

Recommendation: Select fiscal year 1990-1991 as base year

The energy data for the three emissions sources (facilities, fleet and streets/traffic) was generally available back to FY90-91, with the exception of fleet vehicles, for which the earliest data was from FY00-01. Although fuel data was lacking for fleet vehicles prior to FY00-01, information on fleet size was readily available back sixteen years, which enabled an estimation of fleet emissions based on the known emissions rate for FY00-01 through FY05-06.

There were a few other data quality issues related to years 1990 and 1991, but these were either resolved or deemed minor. Traffic signal electricity consumption was missing, but easily estimated since energy use was observed to be constant from 1993 through 1997.³⁰ Since energy data is mostly available through 1990, we recommend that City of Sunnyvale use FY90-91 as a base year, especially since this is the same base year used by Sustainable Silicon Valley (SSV), Kyoto Protocol and California AB32.

Table 6-1. Change in city carbon dioxide emissions over time

Base year	FY05-06 change in emissions
FY90-91	-17.1%

Using this base year, City of Sunnyvale has already reduced emissions in FY05-06 to 17.1% below FY90-91 levels.

³⁰ See Chapter 3

6.3 CO₂ emission reduction goal

Recommendation: Select 5% below FY90-91 emissions level as a reasonably ambitious goal, and returning to FY90-91 emissions levels as a very achievable goal.

City of Sunnyvale has already achieved significant emissions reductions since FY90-91 through the WPCP cogeneration plant installation and LED retrofit of traffic signals. Emissions levels in FY05-06 are already 17.1% below FY90-91 levels. Landfill gas output is expected to continue to decline, however, and will increase the amount of natural gas purchased from PG&E by 175,000 therms by 2010. This corresponds to a CO₂ increase of approximately 2,037,000 lbs by 2010. Preliminary data for 2006 indicates an increase in WPCP natural gas consumption that will already bring city emissions close to FY90-91 levels in the next fiscal year.

Interviews with staff and a review of facility audits indicates that additional large emissions reductions are achievable at City of Sunnyvale through such projects as solar PV installations, focused building optimization program, LED street lighting, and process efficiency at the WPCP. Particular attention to the WPCP is recommended since such a large portion of city emissions are related to natural gas use at the WPCP. There are also many small, yet cost-effective, measures that can continue to be implemented in city buildings including vending misers, additional de-lamping, and high performance T8 retrofits for the WPCP.

Table 6-2 summarizes the estimated emissions and cost impacts of different levels of action according to the categorization of projects from Chapter 5. Tier 1 projects are considered to be most economical, with the most “bang for the buck.” Tier 1 + 2 plus offsets provides insight on what the potential costs for meeting the recommended Sustainable Silicon Valley target of 20% below 1990 levels would be.

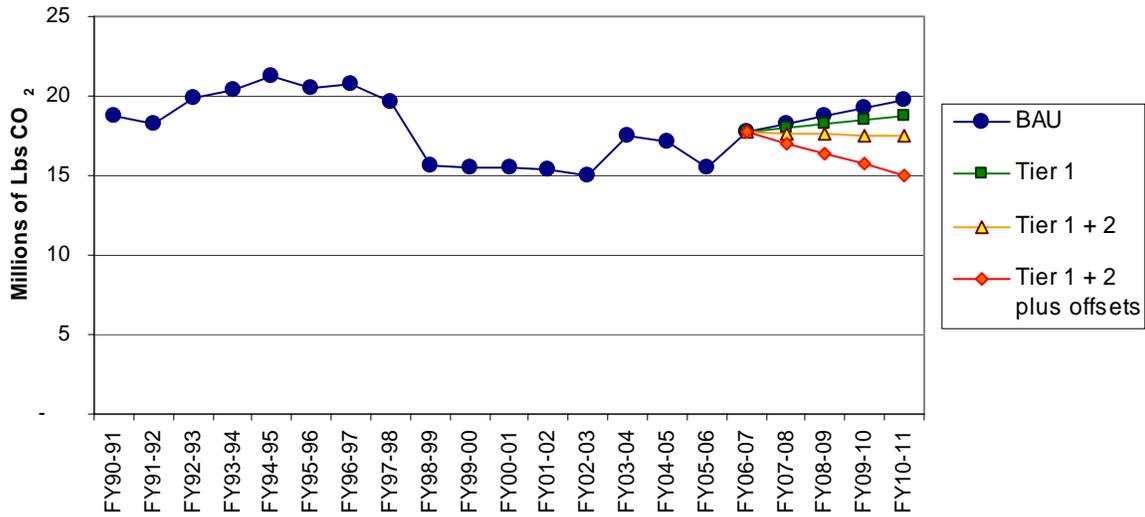
Table 6-2. Comparison of cost and carbon impact of different levels of action

FY10-11 scenario	Emissions reduction relative to FY90-91	Lbs of CO ₂ reduced from BAU scenario	Estimated incremental cost to city	Total simple payback
Business as usual (BAU)	5.4%	0	\$ 0	n/a
Tier 1 projects	- 0.1%	1,034,149	\$ 1,034,149	1.5 years
Tier 1 + 2 projects ³¹	- 6.8%	2,277,034	\$ 6,608,099	18.3 years
Tier 1 + 2 plus offsets	-20%	4,763,486	\$ 6,618,270	18.4 years

This analysis demonstrates that an emissions reduction goal of 5% below 1990 levels by 2010 may be a reasonably ambitious goal, with returning to FY90-91 levels being a very achievable goal. Figure 6-1 below shows graphically how different levels of action are likely to affect future city emissions.

³¹ The Tier 1 + 2 projects include the implementation of 20% biodiesel (B20 instead of B5) and sunscreens on windows (instead of double-paned windows).

Figure 6-1. Projected emissions trend under different levels of action (lbs of CO₂)



All in all, City of Sunnyvale is to be commended on achieving CO₂ reductions since FY90-91. Further efforts to reduce CO₂ emissions are likely to be accompanied by energy savings that will have positive impacts for managing energy costs. While CO₂ emissions reductions require a new way of thinking about resource use and conservation, it can serve as a useful metric for City of Sunnyvale to measure progress towards achieving sustainability for current and future residents.

7. Appendix A – Sustainable Silicon Valley Protocol

CO₂ Emissions Reduction Target and Reporting Protocol Sustainable Silicon Valley

Background

Introduction:

The California Environmental Protection Agency, the Silicon Valley Manufacturing Group, the Silicon Valley Environmental Partnership and other governmental, educational and community organizations formed the Sustainable Silicon Valley initiative in 2001 to explore the possibility of improved regional environmental performance without ‘command and control’ regulations. The group used the model of an Environmental Management System to identify opportunities and priorities for action.

Renewable and other energy use, energy efficiency, and the resulting CO₂ emissions, were chosen by the group as a key action opportunity, because:

- Many Silicon Valley organizations had demonstrated significant energy savings, in part resulting from the recent energy crisis, resulting in cost savings and environmental performance improvements.
- Other regions and organizations (Sonoma County, the City of Toronto, and various Silicon Valley businesses) had already ‘signed up’ to specific CO₂ emissions reductions goals. The goal selected by the group was consistent with other existing regional emissions reduction goals and represents a stretch goal for the region.
- Reducing energy intensity (energy used per unit output) across the commercial, residential and transportation sectors was seen as having multiple benefits, including (but not limited to): opportunities for cost savings, success through broad participation and collaboration, reduction of the environmental impact of the region, and the demonstration of a leadership role on an issue of growing policy and economic significance.

