City of Carmel

2015 Community-wide Greenhouse Gas Inventory

CITY OF CARMEL 2015 COMMUNITY-WIDE GREENHOUSE GAS INVENTORY

PREPARED FOR:

The City of Carmel

Monte Verde Street, Carmel, California 93921

Phone: 831.620.2000

Fax: 831.620.2004

PREPARED BY:

The Association of Monterey Bay Area Governments | Energy Watch

24580 Silver Cloud Court, Monterey, CA 93940

PO Box 2453 Seaside, CA 93955

Phone: 831.883.3750

Fax: 831.883.3755

FEBRUARY 2018

TABLE OF CONTENTS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Carmel's 2015 Community-wide GHG Inventory totals 27,458 metric tons of carbon dioxide equivalent (CO_2e). This represents a 33 percent reduction from the 2005 Baseline Community-wide GHG Inventory. This decrease is the result of emission reductions across four sectors primarily. It is important to note that while analysis of GHG inventory data every five years can identify the amount of change; this type of analysis does not specifically identify the factors that contribute to the changes and their level of contribution. Certain general factors that are able to be identified are noted below, but it should be understood that these are only general contributing factors and not the sole factors responsible for the total GHG changes. Figure 1 shows the 2005 to 2015 GHG emissions by sector.

In the transportation sector emission, reductions of 45 percent occurred from 2005 to 2015. During this period there continued to be an increase in the required fuel efficiency standards. Vehicle Miles Travelled (VMT) were also reduced from 2005 to 2015 on local roads in Carmel. The residential sector also achieved a 21 percent reduction from 2005 to 2015. This can be attributed, in part, by the specific composition of energy delivered by Pacific Gas & Electric Company (PG&E) to include both more renewable energy and energy generated from large hydro operations in their energy mix during this time period. In the solid waste sector, a decrease in the actual tonnage of waste sent to the landfills yielded a 50 percent reduction in emissions. In the commercial and industrial sector there was a 24 percent reduction in emissions from 2005 to 2015. This can be attributed, in part, to decreases in the use of electricity and natural gas.

Figure 1:

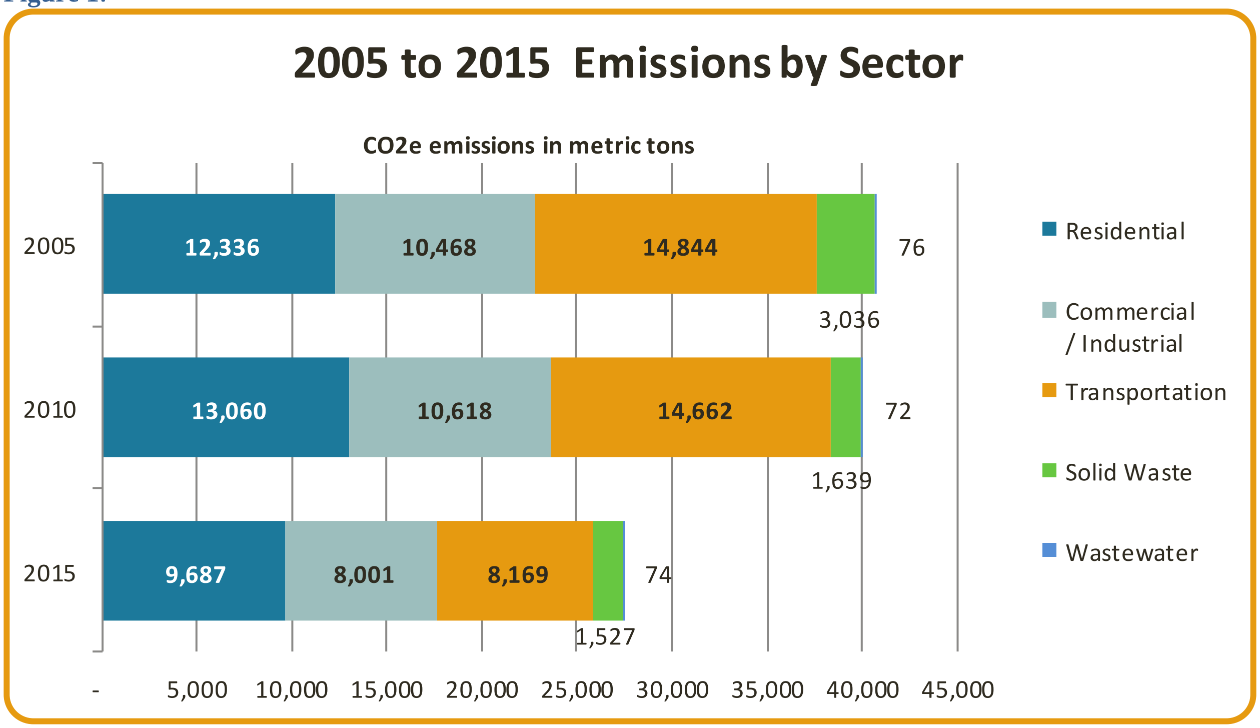

Table 1 summarizes the results of the 2005 Baseline Community-wide GHG Inventory, 2010 Community-wide GHG Inventory and 2015 Community-wide GHG Inventory, broken out by sectors. The percentage change from the 2005 inventory to the 2015 inventory is a reduction of 33 percent.

Table 1:

Community CO2e Emissions by Sector	Residential	Commercial / Industrial	Transportation	Solid Waste	Wastewater	Total
2005	12,336	10,468	14,844	3,036	76	40,760
2010	13,060	10,618	14,662	1,639	72	40,051
2015	9,687	8,001	8,169	1,527	74	27,458
% change 2005- 2015	-21%	-24%	-45%	-50%	-3%	-33%

2015 COMMUNITY-WIDE GHG INVENTORY

2.1 2015 Community-wide GHG Inventory Methodology

When the 2005 Baseline Community-wide GHG Inventory was undertaken for the City of Carmel, it was done so as part of an Association of Monterey Bay Area Governments (AMBAG) regional effort to develop the 2005 baseline GHG inventory reports for all of the AMBAG jurisdictions. At that time only two jurisdictions had completed a 2005 baseline inventory and both of these jurisdictions had utilized the ICLEI method for accounting and reporting of greenhouse gas emissions. As such, the AMBAG jurisdictions voted to use this ICLEI method for all of the remaining AMBAG 19 jurisdictions so that the AMBAG region would have a unified reporting method. In subsequent years this ICLEI method was adopted at the federal level as the *US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*. The State of California supports the use of the *US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* by providing the software at no cost to jurisdictions as well as providing technical support. In the AMBAG region, the 2005, 2010, and 2015 community-wide GHG inventories for all 21 jurisdictions have been completed using the *ICLEI US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*.

