3 – GREENHOUSE GAS EMISSIONS INVENTORY

INVENTORY BACKGROUND & METHODOLOGY

In 2010, the County of San Luis Obispo approved the 2006 Baseline GHG Emissions Inventory (Inventory) as part of the County's update of the Conservation and Open Space Element of the General Plan. The Inventory, prepared in 2009, identifies the major sources of GHG emissions within the unincorporated county[1] and from County government operations, and provides a baseline against which future progress can be measured.

The Inventory uses the baseline year of 2006 because of the availability of reliable data. The State of California uses 1990 as a reference year to remain consistent with the Kyoto Protocol and also because the AB 32 Scoping Plan has well-kept records of transportation trends and energy records in that year.

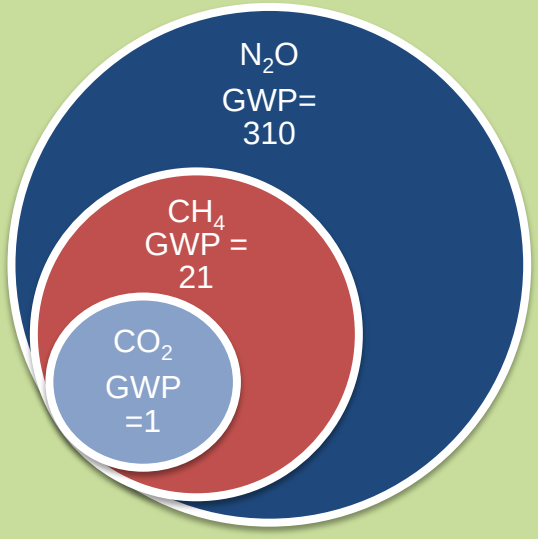
GHG emissions from County government operations were calculated following the Local Government Operations Protocol, which has been developed and continually updated by the California Air Resources Board (CARB), ICLEI – Local Governments for Sustainability (ICLEI), and The Climate Registry (TCR). Currently there is no standard protocol for calculating GHG emissions from community-wide sources. There are sources of GHG emissions (e.g., refrigerants and water reservoirs) that contribute GHGs, but these are difficult or impossible to calculate at the local level. Furthermore, it is likely that new methodologies will be developed to assess additional sources of GHGs in the future and that our method of calculating present emissions will change as technology and science develop. Both the County government operations and community-wide baseline inventories were calculated using the Clean Air and Climate Protection (CACP) Software developed by ICLEI in partnership with the National Association of Clean Air Agencies (NACAA) and Torrie Smith Associates.

The County's Baseline GHG Inventory was calculated using the Clean Air and Climate Protection Software developed by ICLEI in partnership with the National Association of Clean Air Agencies (NACAA) and Torrie Smith Associates.

[1] In this report the term "county" refers to the area inside the jurisdictional boundary of San Luis Obispo County, whereas "County" refers to those activities which are under the operational control of County agencies.

The Inventory measures three primary GHG emissions—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O)—as defined in Chapter 2 of this Plan. These greenhouse gases are then converted to carbon dioxide equivalents (CO_2e), enabling the County to consider different greenhouse gases in comparable terms. The conversion of greenhouse gases is done by comparing the global warming potential (GWP) of each gas to CO_2. For example, methane (CH_4) is 21 times more powerful than CO_2 on a per weight basis in its capacity to trap heat, and therefore one metric ton of CH_4 would be calculated as 21 $MTCO_2e$, while nitrous oxide (N_2O) is 310 times more powerful than CO_2 (see **Figure 3-1**).

Figure 3-1. Global Warming Potentials of CO_2, CH_4, and N_2O*



**Note: This figure is not drawn to scale.*

Inventory Structure

The Inventory is split into a community-wide baseline inventory, detailing the sources of emissions from activities within the unincorporated areas of San Luis Obispo County, and a County operations baseline inventory, determining the sources and quantities of GHG emissions from activities on County-owned or -operated property or by County employees.