On April 24, 2003 Sustainable Silicon Valley (SSV)³² announced that it has adopted a goal to reduce carbon dioxide (CO₂) emissions in the Silicon Valley region by 20 percent by 2010, using 1990 as a base

³² Sustainable Silicon Valley (SSV) is a multi-stakeholder collaborative initiative that includes representatives from business, the environmental community and government whose aim is to improve environmental management and resource conservation in the Silicon Valley through the creation of a Silicon Valley Environmental Management System (EMS). The partners in SSV are the Silicon Valley Manufacturing Group, California Environmental Protection Agency and Silicon Valley Environmental Partnership. Through a multi-stakeholder collaborative process SSV has established a set of environmental indicators that will be the basis for the EMS. Energy and water usage have been identified as the first two significant environmental issues to be addressed by the SSV initiative through a regional environmental management system. The energy use target is the first established by SSV.

The geographic boundaries of Silicon Valley include the area approximately bounded by the City of South San Francisco in the north, by Scotts Valley in Santa Cruz County and Morgan Hill in Santa Clara County in the south, and by the Coastal Range hills west and east of the San Francisco Bay.

year.³³ The group recognized the challenge of such an ambitious goal. At the same time, the group expressed the desire to aim high, and thus encourage creative, collaborative and motivated participation by as wide a group of organizations as possible, highlighting Silicon Valley's leadership and innovation on this issue.

What's in it for You to Participate?

- **Save Money.** By improving your energy efficiency (and thereby reducing your CO₂ emissions), you will save money. That will go directly and completely to your bottom line.
- **Recognition.** Your organization will be publicly recognized for its efforts and achievements. This is a unique PR opportunity to enhance your reputation as a leader and can help respond to increasing requests from customers and the socially responsible investment community.³⁴ SSV is already garnishing interest from high-level government officials for this innovative regional approach.
- **Leadership and Innovation.** Silicon Valley is regarded as a birthplace of innovation. This partnership is a testament to that. The results of your individual energy efficiency (or other innovative) program will be combined with that of other organizations. The cumulative impact will be much greater, and demonstrate how Silicon Valley organizations are collaborating to reduce CO₂ emissions. Many see some type of CO₂ emissions reduction regulations or trading mechanism as inevitable. By participating in this voluntary, innovative, and collaborative effort, your organization will be setting the "rules of the game" for carbon dioxide emission reductions in the United States. This effort serves as an incubator for new technologies and business models. In addition, it helps retain current businesses and attract top talent to one of the most beautiful places in the world.
- **Partnership and Collaboration.** Energy savings projects hinge on two criteria – technological advances and cost savings. By partnering with the SSV, organizations will have access to the best practices and business cases used by all participants in developing their programs. In addition, information on methodologies to document the cost savings, energy savings, and CO₂ reductions will be provided. The International Council for Local Environmental Initiatives (ICLEI) has software available to participants to help with data collection and quantification. ICLEI offers a variety of technical assistance and training through its technical assistance fee structure.

³³ The Protocol to the United Nations Framework Convention on Climate Change (Kyoto Protocol) calls for the United States to reduce its greenhouse gas (GHG) emissions by seven percent in the 2008-2012 time frame, using 1990 as a base year. This protocol (unsigned by the United States), along with actions taken by Sonoma County and all the cities within Sonoma County committing to reduce by 20 percent CO₂ emissions in their jurisdictions by 2010, provided the impetus for the SSV goal.

The goals in the Kyoto Protocol and adopted by Sonoma County and the cities within it do not take into consideration energy intensity, i.e., energy used per unit of GDP. This lack of normalization is the primary basis of the negative reaction to the Kyoto Treaty from the U.S., the largest contributor of GHG emissions in the world (approximately 20-25 percent of the total anthropogenic emissions).

³⁴ The Dow Jones Sustainability Index (DJSI) is an example of socially responsible investing. It is comprised of the top ten percent of companies (leaders in sustainable development) in 68 industry groups in 21 countries. Contrary to the belief that such a group of investments inherently provide poorer returns, the DJSI outperformed the Dow Jones Global Index for the five year period ending August 2001. According to the Social Investment Forum, in 1999 there was more than \$2 trillion in assets under management in the U.S. in portfolios that use screens related to corporate social responsibility, including environmental performance. In 1995 the figure was \$639 billion, and in 1997 \$1.185 trillion. The 1999 portfolio amount accounts for nearly 13 percent of the \$16.3 trillion in investment assets under professional management in the U.S.

Why adopt an energy use goal based on carbon dioxide emissions?

As SSV was developing a target for the energy aspect of this management system, the organizing committee agreed that renewable energy should not be viewed in isolation. Before embarking on major efforts to increase the use of renewable energy, an organization or region must be assured that it is using energy efficiently. Therefore, the SSV organizing committee expanded the focus from renewable energy to energy use, both its efficient use and the increased emphasis on renewable energy technologies.

Energy usage is measured by a variety of units, including kilowatt hours (kWh) of electricity, therms of natural gas, gallons of petroleum-derived fuels (such as gasoline or diesel), and tons of coal.

From an environmental perspective, both the amount and environmental impact of energy use are important. The carbon content of fossil fuels³⁵ can be used as a proxy for the relative environmental impacts of their combustion. While some emissions occur naturally when a fuel is burned and can be cleaned or “scrubbed” (e.g., nitrogen oxide and oxides of sulfur), the carbon in these fuels cannot, and is released, most often as CO₂. In addition to serving as a proxy for the relative cleanliness of different fossil fuels, the carbon compounds released when they are burned (most significantly CO₂) have been implicated as major contributors to global climate change.

CO₂ emissions in Silicon Valley can therefore be viewed as representative of both energy efficiency (the amount of energy used per unit output) and energy effectiveness (the relative carbon intensity of fuels or the amount of renewable energy used).

In 1990, 13.42 million tons of CO₂ were emitted into the atmosphere in Silicon Valley.³⁶ The SSV goal of a 20% reduction on a regional basis means that no more than 10.74 million tons of CO₂ should be emitted in 2010.³⁷ This CO₂ emission reduction goal for Silicon Valley is measured in absolute values

³⁵ The dominant fossil fuels in an industrialized society are coal, fuel oil and its derivatives such as gasoline, diesel, aviation fuel, propane, and natural gas.

³⁶ Source: *2003 Silicon Valley Environmental Index*. Supporting data for the *Index* indicate that 3.66 million tons of carbon emissions occurred in 1990. Using the molecular weights of carbon (12) and carbon dioxide (44), 3.66 million tons of carbon is equivalent to 13.42 million tons of CO₂. Santa Clara County is used as a proxy for Silicon Valley by SSV and Silicon Valley Environmental Partnership (SVEP).

³⁷ Anthropogenic emissions of CO₂ into the atmosphere are caused primarily by the combustion of fossil fuels such as coal, petroleum and its derivatives, and natural gas. In Silicon Valley these emissions are caused directly by (a) burning natural gas, (b) a relatively small amount of coal, and (c) petroleum-based products such as gasoline, diesel, jet fuel, and indirectly by using electricity, a portion of which is generated using fossil fuels. In 2000, approximately 55 percent of the CO₂ emissions in Silicon Valley came from burning gasoline, 18 percent from burning natural gas and 27 percent from electricity use. (Source: *2003 Silicon Valley Environmental Index*; diesel fuel sales are not available on a county-wide basis and therefore not included in SVEP’s calculations of carbon emissions; jet fuel and coal are excluded from the SVEP analysis for a variety of reasons.)