Over the intervening years, technological methodologies changed within the ICLEI software and have impacted the inventory data, with the goal of incorporating developing best practices. Policy changes have contributed changes to the community-wide inventory, to include data sets that had not been included in earlier iterations of the inventory. The California Air Resources Board's vehicle emissions model, EMFAC, has undergone similar technological and best practices updates. Transportation emissions are calculated using this modeling tool.

Given the amount of changes that have occurred in the tools, best practices, and policies surrounding the calculation of community-wide GHG inventories, it was necessary to go back to 2005 and 2010 and re-do these inventories as well as complete the new 2015 inventory in order to have an "apples to apples" comparison. This 2015 Community-wide GHG Inventory does include the updates completed on the 2005 and 2010 community-wide inventories as well to achieve this objective. Details on the methods used are included in Appendix A and Appendix B.

2.2 2015 Community-wide GHG Emissions by Sector

Many local governments find a sector-based analysis most relevant to policymaking and project management, as it assists in formulating sector-specific reduction measures and climate action plan components. This inventory evaluates community emissions from the following sectors:

- Residential
- Commercial and Industrial
- Transportation
- Solid Waste
- Wastewater

The community of Carmel emitted 27,458 metric tons of CO_2e in 2015. As visible in Figure 2 and Table 2, 30 percent of emissions are from the transportation sector, and were generated by fuel use from travel on local roads. Emissions from electricity and natural gas usage in the residential sector generated 35 percent of emissions, while electricity and natural gas consumption in the commercial sector generated 29 percent of emissions. The disposal of waste generated by Carmel residents and businesses in 2015 caused 6 percent of total emissions. The remaining 0.3 percent of emissions was generated from wastewater treatment processes.

Figure 2:

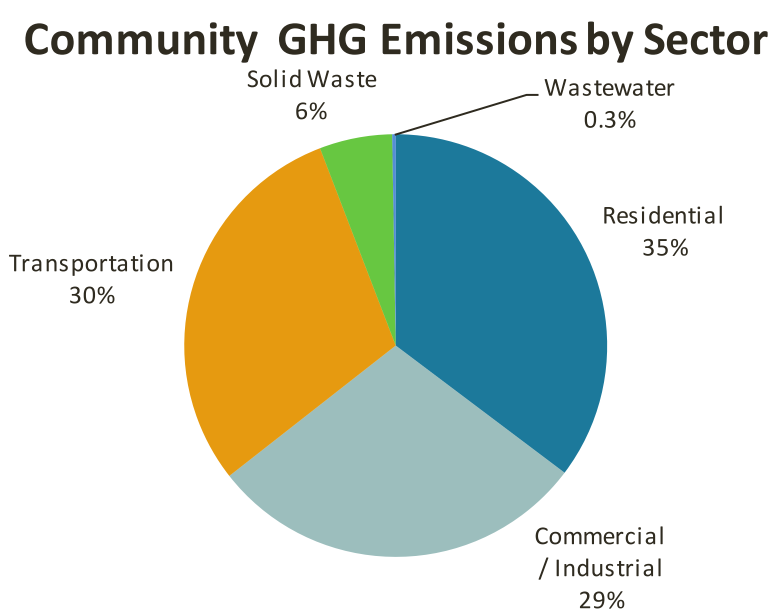

Table 2:

2015 Community Emissions by Sector	Residential	Commercial / Industrial	Transportation	Solid Waste	Wastewater	Total
CO2e (metric tons)	9,687	8,001	8,169	1,527	74	27,458
% of Total CO2e	35%	29%	30%	6%	0.3%	100%

2.2.1 Residential Sector

Carmel's residential sector generated 35 percent of community-wide GHG emissions in 2015 or 9,687 metric tons of CO_2e. Emissions were calculated using 2015 electricity and natural gas consumption data provided by PG&E, and only include consumption through residential buildings. Data on residential equipment usage is not included in this inventory. GHG emissions associated with residential transportation and residential waste generation are included separately in the transportation and waste sector emission totals.

Table 3 provides information on residential emissions on a per household basis. Carmel's households generated 4.6 metric tons of GHG emissions each in 2015. Per household emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing Carmel's rate of emissions with neighboring cities and against regional averages.

Table 3:

Number of Occupied Housing Units	2,120
Total Residential GHG Emissions (metric tons CO2e)	9,687
Residential GHG Emissions/Household (metric tons CO2e)	4.6

Figure 3 and Table 4 illustrate the breakdown of residential GHG emissions by fuel type. Natural gas usage comprised 74 percent of emissions. Natural gas is used in residences for space heating, water heating, and cooking. Electricity usage comprised 26 percent of emissions. In addition to lighting, appliances, and electronics, electricity is used for the same purposes as natural gas.

Figure 3:

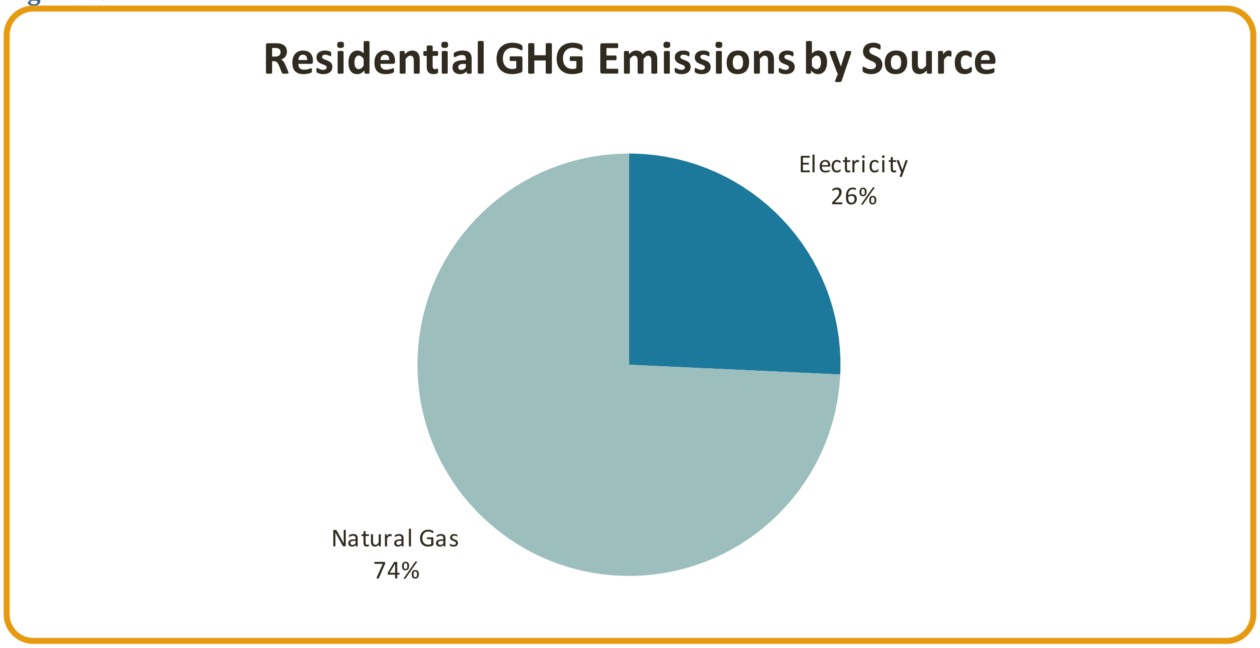

Table 4:

Residential Emission Sources 2015	Electricity	Natural Gas	Total
CO2e (metric tons)	2,493	7,194	9,687
% of Total CO2e	26%	74%	100%

2.2.2 Commercial and Industrial Sector

As mentioned previously, Carmel's businesses and industries generated 29percent of community-wide GHG emissions in 2015, or 8,001 metric tons of CO_2e. PG&E was not able to provide a breakdown between commercial and industrial electricity and natural gas consumption due to the California Public Utilities Commission's (CPUC) 15/15 rule[1].

Figure 4 and Table 5 illustrate the breakdown of commercial and industrial sector GHG emissions by fuel type. Natural gas usage comprised 63percent and electricity comprised 37 percent of emissions.

Figure 4:

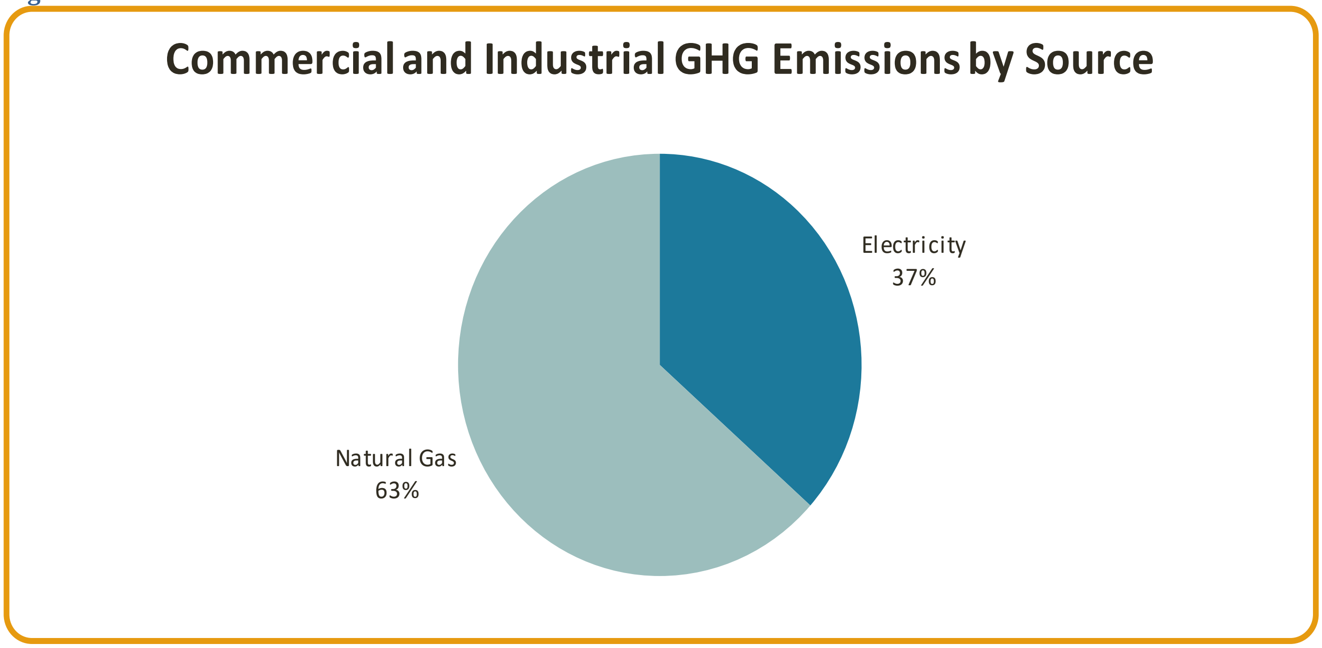

Table 5:

Commercial and Industrial Emission Sources 2015	Electricity	Natural Gas	Total
CO2e (metric tons)	2,928	5,073	8,001
% of Total CO2e	37%	63%	100%

[1]The 15/15 Rule was adopted by the CPUC in the Direct Access Proceeding (CPUC Decision 97-10-031) to protect customer confidentiality. If the number of customers in the compiled data is below 15, or if a single customer's load is more than 15 percent of the total data, categories must be combined before the information is released. With the development of smart meters, the CPUC engaged in further proceedings regarding customer data privacy with the result that more extensive data regulatory processes were developed.

2.2.3 Transportation Sector

As mentioned previously, Carmel's transportation sector generated 30 percent of community-wide GHG emissions in 2015, or 8,169 metric tons of CO_2e. The transportation sector analysis includes emissions from all vehicle use on local roads within Carmel's jurisdictional boundaries. Emissions from air travel of Carmel's residents were not included in the transportation sector analysis.

2.2.4 Solid Waste Sector

As mentioned previously, the solid waste sector accounted for 6 percent of community-wide GHG emissions in 2015 or 1,527 metric tons of CO_2e. Emissions from the solid waste sector are an estimate of methane generation from the anaerobic decomposition of organic wastes (such as paper, food scraps, plant debris, wood, etc.) that are deposited in a landfill. Transportation emissions generated from the collection, transfer and disposal of solid waste are included in transportation sector GHG emissions.