The community-wide baseline GHG inventory has been divided into six sectors, or sources of emissions. Sources of GHG emissions for the community-wide inventory include residential energy use, commercial and industrial energy use, on-road transportation, solid waste, agriculture (livestock, fertilizer, and off-road agriculture equipment), and aircraft. Calculating GHG emissions by sector allows the County to align emissions reduction programs with the largest sources of emissions, making the Inventory an integral component of the County's sustainability efforts.

The County government operations inventory provides a more detailed analysis of the County's streetlights, building energy use, fleet vehicles, waste disposal, and more. Conducting a more in-depth analysis of County operations by individual facility or vehicle allows the County to incorporate potential emissions reductions into

budget and capital improvement decisions when upgrading County facilities or purchasing new vehicles.

Data Collection and Methodology

Creating the community-wide and County government operations emissions inventories required the collection of data from a variety of sources. Data sources for both inventories include:

Community-Wide Inventory Data Sources

- Pacific Gas & Electric Company (PG&E)
- Southern California Gas Company
- California Integrated Waste Management Board
- San Luis Obispo Air Pollution Control District
- SLO County Department of Agriculture
- California Air Resources Board
- Fehr & Peers

County Government Operations Inventory Data Sources

- Pacific Gas & Electric Company (PG&E)
- Southern California Gas Company
- SLO County General Services Agency
- SLO County Sheriff's Department
- SLO County Planning Department
- SLO County Public Works Department
- SLO County Fire Department (Cal Fire)

For community activities and government operations, emissions sources are categorized by scope. Scopes help to identify where emissions originate and what entity retains regulatory control and the ability to implement efficiency measures. The scopes are illustrated in **Figure 3-2** and are defined as follows:

- **Scope 1** – Direct emissions sources located within the unincorporated areas of the county, primarily from combustion of fuels. Examples of Scope 1 sources include the use of fuels such as gasoline or natural gas. GHG emissions from off-road agriculture equipment and nitrogen fertilizer application are considered Scope 1 emissions.

What is a Scope?

Scopes help us to identify where emissions originate and what entity retains regulatory control and the ability to implement efficiency measures.

Scope 1 emissions come from the combustion of fuels such as gasoline or natural gas.

Scope 2 are indirect emissions from purchased electricity used in the unincorporated county.

Scope 3 are all other indirect emissions sources including methane from solid waste, crop fertilization, or other sources of emissions.

- **Scope 2** – Indirect emissions that result because of activities in the unincorporated areas of the county and limited to electricity, district heating, steam and cooling consumption. Scope 2 emissions sources include purchased electricity used in the unincorporated areas and associated with the generation of greenhouse gas emissions at the power plant. These emissions should be included in community-wide analysis, as they are the result of the community's electricity consumption.

- **Scope 3** – All other indirect emissions that occur as a result of activity in the unincorporated areas. Examples of Scope 3 emissions include methane emissions from solid waste generated within the community, which decomposes at landfills either inside or outside of the unincorporated areas of the county. Methane emissions from livestock are considered Scope 3.