There are two ways to reduce CO₂ emissions; reduce the amount of energy used and switch from fossil-based to non-fossil-based fuels. While the use of solar and wind energy to replace fossil fuel is justifiably held up as a poster child for the energy future, a fundamental step before deploying such renewable technologies is to increase energy efficiency. Studies consistently show that energy efficiency can be improved significantly, while generating positive financial returns. SSV expects that most participants in this effort will meet the majority (if not all) of their CO₂ emissions reductions through cost-effective energy efficiency investments in both their stationary and mobile

and is not normalized by economic factors such as gross regional product. However, goals for participants in this SSV initiative can be normalized for economic activity including, but not limited to, sales, number of employees or square footage.

Won't increases in economic activity automatically increase energy use and carbon dioxide emissions?

In modern industrial societies economic activity requires the use of energy, most commonly fossil fuels. Therefore, goals related to energy use (or CO₂ emissions in this case) are often normalized for economic activity, population, or some other variable. Some nations express concern with their international competitive advantage if energy/emissions goals are not normalized, citing the commonly accepted (though less so recently)³⁸ one-to-one correlation of economic growth and energy use as the necessary price for continuing economic prosperity.

Regional emissions of greenhouse gases can vary significantly based on economic cycles. As the economy booms, commercial and industrial activity increases, vacancy rates drop, and more energy is used. All else being equal, carbon dioxide emissions also reflect these changes in the use of energy. As the Silicon Valley economy and population grew in the 1990s for example, emissions of CO₂ increased, reaching 15.7 million tons in 2000. One can contrast this with the reduction in emissions in the 1991-1993 timeframe, during the last recession in Silicon Valley (see Table 1).

Table 1: Estimated CO₂ Emissions in Silicon Valley 1990 --2000³⁹

Base Year	CO₂ emissions (thousand tons)
1990	13,421
1991	13,189
1992	13,273
1993	12,814
1994	14,221
1995	12,269
1996	12,454
1997	13,525
1998	14,097
1999	15,627
2000	15,699

use of energy. Some fuel switching may be appropriate and necessary, especially in the mobile use of energy, e.g., the use of hybrid engines or converting fleets from diesel and gasoline to natural gas.

³⁸ Those that have studied the California economy since the mid-1970s have concluded otherwise. Economic growth can and does occur in an environment of improving energy efficiency. See for example the California Energy Commission's *Inventory of California Greenhouse Gas Emissions and Sinks: 1990-1999* (http://www.energy.ca.gov/reports/600-02-001F/2002-09-14_600-02-001F.PDF).

³⁹ Source: *2003 Silicon Valley Environmental Index*. Supporting data for the *Index* indicate annual tons of carbon emissions. Using the molecular weights of carbon (12) and carbon dioxide (44), tons of carbon is converted to tons of CO₂. Santa Clara County is used as a proxy for Silicon Valley by SSV and Silicon Valley Environmental Partnership (SVEP).

However, from a global environmental perspective, economic normalization of an energy/CO₂ goal makes less sense. Human activities are releasing CO₂ and other greenhouse gases⁴⁰ into the atmosphere at a rate greater than the global ecosystem can assimilate them. Absolute, not economically normalized, reductions of emissions of CO₂ and other greenhouse gases must occur to mitigate the greenhouse gas emissions implicated in global climate change. (SSV recognizes that there are several greenhouse gases, but for the purposes of this SSV goal for energy, only CO₂ is considered.)

An absolute goal won't work for my organization. How else can I participate?

Project participants can select economically normalized CO₂ emission reduction goals. SSV recognizes the arguments for normalizing an energy/CO₂ emissions goal and accepts the environmental importance of an absolute goal. SSV also acknowledges Silicon Valley's global innovation leadership and the extent of its influence in the nation and the world. Therefore, SSV adopted an absolute CO₂ emission reduction goal for the region but provides project participants the flexibility to adopt normalized CO₂ emission reduction goals. SSV recognizes that it is through the efforts of its formal and informal partners and participants, and not of SSV itself, that its CO₂ emission reduction goal will be met. Therefore, ensuring flexibility in setting emissions reduction goals, such as utilizing economically based normalization of CO₂ emissions, is critical to a successful voluntary CO₂ reduction partnership. The SSV also anticipates working with participating organizations to identify and implement innovative and cost effective emissions reductions strategies.

What if my organization is already participating in a reporting protocol –or – What if my organization doesn't have the resources to do a lot of detailed data management?

The protocol adopted by SSV for the accounting and reporting of CO₂ emissions allows participating organizations to choose to normalize using the factor of their choice, such as sales, number of employees, or square footage of the participating facility. Flexibility is also built into the base year. Any year after 1989 can be used. If an organization is already a participant in other programs, such as those listed below, it may already have information applicable to this SSV initiative. Additionally, the reporting protocol is intended to be as simple as possible to ensure ease of use by a wide variety of organizations.

- The General Reporting Protocol of the California Climate Registry (<http://www.climateregistry.org>)⁴¹

⁴⁰ The greenhouse gases addressed by the Kyoto Protocol are CO₂, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride

⁴¹ The California Climate Action Registry (CCAR) is a nonprofit organization that was established by the State of California; the State has promised to protect the early actions of companies registering their annual GHG emissions, in the event of any future regulatory scheme. Companies can adopt any year from 1990 forward as a baseline year for their emissions. The CCAR Protocol requires reporting of direct and indirect GHG emissions addressed in the Kyoto Protocol, including CO₂. Any company registering its GHG emissions with CCAR will be in an excellent position to report to the SSV since reporting requirements under the CCAR protocol are more inclusive than those established by SSV, i.e., a company reports all its (Kyoto Protocol) GHG emissions to the CCAR, the Protocol includes direct and indirect emissions and requires entity-wide emissions reporting (the option exists to record data at the facility level so that if a company wished, it could download data for Silicon Valley facilities only). The CCAR Protocol requires reporting of vehicle usage for company-owned vehicles only; reporting employee travel/commuting is optional. The CCAR Protocol, along with CCAR's web-based reporting tool provide detailed instructions on inventorying GHG emissions; no specific metrics are proposed, although an organization may include these in their annual reports, which when certified, will be available on the Registry website.

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- The International Council Local Environmental Initiatives: Cities for Climate Protection Program (<http://www.iclei.org/>).
 - The World Business Council on Sustainable Development/World Resources Institute's *The Greenhouse Gas Protocol: a corporate accounting and reporting standard* (<http://www.ghgprotocol.org/standard/ghg.pdf>)

Participating organizations may choose to submit their report for any of these other efforts as its report for the SSV. Finally, if an organization chooses to participate in one of these programs in the future, it will already have some of the information necessary for those reporting purposes.

By designing its flexible reporting requirements in a manner that is compatible with the requirements of other greenhouse emissions reporting protocols, SSV intends to minimize duplicative efforts.

CO₂ Emissions Reduction Target and Reporting Protocol Sustainable Silicon Valley

Reporting Protocol

Summary of the SSV Protocol for Measuring and Reporting CO₂ emissions

Table 2 summarizes the steps for participating in the SSV CO₂ Emissions Reduction Project.