2.2.5 Wastewater Sector

As mentioned previously, the wastewater sector accounted for 0.3 percent of community-wide GHG emissions in 2015 or 74 metric tons of CO_2e. This sector accounts for the operation of wastewater treatment facilities used to treat wastewater from Carmel.

Wastewater coming from homes and businesses is rich in organic matter and has a high concentration of nitrogen and carbon (along with other organic elements). As wastewater is collected, treated, and discharged, chemical processes can lead to the creation and emission of two greenhouse gases: methane and nitrous oxide. Methane is generated under anaerobic conditions, which could occur at centralized facilities or septic tanks; however, many centralized treatment facilities utilize aerobic processes, for which methane is not a significant concern. Nitrous oxide is emitted at facilities that utilize nitrification and denitrification of wastewater.

2.2.6 Per Capita Emissions

Per capita emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing one community's emissions with neighboring cities and against regional and national averages. However, due to differences in GHG inventory methods, it may be difficult to obtain comparable per capita emission figures.

As detailed in Table 6, dividing total community GHG emissions by population yields a result of 7.2 metric tons of CO_2e per capita. It is important to understand that this number is not the same as the carbon footprint of the average individual living in City of Carmel (which would include lifecycle emissions).

Table 6:

Estimated 2015 Population	3,824
Community GHG Emissions (metric tons CO2e)	27,458
GHG Emissions / Resident (metric tons CO2e)	7.2

PREVIOUS INVENTORIES

3.1 2005 Baseline Community-wide GHG Inventory

In 2009, AMBAG Energy Watch assisted the City of Carmel with the creation of the 2005 Baseline Community-wide GHG Inventory. This work was completed under the guidance and training provided by ICLEI staff as part of a program funded for all AMBAG jurisdiction by the AMBAG Energy Watch Program. Table 7 shows the results of the 2005 baseline inventory.

Table 7:

2005 Community Emissions by Sector	Residential	Commercial / Industrial	Transportation	Solid Waste	Wastewater	Total
CO_2e (metric tons)	12,340	11,411	17,160	1,965	2,130	45,006
% of Total CO_2e	27%	25%	38%	4%	5%	100%

To accurately calculate GHG emissions, accepted inventorying methods are continuously being updated as new modelling tools, and calculation protocols are released. However, to compare emissions from inventory to inventory, they must follow the same methods. As such when conducting a new inventory, all previous inventories must also be updated. The 2005 baseline inventory was therefore updated to follow the same methods as the 2015 inventory. Table 8 shows the results of the updated 2005 baseline inventory.

Table 8:

2005 Community Emissions by Sector	Residential	Commercial / Industrial	Transportation	Solid Waste	Wastewater	Total
CO_2e (metric tons)	12,336	10,468	14,844	3,036	76	40,760
% of Total CO_2e	30%	26%	36%	7%	0.2%	100%

A few significant changes were made in the following sectors in order for the 2005 inventory to follow the 2015 methodology:

Commercial and Industrial

In 2009, following guidance from ICLEI staff, direct access data was included in the 2005 Baseline Community-wide GHG Inventory. This decision was made with the understanding that higher quality data would become available within the coming years. Data was collected from the California Energy Commission on a countywide basis and allocated to each jurisdiction, following the same repartition as commercial and industrial electricity usage data.

However, the projected improved data sets did not get developed. Given the limitations and inaccuracies in the current data sets, ICLEI recommended the removal of direct access data from the inventory. As such, this update excluded the 2005 direct access data from the 2005 inventory.

Solid Waste

In the 2005 inventory, tonnages from alternative daily cover usage in landfills were not included in solid waste totals used to calculate emissions. This decision was made because green waste when used as ADC material is considered to be recycled. However starting in 2020, green waste used as ADC will no longer be considered to have been recycled (AB 1594). Therefore this ADC data was added to the 2005 solid waste totals, in order to ensure continuity in methods across all inventory years.

Wastewater

In 2009, data was collected in order to calculate emissions from the discharge of nitrogen in the environment as well as to calculate process emissions caused by the wastewater treatment itself. As part of the 2015 inventory, staff updated the 2005 inventory, to reflect changes in the equations used to calculate process emissions, and in order to obtain a more accurate emissions total.

3.2 2010 Community-wide GHG Inventory

In 2013, AMBAG Energy Watch worked with ICLEI and City of Carmel staff, in order to create the 2010 Community-wide GHG Inventory. Table 9 shows the results of this inventory.

Table 9:

2010 Community Emissions by Sector	Residential	Commercial / Industrial	Transportation	Solid Waste	Wastewater	Total
CO2e (metric tons)	13,061	10,025	15,365	1,060	2,282	41,793
% of Total CO2e	31%	24%	37%	3%	5%	100%

Due to the same reasons as for the 2005 baseline inventory, and in an effort to use the same inventorying methods, the 2010 inventory was also updated to follow the same methods as the 2015 inventory. Table 10 shows the results of the updated 2010 inventory.

Table 10:

2010 Community Emissions by Sector	Residential	Commercial / Industrial	Transportation	Solid Waste	Wastewater	Total
CO2e (metric tons)	13,060	10,618	14,662	1,639	72	40,051
% of Total CO2e	33%	27%	37%	4%	0.2%	100%

CONCLUSION

The City of Carmel has taken steps toward reducing its impact on the environment by quantifying its 2005 baseline community-wide GHG emissions and regularly updating the inventory every 5 years. Staff and policymakers have chosen to take a leadership role in addressing climate change, and this leadership will allow the City of Carmel to make informed decisions to create and implement future innovative approaches to reduce its emissions.

This inventory provides an important foundation for the City of Carmel's comprehensive approach to reducing the greenhouse gas emissions in its community.
Specifically, this inventory serves to:

- Establish a guideline for setting future emissions reductions targets.
- Identify the largest sources of communitywide emissions.
- Track changes to community emissions over time.
- Evaluate progress towards emission reduction goals.
- Support the development, implementation and evaluation of strategies to reduce emissions

APPENDIX A: GREENHOUSE GAS INVENTORY GENERAL METHODOLOGY

A.1 Greenhouse Gas Emissions Inventory Protocols

The first step towards achieving tangible greenhouse gas emissions reductions requires identifying baseline levels and sources for emissions. As local governments continue to develop and implement greenhouse gas mitigation efforts, the need for a standardized approach to quantify these emissions is essential. Given this, AMBAG staff used the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions to inventory the GHG emissions of the Carmel community.