San Luis Obispo County's Emissions by Scope

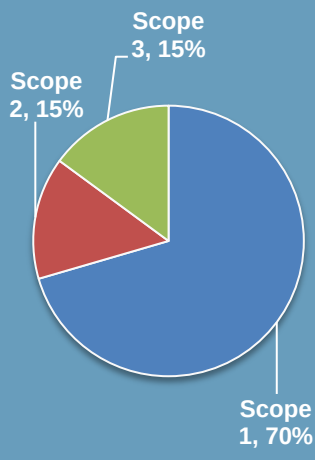
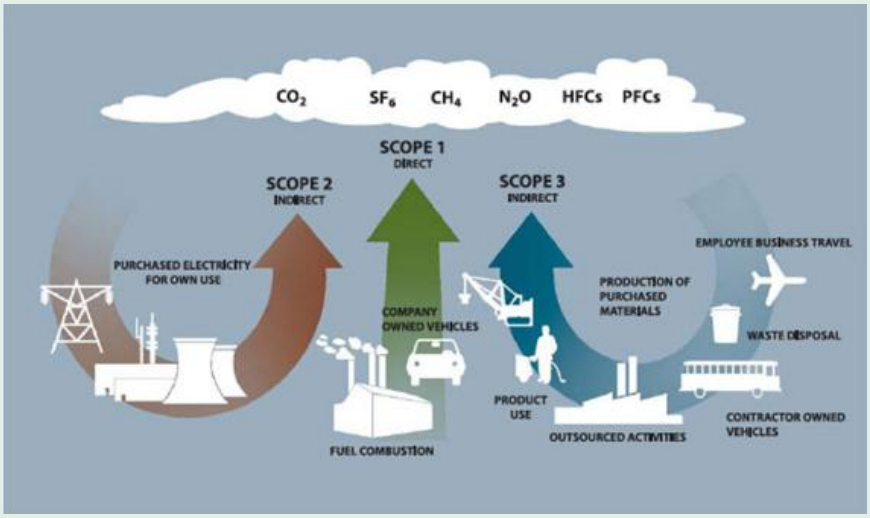


Figure 3-2. GHG Emissions by Scope



Source: New Zealand Business Council for Sustainable Development. 2002. The Challenge of GHG Emissions: The "why" and "how" of accounting and reporting for GHG emissions: An Industry Guide

Data Limitations

The Inventory was developed with the best-available tools, data, and methodology; however, as with any GHG inventory, there are limitations to representing all sources of emissions in a local

jurisdiction. The main factors that limit GHG inventories include (1) data availability, (2) privacy laws, and (3) a lack of a reasonable methodology. The following sections highlight emissions that cannot be included in a GHG inventory due to the factors listed above.

The main factors that limit GHG inventories include:

1. Data Availability
2. Privacy Laws
3. Lack of Reasonable Methodology

Data Availability

Lack of available data prevented the calculation of emissions from the following sources for the following reasons:

- **Rail and port emissions** –The California Air Resources Board OFFROAD 2007 software provides emissions from rail and port activities. However, these numbers are aggregated for the entire San Luis Obispo County area, which includes incorporated, unincorporated, and state or federally owned land. Without data specific to unincorporated areas and without a reasonable methodology for attributing these activities to the unincorporated areas within the county, these emissions cannot be accurately included in the community-wide GHG inventory.

- **Propane use** – Propane is essentially an unregulated fuel in California (except for storage and safety issues, which are regulated). Because it is an unregulated commodity, no data is collected by the State on propane sales or usage. Collecting propane usage data at the local level would be difficult and, since it is not a required part of an inventory, it is not included.

- **Refrigerants** – Similar to propane, above, the amount of fugitive refrigerant emissions cannot be calculated because sales are not tracked.

Privacy Laws

A California Privacy law, known as the 15/15 rule, require commercial and industrial electricity and natural gas to be aggregated when released to the County for analysis. The California 15/15 rule was adopted by the California Public Utilities

Commission in the Direct Access Proceeding (CPUC Decision 97-10-031) to protect customer confidentiality by requiring that any disaggregated information provided by the utilities must include at least 15 customers and that a single customer's load must be less than 15% of an assigned category. If the number of customers in the compiled data is below 15, or if a single customer's load is more than 15% of the total data, categories must be combined before the information is released.

Privacy laws such as California's 15/15 rule limit the release of certain energy data if there are less than 15 customers or any single customer accounts for more than 15% of the sectors total energy use.

Life-Cycle Emissions

A lack of a reasonable methodology prevents estimation of life-cycle emissions for the community. Life-cycle emissions are emissions associated with the production and disposal of items consumed by a community (i.e., "cradle to grave"). For instance, a life-cycle assessment of vehicle emissions would include those from the design, extraction of raw materials, production, delivery, and disposal of each car in the county. In contrast, this Inventory only captures how much that car is driven in the county consistent with standard protocol.