Table 2: Steps for Participants in the SSV CO₂ Emissions Reduction Project

A participating organization will:

1. Choose one (or more) of its facilities in Silicon Valley;
2. Select a baseline reporting year for each facility;
3. Track each facility's annual electricity and natural gas use;
4. Adopt a goal for CO₂ emissions reduction (percentage and year),
5. Report annually to SSV (either annual energy use or convert total energy use (kWh, therms, gallons) into CO₂, to determine total annual emissions). If the participant chooses to use a normalizing factor, that factor should also be reported annually.
6. Include a brief description (one-two paragraphs) of some (two-five) of the key actions it has taken that led to the decreasing emissions of CO₂.

In addition, organizations may:

1. Select a normalizing factor for each facility;
2. Track its diesel and/or gasoline use for its fleet, employee business use of personal vehicles, and/or employee commuting;

This is a voluntary project; there are no sanctions for a participant failing to meet its goal.

How will my organization be recognized for its achievements?

SSV will release a report annually, documenting CO₂ emissions in the region and compare it to the 2010 goal. Publication of this report will most likely be via the worldwide web. Included in the SSV annual report will be:

- A list of all project participants,
- Highlights of the organizations achieving the most substantial CO₂ emissions reductions in the previous reporting period and since their base years,
- Highlights of the actions taken by project participants that led to the decreasing emissions of CO₂, and
- Beginning in 2005, the organizations matching or exceeding the Valley goal of 20% CO₂ reductions on an absolute or normalized basis and highlights of their efforts.

At a participant's request, the SSV can provide shareholders or customers with documentation of an organization's participation in this regional goal as part of demonstrating their Environmental Stewardship or Corporate Social Responsibility programs.

Who may participate?

All organizations in Silicon Valley (which for this purpose includes the counties of Santa Clara, San Mateo and Alameda) are invited and encouraged to participate. This includes all sizes and types of businesses, governmental, educational, and non-governmental organizations and associations.

To be listed as a project participant in the SSV annual report, an organization must complete the six steps in Table 2 above and submit a report, which demonstrates a reduction in CO₂ emissions.

Participants that meet or exceed the Silicon Valley regional goal of 20 percent reduction in its CO₂ emissions will be listed and have specific highlights in the annual report.

Detailed Information

On the Measuring and Reporting of CO₂ emissions

Physical site: While the intent is to provide for a broad level of participation, an organization may choose any facility in Silicon Valley for inclusion in this effort. If an organization has two physically independent facilities in Silicon Valley, e.g., in different parts of the Valley, either or both can be included. However, an entire physically-dependent facility must be included. The general rule is that multiple buildings/facilities at a single physical site that share electric and natural gas meters must be included.

Examples: The entire administration building must be included in the program rather than one or several departments in the building. An entire manufacturing site must be included, rather than just the warehouse building unless the warehouse is physically independent from the manufacturing facility, i.e., located in a different place and with its own electric and natural gas meters.

Energy use measured: Ideally, all of the major uses of fossil-based energy in Silicon Valley, i.e., electricity, natural gas, diesel and gasoline, would be measured. At a minimum, annual electricity and natural gas usage will be tracked over time. Information readily available from a participant's electricity and natural gas bills will suffice for these measurement purposes.

Gasoline and diesel fuel usage is more difficult to measure. A participant may choose not to include the gasoline and diesel fuel usage at all. (However, the participant may lose significant potential for emissions reduction since gasoline accounts for more than half of the CO₂ emissions in the Valley. Additionally, the California Climate Action Registry requires inclusion of fleet vehicles)

Alternatively, a participant may choose to include only its fleet's use of gasoline and diesel fuel. Presumably the participant would have a record of gasoline and diesel fuel usage by its fleet. Or, a participant may choose to include an estimate of its employees' use of gasoline for commuting and company business. Measurement of employee use of gasoline can be determined by the participant, but the measurement protocol must be consistent over time.⁴² Whichever energy use is being reported by an organization, the measures should be consistent over time.

⁴² A number of measures could be used. One way of doing this would be for the participating organization to survey its employees annually to determine their mode of commuting to work. If the commute mode is automobile, other information should be ascertained, such as the average fuel economy (miles/gallon) of the vehicle (or type of automobile, e.g., subcompact, compact...SUV), number of miles driven per week, number of people in the vehicle, and other relevant information. With this information the average gasoline usage (gallons) can be determined.

Energy Use and Carbon Dioxide Emissions to be Reported: A participant may report either its annual energy use in kWh of electricity, therms of natural gas and (if included in the participant’s measurements) gallons of gasoline and diesel fuel. Alternatively, the participant may convert these energy measures into the carbon dioxide emissions that results in the use of the energy (see Table 3).

Table 3: Fossil Fuel Use → Carbon Conversion factors:

Fuel	Carbon (C) Conversion Factor & Source	Geographically-Based Participants (city, county)	Facility-Based Participants (company, NGO, government use)
Natural gas	3.174 lbs C/therm or 11.64 lbs CO ₂ per therm (EPA Workbook 1995)	Annual natural gas sales (therms) within the city or county multiplied by 11.64 lbs CO ₂ per therm divided by 2000 lbs/ton.	Annual natural gas sales to the facility multiplied by 11.64 lbs CO ₂ per therm divided by 2000 lbs/ton.
Gasoline	5.30 lbs C/gallon or 19.43 lbs CO ₂ per gallon (EPA Workbook 1995)	Annual gasoline sales (gallons) within the city or county (from Board of Equalization) multiplied by 19.43 lbs CO ₂ per gallon divided by 2000 lbs/ton.	Annual gasoline usage by facility fleet (gallons) multiplied by 19.43 lbs CO ₂ per gallon divided by 2000 lbs/ton. Fleet usage determined by sales invoices. Employee commute mileage (if measured) to be determined by participant.
Diesel	5.74 lbs C/gallon or 21.05 lbs CO ₂ per gallon ⁴³	Annual diesel sales (gallons) within the city or county multiplied by 21.05 lbs CO ₂ per gallon divided by 2000 lbs/ton.	Annual diesel usage by facility fleet (gallons) multiplied by 21.05 lbs CO ₂ per gallon divided by 2000 lbs/ton. Fleet usage determined by sales invoices.
Electricity	Annual PG&E-specific electric generation portfolio determines weighted average lbs CO ₂ per kWh sold in Santa Clara County (from CEC and SVEP)	Annual electricity sales (kWh) within the city or county multiplied by appropriate factor divided by 2000 lbs/ton.	Annual electricity sales (kWh) within the facility multiplied by appropriate factor divided by 2000 lbs/ton.

Additionally, CCAR works closely with the California Air Resources Board to ensure that emission factors are as up-to-date as possible and participants in the Silicon Valley challenge can access these factors through CCAR’s Protocol and its regular updates.

⁴³ Diesel: 130,500 Btu/gallon (source: http://bioenergy.ornl.gov/papers/misc/energy_conv.html)

44.0 pounds Carbon per MMBtu (source: http://www.energy.ca.gov/reports/600-02-001F/2002-09-14_600-02-001F.PDF). 44/12 = molecular weight of CO₂/C.

Calculation: 44/12*44.0*0.1305 = 21.054 lbs CO₂/gallon (or 5.742 lbs C/gallon)

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Base year: The participant that strives to be highlighted as having adopted a CO₂ emissions reduction goal that meets or exceeds the Silicon Valley regional goal of 20 percent may select as a base year any year after 1989. Since the SSV goal is to reduce CO₂ emissions in 2010 to a level 20 percent below the 1990 level, the CO₂ emissions in the base year chosen determines the participant’s goal for 2010. Table 4 depicts the goal for each base year chosen.