A.1.1 Community Emissions Protocol

The U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Community Protocol), developed by ICLEI, provides an easily implementable set of guidelines to assist local governments in quantifying greenhouse gas emissions for the entire community within their geopolitical boundaries. AMBAG staff used this protocol to inventory Carmel's community emissions.

A.2 Quantifying Greenhouse Gas Emissions

A.2.1 Establishing a Base Year

A primary aspect of the emissions inventory process is the requirement to select a base year with which to compare current emissions. While the state's AB 32 emissions reduction goals establish a 1990 base year for the state, most local governments lack comprehensive data from that time period and would be unsuccessful in conducting an accurate inventory for that year. Therefore, the majority of municipalities conducting GHG emissions inventory opt to use 2005 as their base year. Similar to these jurisdictions, Carmel's greenhouse gas emissions inventory utilizes 2005 as its base year.

A.2.2 Establishing Boundaries

Setting an organizational boundary for the greenhouse gas emissions accounting and reporting is an important step in the inventory process. Carmel's community inventory assesses emissions resulting from activities taking place within the City of Carmel's geopolitical boundary. The community protocol defines geopolitical boundary as that "consisting of the physical area or region over which the local government has jurisdictional authority". Activities that occur within this boundary can be, for the most part, controlled or influenced by Carmel's policies and educational programs. Although Carmel may have limited influence over the level of emissions from some activities, it is important that every effort be made to compile a complete analysis of all activities that result in greenhouse gas emissions.

A.2.3 Emission Types

The U.S. Community Protocol recommends assessing emissions from the six internationally recognized greenhouse gases regulated under the Kyoto Protocol:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous Oxide (N_2O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulfur hexafluoride (SF_6).

However, quantifying emissions beyond the three primary GHGs (CO_2, CH_4, and N_2O) can be difficult. Therefore ICLEI has developed a means for local governments to produce a simplified inventory that includes the three primary GHGs yet is still in accordance with U.S. Community Protocol methodology.

A.2.4 Quantification Methods

Greenhouse gas emissions can be quantified in two ways:

- Measurement-based methodologies refer to the direct measurement of greenhouse gas emissions (from a monitoring system) emitted from a specific source such as the flue of a power plant, a wastewater treatment plant, or an industrial facility.
- Calculations-based methodologies calculate emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:
  activity data X emission factor = emissions

Activity data refer to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled.

Known emission factors are used to convert energy usage or other activity data into associated emissions quantities. They are usually expressed in terms of emissions per unit of activity data (e.g. lbs. CO_2/kWh of electricity).

A.2.5 SEEC ClearPath Software

To facilitate community efforts to reduce greenhouse gas emissions, ICLEI developed the SEEC ClearPath California tool (ClearPath). ClearPath is a cloud-based software package available to local governments at no cost and is fully compatible with the U.S. Community Protocol.

Greenhouse gas emissions are aggregated and reported in terms of equivalent carbon dioxide units, or CO_2e. This standard is based on the Global Warming Potential (GWP) of each gas, which is a measure of the amount of warming a greenhouse gas may cause, measured against the amount of warming caused by carbon dioxide. Converting all emissions to equivalent carbon dioxide units allows for the consideration of different greenhouse gases in comparable terms.

A.3 Evaluating Emissions

There are several important concepts involved in the analysis of emissions arising from many different sources and chemical/mechanical processes throughout the community. Those not touched on already are explored below.

Community emissions sources are categorized according to where they fall relative to the geopolitical boundary of the community, or the operational boundaries of the government. Emissions sources are categorized as direct or indirect emissions – scope 1, scope 2, or scope 3. One of the most important reasons for using the scopes framework for reporting greenhouse gas emissions at the local level is to prevent double counting for major categories such as electricity use and waste disposal. 2015 emissions by scope are included here.

Community scope definitions (Table 11):

The scopes framework identifies three emissions scopes for community emissions:

- **Scope 1**: All direct emissions from sources located within the geopolitical boundaries of the local government.
- **Scope 2:** Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, and cooling. Scope 2 emissions occur as a result of activities that take place within the geopolitical boundaries of the local government, but that occur at sources located outside of the government's jurisdiction.
- **Scope 3:** All other indirect or embodied emissions not covered in scope 2 that occur as a result of activity within the geopolitical boundaries.

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

Table 11:

Sector	Scope 1	Scope 2	Scope 3
Residential	Natural Gas	Electricity	
Commercial and Industrial	Natural Gas & Point Source Emissions	Electricity	
Transportation	Gasoline and Diesel		
Solid Waste			Future Emissions
Wastewater			Fugitive Emissions

A.4 2015 Emissions by Scope

Including all scopes, the community of Carmel emitted 27,458 metric tons of CO_2e in the year 2015. As illustrated in Figure 5 and Table 12, 74 percent of total emissions are scope 1 emissions, 20 percent are scope 2 emissions and the remaining 6 percent are scope 3.

Figure 5:

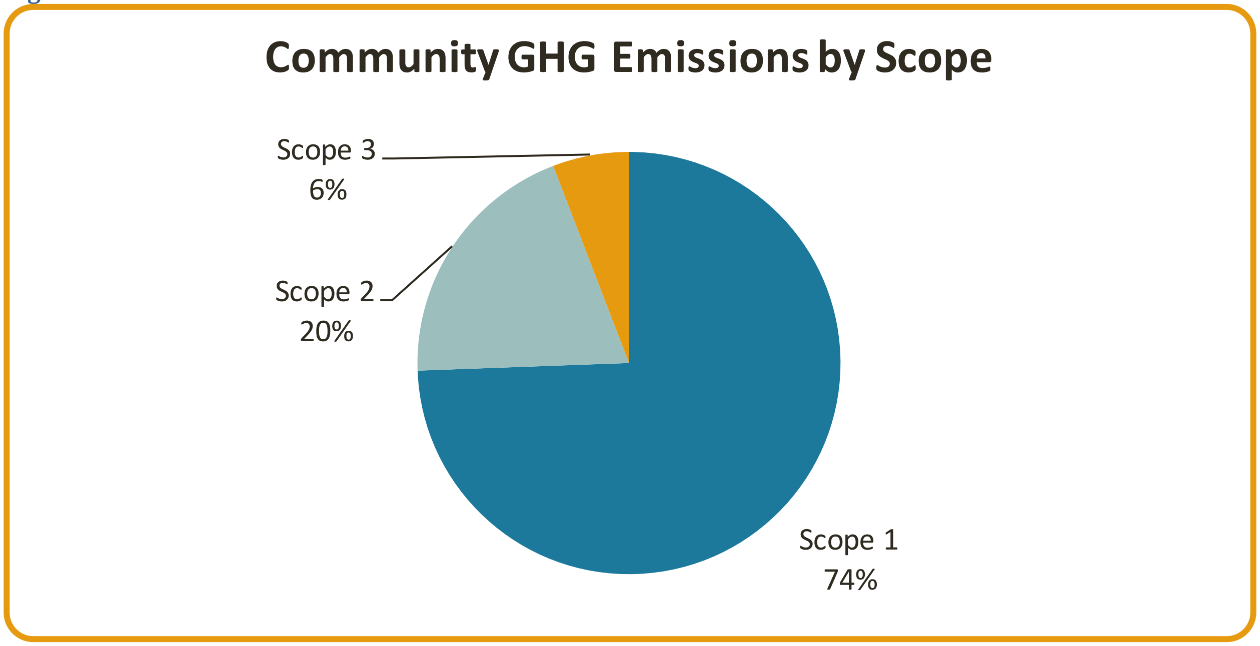

Table 12:

Sector	Scope 1	Scope 2	Scope 3	Total
Residential	7,194	2,493		9,687
Commercial and Industrial	5,073	2,928		8,001
Transportation	8,169			8,169
Solid Waste			1,527	1,527
Wastewater			74	74
Total	20,436	5,421	1,601	27,458
Percentage of Total CO2e	74%	20%	6%	100%

A.4.1 Scope 1

As illustrated in Figure 6 and Table 13, 40 percent of scope 1 emissions came from the transportation sector. Emissions from the transportation sector came from diesel and gasoline use on local roads within the City of Carmel's jurisdictional boundaries. The residential sector emissions are the result of natural gas combustion from within Carmel households, and constituted 35 percent of scope 1 emissions. The remaining 25 percent of scope 1 emissions were generated by natural gas consumption from Carmel's businesses.

Figure 6:

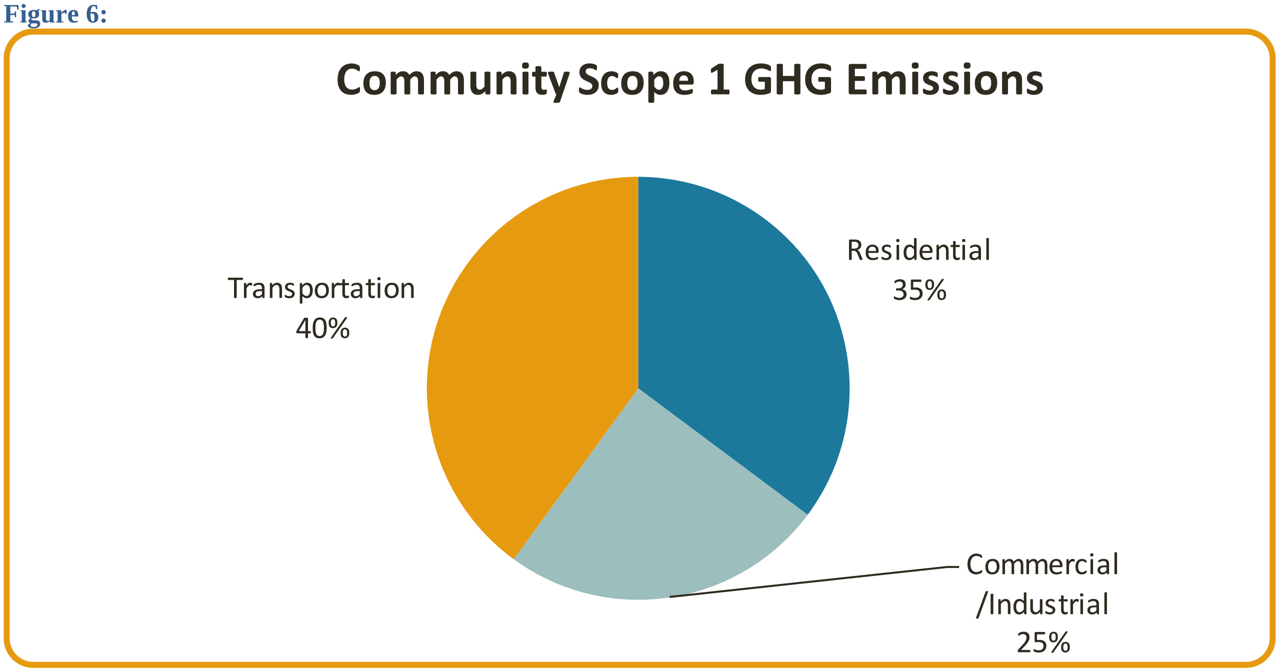

Table 13:

Scope 1 emissions by Sector	Residential	Commercial /Industrial	Transportation	Total
CO2e (metric tons)	7,194	5,073	8,169	20,436
% of Total CO_2e	35%	25%	40%	100%

A.4.2 Scope 2

As illustrated in Figure 7 and Table 14, Carmel's scope 2 emissions were the result of two sectors. Approximately 46 percent of emissions came from electricity consumption in the residential sector. The remaining 54 percent of emissions were generated by electricity consumption in the commercial and industrial sector.