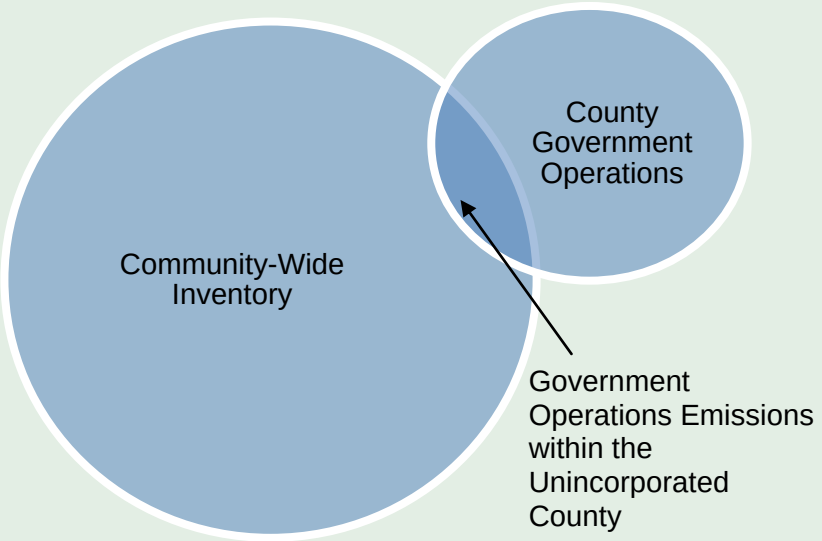
Review of similar inventories, including the California Greenhouse Gas Inventory prepared by the California Air Resources Board (CARB), indicates that those sources not included in the Inventory for the reasons stated above comprise only a small portion of total emissions in the county. Once CARB adopts a community-wide protocol, it is likely that methodology and accessibility to data will improve. The emissions identified in this report are primarily GHGs that the community has directly caused and has the ability to reduce through implementation of conservation actions, a GHG reduction plan, or corresponding efforts.

Relationship Between the Community-Wide and County Operations Inventory

It is important to note that some of the County government emissions are a subset of the community-wide inventory, depending on the location of each facility and where the County's vehicles are used. Any County-operated facility located in the unincorporated areas of the county would be a subset of the community-wide

inventory, as the facility's energy use or waste disposal would be reported within the community-wide data. It is best to think of the two inventories as overlapping, where some of the County government operations emissions fall within the community-wide inventory, while the remaining emissions would fall into the GHG emissions inventories of the incorporated cities within the county.

Figure 3-3. Relationship Between Community-Wide and County Operations Inventory



For example, the County's main jail, located in the unincorporated area of the county, would be classified under the commercial/industrial energy use within the community-wide inventory, while the County Government Center, located in the City of San Luis Obispo, is included in the commercial/industrial energy use in the City of San Luis Obispo's community-wide inventory.

GREENHOUSE GAS EMISSIONS INVENTORY UPDATE

Purpose of the Update

In 2010, the community-wide and County operations inventories were updated as part of the Plan development to ensure that they utilize accurate information and up to date methodology. The government operations inventory has been updated to adhere to

the Local Government Operations Protocol version 1.1 released in May 2010 by CARB. Community-wide GHG inventories, unlike municipal GHG inventories, do not have a protocol to follow. Community-wide inventories instead rely on best practices and a draft international protocol named the International Local Government GHG Emissions Analysis Protocol (IEAP) version 1.0 developed by ICLEI. The community-wide inventory was revised to include up-to-date data for key sectors as discussed below.

Revised Community-Wide GHG Inventory Sectors

Transportation

The transportation sector of the community-wide inventory has been updated to provide a more accurate estimate of transportation emissions that the County has the ability to control. The original inventory analysis calculated emissions from vehicle miles in the jurisdictional boundaries of the unincorporated county using Caltrans Highway Performance Monitoring System data. This approach attributes all miles traveled on roadways in the unincorporated county, including through traffic where vehicles do not have an origin or destination within the unincorporated areas. The updated analysis utilizes the San Luis Obispo Council of Governments (SLOCOG) transportation demand forecast model to develop transportation-related GHG emissions data and vehicle miles traveled (VMT) for trips that have an origin and/or destination in the unincorporated county.