Table 4: Estimated CO₂ Emissions in Silicon Valley and Goal for Each Base Year

Base Year	CO ₂ emissions (thousand tons)	Goal for 2010
1990	13,421	20%
1991	13,189	19%
1992	13,273	19%
1993	12,814	16%
1994	14,221	25%
1995	12,269	12%
1996	12,454	14%
1997	13,525	21%
1998	14,097	24%
1999	15,627	31%
2000	15,699	32%

Normalization of CO₂ emissions: Each participant may choose to adopt an absolute or normalized goal and determines which (if any) normalization factor is to be used. Among the more commonly used normalization factors are sales, number of employees, square footage of facilities, and number of vehicles in a fleet.

A participant that strives to be highlighted as having adopted a CO₂ emissions reduction goal that meets or exceeds the Silicon Valley regional goal of 20 percent choosing 1993 as a base year and an absolute goal would commit to reducing its CO₂ emissions in 2010 by 16.21 percent. A participant choosing 1993 as a base year and a goal normalized for sales would commit to reducing its CO₂ emissions per unit of sales in 2010 by 16.21 percent.

Frequency of reporting: Each participant should report annually to the SSV administrator three months after the end of the participant’s fiscal year (or the calendar year). This report should be sent electronically to the SSV administrator (address TBD).

Content of Report: To enable effective tracking, the participant’s report should include:

1. Name of the organization;
2. Address of the participating facility(ies);
3. Standard Industrial Classification (SIC) Code of the participating facility(ies);
4. Contact information, i.e., name, address, telephone, and email, for the key person gathering the data;
5. Energy sources being tracked, e.g., natural gas, electricity, gasoline, diesel;
6. Base year adopted and CO₂ emissions reduction goal;
7. Normalization factor (if any);
8. Energy use tracked annually since the base year and through the most current year (this information can be provided in units of energy or CO₂ emissions as described above).

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9. Comparison of energy use (or CO₂ emissions) reported for the current year to the base year.
 10. A short narrative of activities/programs undertaken or planned to meet the 2010 target. (This information will likely be shared with others as “best practices” and included in SSV’s annual reports).

To the extent a participant gets better data after submitting its annual report to SSV, for example more accurate or comprehensive data or data certified by a third party, it should submit the improved data.

8. Appendix B – Summary of City facility CO₂ reduction projects

For the purposes of the CO₂ emissions inventory, we examine the 15 facilities below to document facility attributes, past retrofit projects and the results of recent facility energy audits.

The facilities include:

1. City Hall
2. City Annex
3. South Annex
4. Community Center and Senior Center
5. Senior Center
6. Corporation Yard
7. Library
8. Public Safety
9. Fire Stations
10. Water Pollution Control Plant

This section summarizes the facility information gathered from city facility engineers (Tony Perez, Javier Lopez), PG&E energy audits and recent Energy Solutions facility audits completed as part of the Association of Bay Area Governments (ABAG) Energy Watch program. Energy Solutions provided a draft summary document titled “Energy Efficiency Evaluation Survey for the City of Sunnyvale” dated 1-24-07. See Appendix E for original documents.

Most energy saving projects identified by PG&E audits were quantified and included in the summary table of potential emissions reduction projects. In addition, KEMA identified a few additional projects from conversations with facility engineers and based on data provided by staff. City of Sunnyvale staff provided information as needed, but some lighting replacement and retrofit projects were not quantified, as a thorough lighting inventory and evaluation of intermittent use areas for occupancy sensors and further delamping was beyond the scope of this project. These lighting projects are documented below as possible projects, with savings estimates calculated when possible.

In many cases, energy savings assumptions related to PG&E suggested projects were recalculated using updated Database for Energy Efficient Resources (DEER) savings numbers. DEER is a California Energy Commission and California Public Utilities Commission (CPUC) sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source. DEER values can be referenced at <http://www.energy.ca.gov/deer/>. The values are meant to be rule-of-thumb, and actual savings may vary.

The assumed cost of electricity and natural gas is based on the previous two years of billing data received from PG&E.

- Electricity rates for the past two years ranged from an average \$0.116/kWh (Public Safety) to \$0.162/kWh (South Annex). Therefore, an average rate of \$0.14/kWh was used to estimate cost savings per kWh saved. This is a somewhat conservative value, as electricity rates will likely escalate in future years.
- Natural gas rates for the past two years ranged from an average \$1.16/therm (Public Safety) to \$1.32/therm (City Hall). Therefore, an average rate of \$1.20/therm was used to estimate cost savings per therm saved.

Based on the Association of Bay Area Government (ABAG) Benchmarking Study completed 1/12/07 (see Appendix E), some building optimization opportunities may exist to further reduce facility energy use. KEMA estimates that targeted functional testing of equipment, metering and performance monitoring, billing analysis can identify opportunities for system tune-ups to reduce facility energy use to close to the benchmarked quantity (kWh or therm per square foot).

For FY05-06, the ABAG program estimates that city facilities consume 2,515,000 kWh more than the benchmarked level. Based on KEMA's experience performing such building optimization projects, the estimated cost of such a study would be approximately \$76,000. The Nevada Building Optimization program indicates that tremendous savings are often possible in commercial and municipal buildings. A review of the Nevada program data for 2005 and 2006 indicates that savings of approximately 1.92 kWh per square foot of building, is available for no cost or very low cost. Therefore, estimated savings related to no cost/low cost measures are calculated by multiplying 1.92 kWh by 310,924 square feet of building space. This is a rough estimation, and does not include natural gas savings which would also be achieved through system optimization.

1. City Hall

Location: 456 W. Olive Avenue

Building square footage: 34,673

PG&E accounts: Electricity #1105922015 and #1105922030; Natural gas #1105922060 and #1105922050

Recent retrofits

The HVAC system was replaced in 2000.

Planned retrofits

According to Energy Solutions, the HVAC system consists of two multi-zone units on one variable air volume (VAV) air handler. The existing Honeywell control system is scheduled to be replaced in 2007-2008. Although control sequences are unknown, no significant problems have been reported. The system has a screw chiller, cooling tower with VFD on fan, and boiler. There are plans to convert the two multi-zone units to VAV system.

Potential new projects

Source: PG&E energy survey (December 26, 2006)

The PG&E audit identified several energy saving measures, including:

- Reducing lighting levels in stairwell. The area is deemed to be over lit. Recommendation to remove one existing fixture, or replace both with bi-level stairwell fixtures.
 - Information on current fixture type, quantity and operating hours would be needed to estimate savings.
- Install vending machine controller on two refrigerated machines. Vending machine controllers monitor the room's temperature and automatically re-power the vending machine at one to three hour intervals, to ensure that the vended product stays cold. Vending machine controllers are simple external plug-and-play products that generally require less than 15 minutes to install.
 - KEMA used DEER assumptions of:
 - Energy savings: 1612 kWh/controller

- Project cost: \$179/controller
- Incentive: \$90/controller
- Install variable frequency drive (VFD) controllers on VAV air handler unit (AHU) in West Wing. Per conversation with HVAC engineer Javier Lopez, the AHU is assumed to be 7.5 horsepower.
 - KEMA used the following DEER assumptions: 978 kWh saved annually per horsepower, project cost of \$222 per horsepower.
 - Sunnyvale estimated a total cost of \$12,000 for this project.