Figure 7:

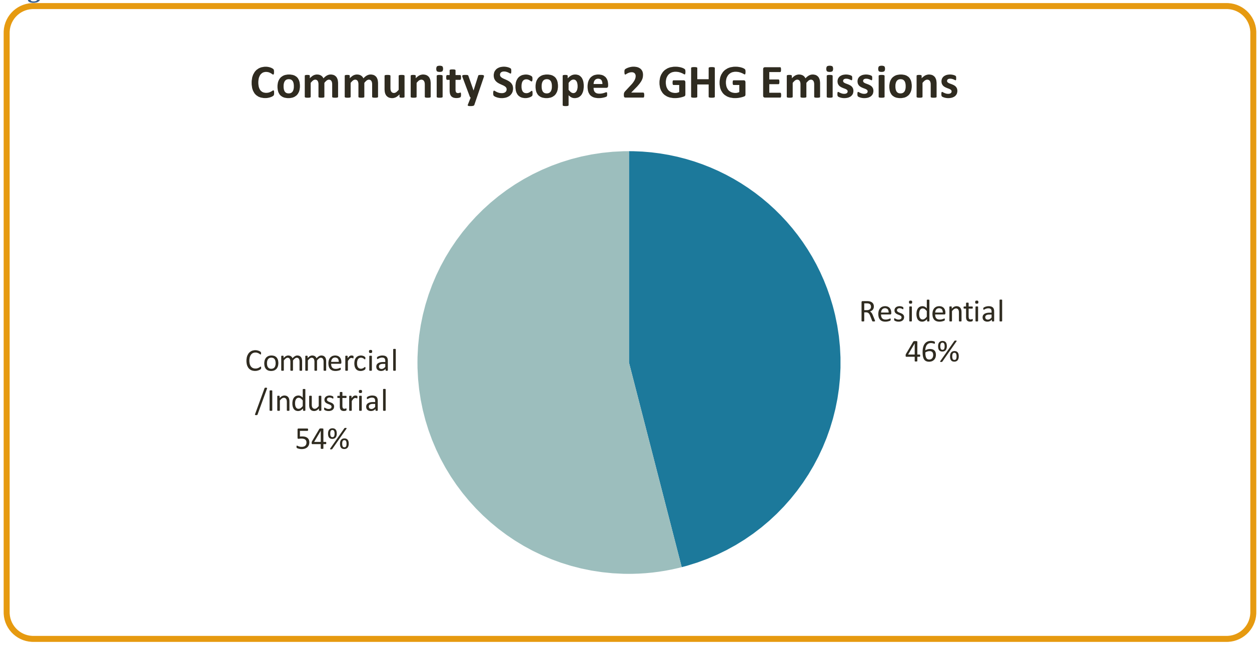

Table 14:

Scope 2 emissions by Sector	Residential	Commercial /Industrial	Total
CO2e (metric tons)	2,493	2,928	5,421
% of Total CO2e	46%	54%	100%

A.4.3 Scope 3

As illustrated in Figure 8 and Table 15, 95 percent of scope 3 emissions came from the solid waste sector. Emissions in this category are an estimate of future emissions over the lifecycle decomposition of waste sent to landfills in 2015. The remaining 5 percent of emissions were generated due to the treatment of wastewater generated by Carmel's residents and businesses.

Figure 8:

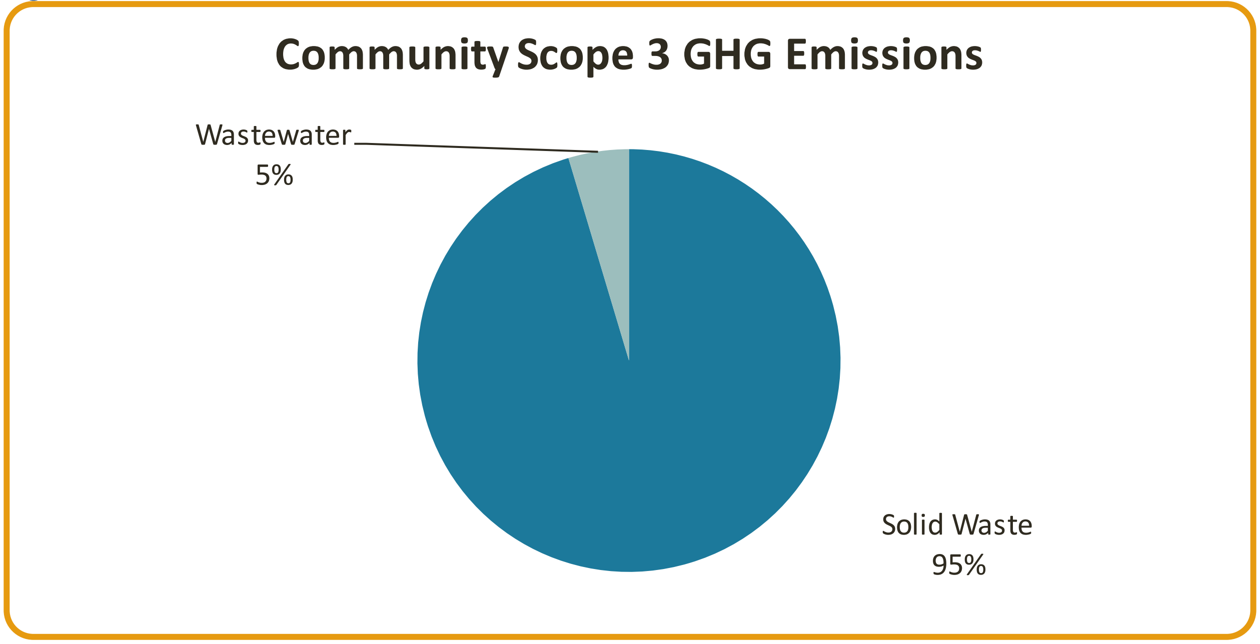

Table 15:

Scope 3 emissions by Sector	Solid Waste	Wastewater	Total
CO2e (metric tons)	1,527	74	1,601
% of Total CO2e	92%	8%	100%

APPENDIX B:COMMUNITY INVENTORY SECTOR METHODOLOGIES

This appendix expands on the description of methodology provided in Appendix A, describing in more details the data sources and processes used to calculate emissions in the community inventory.

B.1 Overview of Inventory Contents and Approach

The community inventory describes emissions of the major greenhouse gases from the residential, commercial and industrial, transportation, solid waste, and wastewater sectors. As explained in Appendix A, emissions are calculated by multiplying activity data—such as kilowatt hours or VMT —by emissions factors, which provide the quantity of emissions per unit of activity. Activity data is typically available from electric and gas utilities, planning and transportation agencies and air quality regulatory agencies. Emissions factors are drawn from a variety of sources, including PG&E, the Community protocol, and air quality models produced by the California Air Resources Board (CARB).

B.2 Built Environment Methodology: Residential, Commercial and Industrial Sectors

Data on electricity and natural gas sold to Pacific Gas and Electric customers as bundled service (both energy generation and transmission/distribution) was provided through the PG&E Green Communities portal. Bundled PG&E electricity emissions were calculated in ICLEI's ClearPath software using PG&E-specific emissions factors provided by PG&E. All natural gas emissions were calculated in ClearPath with default emissions factors from the community protocol.