To refine this sector, a land-use-based approach was used to allocate vehicle trips and VMT to unincorporated San Luis Obispo County by weighting trips based on their origin and destination.

- Internal Trips: All VMT associated with trips made in the unincorporated county were attributed to the unincorporated county.
- Internal-External Trips: Half of the VMT associated with trips from an origin within the unincorporated county and a destination outside of the unincorporated county.

- External-Internal Trips: Half of the VMT associated with trips from an origin outside of the unincorporated county and a destination within the unincorporated county.

- External-External Trips: Trips through unincorporated San Luis Obispo County without an origin or destination within the unincorporated county are not included.

Appropriating VMT and vehicle trips to the unincorporated county using this method resulted in 660 million miles of vehicle travel in 2006.

Annual VMT was then analyzed to determine GHG emissions from vehicle travel using the Emissions Factor (EMFAC) 2007 model developed by the California Air Resources Board. EMFAC 2007 uses emissions rates for different types of vehicles in conjunction with travel activity statistics to calculate vehicle based emissions in $MTCO_2$ per day. $MTCO_2$ per day is then converted into annual $MTCO_2e$ by multiplying daily emissions by 347 to account for reduced vehicle activity on weekends and multiplied by 100/95[2] to convert CO_2 into CO_2e.

Agriculture – Crop Fertilizer

In addition to the transportation sector update to the community-wide inventory, the "other" sector was also updated to include emissions from fertilizer application on agricultural land. Synthetic fertilizers are used to increase crop yields through increased input of nitrogen into the soils, which undergo two microbial processes that convert this nitrogen into nitrous oxide emissions.[3] The production of nitrous oxide is complex and affected by multiple factors, including temperature, moisture content, and oxygen concentrations in the soil.[4] Nitrous oxide (N_2O) contributes only a small percentage of total U.S. greenhouse gas emissions; however,

Nitrous oxide (N_2O) contributes only a small percentage of total U.S. greenhouse gas emissions; however, fertilizer application is one of the largest contributors to all N_2O emissions.

[2] United States Environmental Protection Agency 2005.

[3] Paustian, et al. 2006.

[4] Snyder, et al. 2009.

fertilizer application is one of the largest contributors to all N_2O emissions.

Agriculture plays a major role in the county's economy, with an annual crop yield worth an estimated $623 million in 2009[5]. Accurately accounting for emissions related to agriculture will help guide future policy decisions to reduce greenhouse gas emissions in balance with economic considerations in the agriculture sector. Due to the range of crops grown within the county, it was not feasible to gather fertilizer use data for each crop. Instead the 2006 San Luis Obispo County Crop Report was used to identify the top three crops by acreage (i.e., fruits and nuts, vegetables, and field crops).

The average amount of nitrogen fertilizer used in farming practices was identified with the assistance of the local Farm Advisor and the University of California Cooperative Extension's cost study reports. Utilizing both the local Farm Advisor and the UC Cooperative Extension data ensures that the data for average fertilizer application and nitrous oxide emissions was representative of local soil conditions and microclimates within the county.

Aircraft – Landings and Take-offs

The emissions within the "other" sector for aircraft account for emissions associated with aircraft landings and take-offs at the San Luis Obispo County Regional Airport and the Oceano County Airport, the two commercial and general aviation facilities located within the unincorporated areas of San Luis Obispo County.

Following the completion of the initial 2006 community-wide baseline inventory, the Airport Cooperative Research Program (ACRP) released the "Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories" in 2009.[6] The guidelines provide a methodology for inventorying GHG emissions related to aircraft and airport operations. While the report is intended to provide directions for conducting a facility-scale emissions inventory, the methodology

[5] County of San Luis Obispo, 2009.