Based on interviews with HVAC engineer, Javier Lopez, and reviewing PG&E and Energy Solution audits reports, two additional potential projects were identified:

- Convert multizone to VAV. Per conversation with Javier, the square footage of City Hall is 34,600 square feet, with East Wing and Basement units sized at 10,700 cfm and 17,250 cfm, respectively.
 - This project is currently planned and was not included in the recommendations for additional projects.

2. City Hall Annex

Location: 650 W. Olive Avenue

Building square footage: 20,900

PG&E accounts: Electricity #1105922020; Natural gas #1105922040

Occasionally referred to as City Annex, this facility is currently working towards Green Building certification.

Recent retrofits

According to the PG&E audit (4-9-05), a new 75-ton screw chiller and a 750,000 BTU boiler with an energy management system were installed in September 2004. Energy Solutions also observed that the main air handler unit is variable air volume (VAV) with no fan modulation. The facility has been retrofitted with T8 lamps, as well as delamped for energy savings. In addition, occupancy sensors were observed in various rooms. Exit signs have been retrofitted with LED technology.

Planned retrofits

None identified at this time.

Potential new projects

The 4-9-05 PG&E audit identified several energy saving measures, including:

- Variable speed drive motors on HVAC fan motors. Per Javier Lopez, City Annex motors are 30 horsepower.
 - KEMA used the following DEER assumptions: 978 kWh saved annually per horsepower, project cost of \$222 per horsepower (total cost of \$6660).
 - Sunnyvale facilities estimated a cost of \$12,000 for this project.
- Re-wiring lights in print shop for reduced lighting and more control
 - A remodel is planned for FY08-09. In order to quantify the energy savings related to this project, an inventory of existing fixtures, operating hours and blueprints would be necessary to establish the baseline for current usage. Since the print shop is used infrequently and only for short periods of time, it was determined that information requests related to other projects should be prioritized.

Based on interviews with HVAC engineer, Javier Lopez, and reviewing PG&E and Energy Solution audits reports, two additional potential projects were identified. Note that these projects are mutually exclusive and either project can be implemented, but not both. Javier Lopez indicates that these cooling towers serve 70 tons of load.

- Cooling tower fan – two speed
 - This project was completed.

3. South Annex

Location: 603 All America Way

Building square footage: 5,100

PG&E accounts: Electricity #1105922055; Natural gas # n/a

Also known as City Hall – South Annex, this facility is currently working towards Green Building certification.

Recent retrofits

Exit signs have been replaced with LED signs. Timers control HVAC use.

Planned retrofits

None identified at this time.

Potential new projects

PG&E audit indicates that South Annex has not undergone lighting retrofits of overhead linear fluorescent lamps and ballasts to modern T8 lamps and electronic ballasts.

- Sunnyvale staff indicate that this project has been completed.

KEMA also identified one refrigerated vending machine which could have a vending machine controller installed to power down the vending machine when area is vacant.

- KEMA used DEER energy savings assumptions.
- Energy savings: 1612 kWh annually for a vending machine controller
- Project cost: \$179/controller
- Incentive: \$90/controller

4. Community Center

Location: 550 E. Remington Drive

Building square footage: 88,962

PG&E accounts: Electricity #1105922001 and #1105922150, Natural gas #1105922140

Senior Center accounts: Electricity #1105922584, Natural gas #1105922565

This facility is currently working towards Green Building certification. The Community Center consists of five main buildings: Creative Arts Center, Performing Arts Center and Theatre, Indoor Sports Center, Recreation Center and Senior Center (new building in 2002-2003).

Recent retrofits

In 2005, according to the PG&E audit 3-10-06, the Community Center gym installed T5 fluorescent lighting that can be controlled with three lighting banks. The new Senior Center has a modern energy management system (EMS), and an interactive photovoltaic solar system that is grid inter-tied. Most areas of the campus utilize modern T8 lighting and LED exit signs. Some compact fluorescent light bulbs are used in fixtures in place of incandescent lamps.

Creative Arts Center has rooftop units and split DX systems. Performing Arts Center currently has multizone (7 zones) unit located on roof, with 2 stages of cooling, 3 stages of heat and is controlled by DOS version of Trane Tracer system. This building also has 2 rooftop packaged units. The gym has a heating and ventilation unit located on the roof, with no cooling. The Recreation Center is one-half served by a built up DX system with duct furnace and the other half served by multizone unit similar to the Performing Arts Center. Refrigerator was recently replaced with energy-efficient models.

Planned retrofits

The Creative Arts Center and Theatre is targeted for replacement of the HVAC units and a new roof. Energy Solutions states that “all large major equipment is slated for replacement.”

Potential new projects

The PG&E audit 3-10-06 suggested:

- Installation of “cool roof” product on the Creative Art Center and Theatre buildings to minimize heat gain compared to existing tar and gravel roof. A roof retrofit is already planned.
 - This project is planned.
- Install occupancy sensors in dressing rooms, Rehearsal Room A, and other intermittent use areas.
 - To calculate potential savings, a thorough lighting inventory including type of fixture, quantity and operating hours would be required for each identified intermittent space.
- Reset domestic hot water tanks to minimum temperature of 110 degrees F.
 - Initial survey indicates 2 tanks in Theater building, 1 tank in Creative Arts Center building, 2 tanks in Recreation Center.
 - City staff indicates that current hot water temperature is already set between 110 – 120 degrees F.
- Raise temperatures on refrigerators in kitchens when not in use.
 - To estimate savings, data on current temperature and potential hours of non-use would need to be collected.
- Replace remaining incandescent flood lamps in corridors with reflector compact fluorescent lamps (CFLs).
 - This measure was already completed by City of Sunnyvale.
- Install vending machine controls on all 3 machines
 - KEMA used DEER energy savings assumptions. See previous calculation in City Hall section.
- Replace Dance Studio 460 watt metal halides with six fluorescent fixtures T5
 - KEMA used DEER energy savings assumptions.
 - Metal halides used 0.458 kW, with T5 using 0.232 kW
 - T5 are \$395 each, according to the PG&E work papers (BEST program documents)
 - Sunnyvale estimates that this project would cost \$7,500
- Retrocommission Senior Center to ensure that systems are still optimized.
 - This measure was not quantified at this time.

5. Corporation Yard

Location: 200 Commercial Street

Building square footage: 49,130

PG&E accounts: Electricity #1105922080 and #1105922085, Natural gas #1105922075

This facility consists of several buildings including fleet shops, administrative building, trailer, stores warehouse, sign shop and back area shops.

Recent retrofits

According to Energy Solutions, the HVAC system at the Corporation Yard consists of small split systems. Approximately two-thirds of the space is conditioned, with some areas having heat only. The administrative building has newer split systems. There are perhaps 5-6 older units.

The PG&E audit 2-15-07 identified that virtually all lighting fixtures throughout the Corporation Yard campus have been retrofitted with T8 lamps and electronic ballasts. Occupancy sensors were found throughout the campus to control lighting. Most of the campus has also undergone delamping of fixtures. Furthermore, the outdoor eave fixtures were retrofitted with circular compact fluorescent lamps.

Planned retrofits

None identified at this time.