B.3 Transportation Sector Methodology

On-road transportation emissions were derived from local jurisdiction vehicle miles traveled (VMT) data and regional vehicle and travel characteristics. Observed VMT on non-state facilities (referred to in the inventory as "local roads") was obtained from Caltrans' Highway Performance Monitoring System reports.

The EMFAC 2014 model developed by CARB was used to calculate emissions from these VMT figures. EMFAC defaults for each county include regionally-specific information on the mix of vehicle classes and model years, as well as ambient conditions and travel speeds that determine fuel efficiency. The model estimates carbon dioxide, methane, and nitrous oxide emissions from these factors as well as from inputted vehicle activity data.

For purposes of this inventory, AMBAG Energy Watch staff ran the model for each of AMBAG's three counties (Monterey, Santa Cruz, and San Benito), leaving all CARB default values in place (including VMT). Staff then used the EMFAC output to calculate local fleet mix and emissions factors for each vehicle type. Different emissions factors were calculated for CO_2,

CH_4 and N_2O. The total VMT was then distributed among the various EMFAC-defined vehicle types according to percentages derived from the EMFAC output. The appropriate emissions factor for each vehicle type was then applied for these greenhouse gases. Finally, global warming potentials were factored in and the total emissions from each vehicle type were summed to reach the total CO_2e emissions from the transportation sector.

B.4 Solid Waste Sector Methodology

Emissions from solid waste were captured by estimating future emissions from decomposition of waste generated in the local jurisdiction in the inventory year ("community-generated solid waste").

Community-generated solid waste emissions were calculated in ClearPath using waste disposal data obtained from the California Department of Resources Recycling and Recovery (CalRecycle) Disposal Reporting System, which records tonnages of municipal solid waste and alternative daily cover by local jurisdiction. As some types of waste (e.g., paper, plant debris, food scraps, etc.) generate methane within the anaerobic environment of a landfill and others do not (e.g., metal, glass, etc.), it is important to characterize the various components of the waste stream. Waste characterization for community generated solid waste was estimated using the CalRecycle 2003, 2008 and 2014 California statewide waste characterization study.[2]

Most landfills in the bay area capture methane emissions either for energy generation or for flaring. EPA estimates that 60 percent to 80 percent[3] of total methane emissions are recovered at the landfills to which City of Carmel sends its waste. Following the recommendation of the community protocol, AMBAG adopted a 75 percent methane recovery factor.

Recycling and composting programs are reflected in the emissions calculations as reduced total tonnage of waste going to the landfills. The model, however, does not capture the associated emissions reductions in "upstream" energy use from recycling as part of the inventory.[4] This is in-line with the "end-user" or "tailpipe" approach taken throughout the development of this inventory. It is important to note that recycling and composting programs can have a significant impact on greenhouse gas emissions when a full lifecycle approach is taken. Manufacturing products with recycled materials avoids emissions from the energy that would have been used during extraction, transportation and processing of virgin material.

B.5 Wastewater Sector Methodology

Emissions from wastewater treatment were calculated by first assessing the treatment steps used to transform Carmel's wastewater. Staff then used the ClearPath tool and a population based method to estimate treatment process emissions, in accordance with the methodology delineated in the US Community protocol. Fugitive nitrous oxide emissions from effluent discharge were also estimated using this method.

[2] CalRecycle Waste Characterization Studies available at https://www2.calrecycle.ca.gov/WasteCharacterization/Study

[3] AP 42, section 2.4 Municipal Solid Waste, 2.4-6, http://www.epa.gov/ttn/chief/ap42/index.html

[4] "Upstream" emissions include emissions that may not occur in your jurisdiction resulting from manufacturing or harvesting virgin materials and transportation of them.

APPENDIX C: GLOSSARY

This Appendix provides a brief description of technical terms used in the inventory.

Activity Data:
Data on the magnitude of a human activity resulting in emissions or removals taking place during a given period of time. Data on energy use, metal production, land areas, management systems, lime and fertilizer use and solid waste production are examples of activity data.

Baseline year:
A specific year against which emissions are tracked over time. For this inventory, the baseline year is 2005.

Boundaries:
GHG accounting and reporting boundaries can have several dimensions, i.e., jurisdictional, operational or geopolitical. The inventory boundary determines which emissions are accounted and reported.

Carbon Dioxide Equivalent:
A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Carbon dioxide equivalents are commonly expressed as metric tons of carbon dioxide equivalents ($MTCO_2e$). The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP. See appendix A.

Community GHG Inventory:
A calculation of GHG emissions generated as a result of activities within a community.

Consistency:
Consistency means that an inventory should be internally consistent in all its elements over a period of years. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks.

Direct GHG emissions:
Emissions from sources that occur within a jurisdiction's operational or geopolitical boundaries are called direct GHG emissions.

Emissions Factor:
A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of carbon dioxide emitted per kWh of electricity use or per therms of natural gas use).

Fugitive emissions:
Emissions that are not physically controlled but result from the intentional or unintentional releases of GHGs. They commonly arise from the production, processing transmission storage and use of fuels and other chemicals, often through joints, seals, packing, gaskets, etc.

Global Warming Potential:
A measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide.

Greenhouse gases (GHGs):
Gases which when released in the atmosphere have a warming impact. The GHG's considered in this inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O).

Indirect emissions:
Emissions that are a consequence of activities inside a jurisdiction, but occur from sources outside of the inventory boundaries, e.g., as a result of the import of electricity, heat, or steam.

Intergovernmental Panel on Climate Change:
The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. Leading experts on climate change and environmental, social, and economic sciences have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

Methane (CH_4):
A hydrocarbon that is a greenhouse gas with a global warming potential estimated at 25 times that of carbon dioxide (CO_2). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, flooded rice fields, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The GWP is from the IPCC's Fourth Assessment Report (AR4).

Nitrous Oxide (N_2O):
A powerful greenhouse gas with a global warming potential of 298 times that of carbon dioxide (CO2). Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, manure management, fossil fuel combustion, nitric acid production, and biomass burning. The GWP is from the IPCC's Fourth Assessment Report (AR4).

Process emissions:
Emissions from industrial processes involving chemical transformations other than combustion.