[6] Transportation Research Board 2009.

can be adjusted to calculate community-wide Scope 3 emissions from aircraft landing and takeoff operations (LTO). The methodology used in this inventory diverges from ACRP guidelines in that it only includes emissions associated with the aircraft operations that directly impact air quality in the unincorporated county, and not the GHG emissions from aircraft through the duration of the flight. LTO operations are defined as the aircraft operations that occur below 3,000 feet in altitude, which is often considered the inversion layer level where emissions have a direct impact on the community's air quality.

Calculating emissions from aircraft landings and take-offs requires detailed information on the make and model, as well as engine types, of aircraft, and the annual number of landings and take-offs, all of which were provided in an engineering report prepared by SLO APCD in 2008. The number of landings and take-offs for each aircraft arriving and departing the San Luis Obispo County Regional Airport and the Oceano County Airport was entered into the Federal Aviation Administration's (FAA) Emissions and Dispersion Modeling System (EDMS)[7] to calculate the CO_2 emissions and fuel consumed during landing and take-off periods. Methane and N_2O were calculated using the fuel coefficients provided by the ACRP guidebook and converted into CO_2e. In total, updates to the community-wide greenhouse gas emissions inventory provide a more accurate account of the GHGs emitted in 2006, but do not significantly change any sector's contribution to the total community-wide emissions total.

For additional details on the 2010 Inventory review and update, please refer to **Appendix A.**

Updated 2006 Baseline Community-Wide Greenhouse Gas Emissions Inventory

The community-wide inventory with updated emissions sources provides the basis for developing the emissions reduction measures presented in this Plan. The inventory findings are presented in **Figure 3-3** and **Table 3-1.**

[7] Federal Aviation Administration Office of Environment and Energy 2009.

The primary sectors of GHG emissions are transportation (40%), commercial and industrial energy (24%), agriculture (off-road equipment, livestock, and crops) (18%), residential energy (15%), waste (3%), and aircraft (less than 0.1%).

Figure 3-4. Unincorporated San Luis Obispo County 2006 GHG Emissions

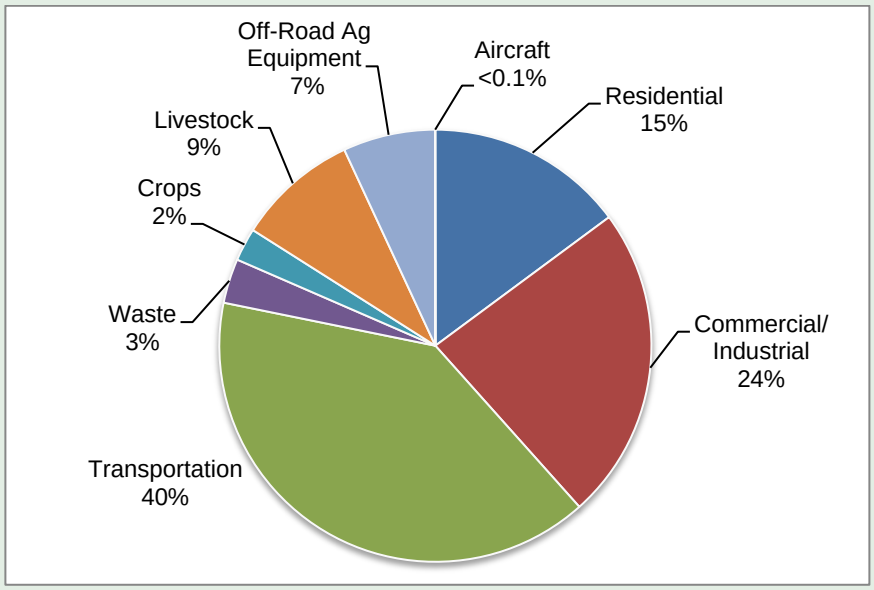


Table 3-1. Unincorporated San Luis Obispo County 2006 GHG Emissions

	2006 GHG Emissions ($MTCO_2e$)	Percentage of Total Emissions
Residential	136,360	15%
Commercial/Industrial	215,970	24%
Transportation	365,260	40%
Waste	30,540	3%
Other – Crops	22,630	2%
Other – Livestock	83,420	9%
Other – Off-Road Equipment	63,280	7%
Other – Aircraft	240	< 0.1%
Total	917,710	100%[1]