Potential new projects

The PG&E audit identified a few potential areas for further energy efficiency:

- Replace older T12 lamps and magnetic ballast in Meter Shop with T8 lamps and electronic ballasts.
 - This project has been completed.
- Replace metal halide fixtures in Central Storage with six T5 fixtures.
 - DEER energy savings assumptions were used.
 - Metal halides used 0.458 kW, with T5 using 0.232 kW
 - Assume 2800 hours operation per year, and a cost of \$395 for each fixture
 - Sunnyvale estimates that this project would cost \$25,000
- Additional delamping
 - This measure would require facilities to revisit the delamping opportunities on an area by area basis, checking in with staff members about individual lighting needs and encourage staff to test further delamping opportunities in some areas that have not been delamped.
- Evaluate occupancy sensor performance and replace with new sensors
 - This project would require the identification of sensors that are not functioning well, and an inventory of fixture type and operating hours.
- Install vending machine controller on refrigerated beverage machines.
 - KEMA used DEER energy savings assumptions. See previous calculation in City Hall section.

6. Library

Location: 665 W. Olive Avenue

Building square footage: 60,870

PG&E accounts: Electricity #1105922065, Natural gas #1105922045

Recent retrofits

Major HVAC equipment was replaced at the Library in 2006. Some issues appear to remain with controls problems, but are being worked through as part of the warranty with the contractor. System has VAV reheat system with chiller and boiler. There is no VFD on the chiller, or balance valves on chilled or hot

water. Economizers are installed. PG&E audit 12-26-07 note that all lighting is T8 with electronic ballasts.

Planned retrofits

None identified at this time.

Potential new projects

Energy Solutions notes that there may be potential to save energy through control augmentation and operation improvements. The PG&E audit 12-26-07 suggests:

- Additional delamping in areas adjacent to skylight area and upstairs office/mezzanine area that is not over workstations.
 - Information on quantity of current lighting, type of fixtures and operating hours would be needed. The area under question is only about 900 square feet.
- Install occupancy sensors in conference room and all intermittent use areas.
 - Information identifying intermittent use areas would be needed, along with fixture count, type and operating hours.
- Install vending machine controller on refrigerated beverage machine.
 - KEMA used DEER energy savings assumptions. See previous calculation in City Hall section.
- Install variable frequency drive (VFD) controllers on air handler fans. Per Javier Lopez, air handler fans are 20 horsepower
 - DEER savings assumptions were used.
 - Energy savings: 978 kWh per horsepower
 - Project cost: \$222 per horsepower
 - Sunnyvale estimates this project would cost \$12,000
- Investigate high nighttime base load energy use.
 - Even after contractor tune-up of HVAC system, energy base load of 50-60 kW demands are observed throughout the night. City of Sunnyvale is recommended to review programming settings. Staff may wish to visit the Library after hours to investigate whether equipment is running during night time hours. Exterior lighting should also be examined.

7. Public Safety

Location: 700 All America Way

Building square footage: 40,950

PG&E accounts: Electricity #1105922035, Natural gas #4503192657

Recent retrofits

No information provided.

Planned retrofits

The HVAC system is scheduled to be replaced in 2007-2008.

Potential new projects

No PG&E or Energy Solutions audits were available for this facility. KEMA was provided information on two refrigerated vending machines and included the installation of vending machine controllers are a potential project.

- KEMA used DEER savings assumptions for vending machine controller project. See previous calculation in City Hall section.

8. Fire Stations

FS #1: 171 N. Mathilda Avenue, Square footage = 4415
Electricity #1105922130, Natural gas #1105922135

FS #2: 795 E. Arques Avenue, Square footage = 6609
Electricity #1105922095, Natural gas #1105922090

FS #3: 910 Ticonderoga Drive, Square footage = 4415
Electricity #1105922100, Natural gas #1105922105

FS #4: 996 Wolfe Road, Square footage = 4415
Electricity #1105922155, Natural gas #1105922160

FS #5: 1120 Lockheed Way, Square footage = 4415
Electricity #1105922120, Natural gas #1105922125

FS #6: 1282 N. Lawrence Station Road, Square footage = 4415
Electricity #1105922110, Natural gas #1105922115

Recent retrofits

A PG&E audit was performed in 2003, but Sunnyvale staff indicates that no retrofits were made in response to the audit. All of the fire stations have had at least one round of energy efficiency upgrades previously.

Planned retrofits

None identified at this time.

Potential new projects

The PG&E audit 2003 identified several energy saving measures, including:

- Replace remaining T12 fixtures with T8 lamps.
 - This project was completed.
- Install occupancy sensors in engine bays
 - PG&E Fire Station audit report (2003) values were used.
- Install 3 programmable thermostats in Fire Station #2
 - This project was completed.
- Replace single-pane, aluminum frame windows with double-pane windows to increase comfort level inside and reduce noise level from outside.
 - KEMA received detailed window square footage (1337 sq ft) from city staff to perform calculations and used DEER savings values
 - Full cost of double-paned windows is used here since there are no plans to retrofit windows. If City of Sunnyvale were planning to replace the windows already, then the incremental cost of double-paned windows may be used as the initial project cost, making the project more cost-effective.
 - \$18.48 per square feet is used for a total project cost of \$24,708
 - Sunnyvale estimates this project cost to be \$125,000

In addition to the PG&E audit suggestions, KEMA also included window sunscreen covers for Fire Stations since double-pane window replacement costs and payback period was so high. Window sunscreens work effectively during daytime hours and can offer a lower cost option for reducing electricity consumption related to air-conditioning.

- DEER energy savings assumptions were used for window sunscreen projects.

9. Water Pollution Control Plant

Location: 1444 Borregas Avenue

Building square footage: n/a

PG&E accounts: Electricity #0314283663 (0314283005?), Natural gas #0220504465 (0220504005?)⁴⁴

Recent retrofits

The buildings at the Water Pollution Control Plant (WPCP) were constructed between 1952 and the early 1980s. There are some 24 hour, 7 days a week operations with 32-35 staff at the facility. Currently, the cogeneration plant has a two engine 800 kW capacity system (1600 kW total) that runs on a mixture of digester gas, landfill gas and purchased natural gas. The cogeneration heat is used for digester heating and space heating.

According to Energy Solutions, “the administrative building has one roof top unit (RTU) serving the administrative areas. This unit operates continuously although the space is only occupied during normal business hours. The restrooms have one RTU.” The Lab has 2 RTUs: one that serves an office with electronic equipment, and one that serves an area with fume hoods. It is uncertain whether these RTUs are operating continuously even though lab hours are 8am – 5pm, with some occasional after-hours use.

The primary building has four floors with five RTUs for offices, exercise room and training room. All RTUs are manually controlled. Lighting fixtures are all T12s with motion sensors. The trailer has one window unit which operates 24/7.

Planned retrofits

None identified at this time.

Potential new projects

Energy Solutions indicates that there may be some opportunities for:

- Controls to reduce energy consumption related to 24/7 operation of HVAC systems.
 - This project was not assessed further, as an energy audit to address heating and cooling options plant-wide was underway.
- Replacement of T12 lamps and magnetic ballasts with high performance T8 lamps and electronic ballasts.
 - Energy savings and project costs from the Energy Solutions report are used here. See Appendix E. Total project cost was estimated to be \$14,028
 - Sunnyvale estimates this cost to be closer to \$20,000
- Due to the quantity of T12 lamps, a large potential for energy and cost savings were also identified for de-lamping some fixtures.
 - Energy Solutions suggests potential savings on the order of 25% in addition to the savings from the T12 to T8 retrofit

⁴⁴ Account numbers were provided by Julie Benabente in document “Consultant Info 010307.doc” The numbers in parentheses with question marks are the account numbers listed on the spreadsheet provided by the PG&E account representative Mike Wittig on 1/14/07. Now contained in file <City of Sunnyvale 1990 to 2006 usage v4.xls> Sheet “Customer Report2” Row 80 (electricity) and Row 103 (natural gas)

Electricity savings at the WPCP are expected to result in reduced natural gas consumption in the cogeneration plant. Therefore, cost savings related to electricity savings are estimated at \$0.094/kWh, with an emissions factor of 0.032 lbs CO₂/kWh (per Appendix A).

KEMA also notes that there are 2 refrigerated vending machines which are candidates for vending machine controllers.

- DEER energy savings assumptions were used. See previous calculation in City Hall section.

9. Appendix C – Detailed descriptions of fleet CO₂ emissions reduction options

Historic fleet size (originally provided by Mike Chan)

* denotes missing data, with fleet size estimated according to general trend

	Fleet size (# of vehicles)
FY89-90	574
FY90-91	*573
FY91-92	*571
FY92-93	*570
FY93-94	568
FY94-95	568
FY95-96	579
FY96-97	*589
FY97-98	*603
FY98-99	608
FY99-00	615
FY00-01	618
FY01-02	618
FY02-03	553
FY03-04	526
FY04-05	533
FY05-06	534

In general, the historic CO₂ emissions related to fleet operations are the greatest source of uncertainty related to the city emissions inventory. To be conservative, historic emissions were calculated using the historic fleet size (as estimated with missing data) and fuel consumption trends for FY00-01 through FY05-06.

Potential emissions reduction projects related to fleet operations are presented below, along with calculation methodology and assumptions.

Biodiesel projects

Use FY05-06 diesel consumption of 62,578 gallons
 B5 would offset 5% x 62,578 = 3128.9 gallons of diesel
 B20 would offset 20% x 62,578 = 12,515.6 gallons of diesel

Assume \$50 initial project cost per unit, related to fuel filter change out and other maintenance.
 100 diesel units x \$50 = \$5000 initial project cost

Hybrid vehicle replacement (assume 4 vehicles replaced per year)

Assume 5000 miles/year for each vehicle
 Fuel efficiency for conventional vehicle = 22 miles per gallon (mpg)

Fuel efficiency for hybrid vehicle = 40 mpg

Fuel consumption per year per conventional vehicle
 = 5000 mi/22 mpg = 227.3 gallons

Fuel consumption per year per hybrid vehicle
 = 5000 mi/40 mpg = 125 gallons

Gallons of gasoline saved = 227.3 – 125 gallons = 102.3 gallons

Assume cost of hybrid = \$23,650

Assume cost of conventional = \$18,700

Incremental cost = \$23,650-\$18,700 = \$4950 (assume incremental cost due to normal replacement schedule, vehicles would be replaced anyways)

Annual gasoline saved with 4 hybrids = 4 x 102.3 gallons = 409 gallons

Annual CO₂ benefit = 409 gallons x 19.43 lbs CO₂/gallon = 7948 lbs CO₂

Annual savings with 4 hybrids= 409 gallons x \$3.05 = \$1248

Initial project cost = 4 x \$4950 = \$19,800

Prioritize fuel efficiency (assume 4 vehicles replaced each year)

Assume 5000 miles/year for each vehicle

Fuel efficiency for conventional vehicle = 22 miles per gallon (mpg)

Fuel efficiency for slightly higher mpg = 24 mpg

Fuel consumption per year per conventional vehicle
 = 5000 mi/22 mpg = 227.3 gallons

Fuel consumption per year per slightly higher mpg
 = 5000 mi/24 mpg = 208 gallons

Gallons of gasoline saved = 227.3 – 208 gallons = 18.9 gallons

Assume no additional cost for 2 mpg higher efficiency of conventional vehicle

Annual gasoline saved with 4 higher mpg vehicles = 4 x 18.9 gallons = 75.8 gallons

Annual CO₂ benefit = 75.8 gallons x 19.43 lbs CO₂/gallon = 1472 lbs CO₂

Annual savings with 4 higher mpg vehicles = 75.8 gallons x \$3.05 = \$231.06

Summary of fleet emissions reduction projects analyzed

Specific target	Project description	Annual gasoline saved (gallons)	Annual diesel saving (gallons)	Annual CO ₂ benefit (lbs)	Annual operating cost (\$)	Initial project cost (\$)
Diesel vehicles	5% biodiesel (B5) in all diesel vehicles		3,115.74	65,586	\$ -	\$ 5000
Diesel vehicles	20% biodiesel (B20) in all diesel vehicles		12,462.96	262,345	\$ -	\$ 5000
Gasoline vehicles	Replace 4 vehicles with hybrid vehicles	409		7948	\$ (1248)	\$ 19.800
Gasoline vehicles	Replace vehicles only with more efficient models (2 mpg better), 4 vehicles a year	75.8		1472	\$ (231)	\$ -

10. Appendix D – Detailed descriptions of street lighting and traffic signal CO₂ emissions reduction options

Specific target	Project description	Annual kWh saved	Annual CO ₂ benefit	Annual PG&E bill savings	Initial project cost without rebates	Simple payback without rebates/with rebates
		(kWh)	(lbs)	(\$)	(\$)	(yrs)
Street lights	200 Watt HPS replaced with LED	1,196,370	681,930.90	\$ (167,491.80)	\$ 3,190,320	19/18
Street lights	150 Watt HPS replaced with LED	265,860	151,540.20	\$ (37,220.40)	\$ 620,340	17/15
Street lights	70 Watt HPS replaced with LED	350,935	200,033.06	\$ (49,130.93)	\$ 2,392,740	49/45

LED street lighting energy savings

Total 8862 street lighting fixtures.

According to Dennis Ng, the approximate distribution of HPS wattage is as follows:

- 45% are 200 watt HPS
- 45% are 70 watt HPS
- 10% are 150 watt HPS

200 watt HPS would be replaced with 125 watt LEDs

70 watt HPS would be replaced with 48 watt LEDs

150 watt HPS would be replaced with 75 watt LEDs

kWh savings are calculated using the following formula:

$$(\text{Old wattage} - \text{New wattage}) * (\# \text{ of fixtures}) * 4000 \text{ operating hours / year}$$

LED street lighting cost calculations

An LED street light retrofit requires the complete replacement of the head at the top of the pole. According to Dennis Ng, there are no PG&E rebates specifically for LED street lights, but there are general energy efficiency rebates of \$0.05 per kWh saved, which Mr. Ng estimated to be \$40-50 per unit.

Each LED fixture is estimated to cost approximately \$800/unit for the 125 watt LED, \$700/unit for the 75 watt LED, and \$600/unit for the 70 watt LED, per Dennis Ng.

In addition to energy savings, LEDs also last longer than conventional lighting technology and need only be replaced every five to twelve years. This results in reduced maintenance costs, which have not been quantified here.

11. Appendix E – Facility audit reports

Energy efficiency studies

1. PG&E Energy audits for Fire Stations #1-6 (2003)
2. PG&E City Annex Audit (4/8/2005)
3. PG&E Community Center Site Assessment (3/10/2006)
4. ABAG Energy Solutions Preliminary Benchmarking Analysis (11/30/06)
5. PG&E Energy Survey for City Hall, South Annex and Library (12/26/2006)
6. ABAG Energy Solutions Energy Efficiency Evaluation Survey (1/24/07)
7. PG&E Corporation Yard Site Survey (2/15/2007)
8. ABAG Energy Solutions Lighting Audit Report (4/12/2007)

Renewable energy study

1. SPG Solar Feasibility Study (2/5/2007)