1. Due to rounding, the sum of individual values may not equal the total given.

Revised County Operations GHG Emissions Sectors

Employee Commute

As part of Plan preparation, a peer review of the County government operations GHG emissions inventory was completed to ensure accuracy and update the inventory consistent with the Local Government Operations Protocol version 1.1, released in May 2010. As part of the peer review, the findings of the employee commute survey were updated. While the updated employee commute emissions are significantly less than the original inventory, the sector still accounts for the largest portion of the County's operational emissions. The updated County operations inventory findings are presented in **Figure 3-4** and **Table 3-2** below.[8]

Updated County Operations GHG Emissions Inventory

The County operations inventory with updated emissions sources provides the basis for developing the emissions reduction measures presented in this Plan. The inventory findings are presented in **Figure 3-5** and **Table 3-2.**

The primary sectors of GHG emissions are employee commute (46%), buildings (30%), vehicle fleet (20%), water/sewage (2%), waste (2%), streetlights (0.4%), and other (<0.1%).

County Operations are inventoried and assessed because the County has financial and operational control to make changes to operations that will save the County energy and the taxpayers money.

[8] California Air Resources Board, California Climate Action Registry, ICLEI-Local Governments for Sustainability, and The Climate Registry 2010.

Figure 3-5. San Luis Obispo County Operations 2006 GHG Emissions

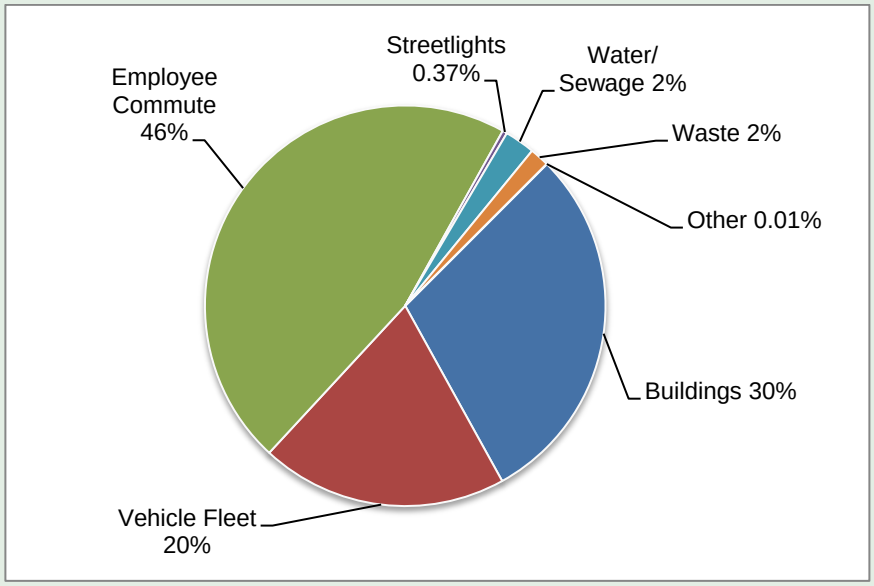


Table 3-2. San Luis Obispo County Operations 2006 GHG Emissions

	2006 GHG Emissions ($MTCO_2e$)	Percentage of Total Emissions
Buildings	4,970	30%
Vehicle Fleet	3,360	20%
Employee Commute	7,800	46%
Streetlights	60	0.4%
Water/Sewage	410	2%
Waste	270	2%
Other	<10	<0.1%
Total	16,870	100%[1]

1. Due to rounding, the sum of all numbers may not add up to 100.0%.

The baseline inventories for both community-wide and County operations will be the basis for the GHG emissions forecasts and development of emissions reduction targets presented in Chapter 4.

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