Campbell Climate Action & Adaptation Plan

Greenhouse Gas Inventory Analysis Report

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CITY OF CAMPBELL
Climate Action & Adaptation Plan

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1 Introduction

This document presents the data, methods, and results for a 2022 greenhouse gas (GHG) emissions inventory and 2045 forecast Campbell. This is the first GHG emission inventory for Campbell, and includes communitywide emissions, as well as emissions from municipal operations. The inventory was conducted to support Campbell's GHG emissions reduction targets, and ultimately the Campbell Climate Action and Adaptation Plan (CAAP).

California (the State) has set statewide GHG emissions reduction goals to mitigate negative climate change impacts and transition the State to a low-carbon economy. In particular, the State has established goals to reduce statewide GHG emissions 40 percent below 1990 levels by 2030, as established by Senate Bill (SB) 32, and achieve net zero GHG emissions as soon as possible, but no later than 2045, as established by Assembly Bill (AB) 1279.[1] The California Air Resources Board (CARB) is the agency responsible for addressing these goals and developing strategies to achieve them. Many local jurisdictions are completing their own GHG inventories, forecasts, and climate action plans (CAPs) to align with SB 32 and AB 1279.

Local governments play a fundamental role in reducing local GHG emissions and preparing for a more resilient future. Local policies can influence high-emissions behaviors and mitigate climate change effects.[2] To this end, the City is developing a CAAP to align with State goals, increase resilience and climate change preparedness, maintain healthy air and water resources, and improve community health and the local economy. The forthcoming CAAP will include the 2022 GHG emissions inventory for the community (2022 Community GHG Inventory) and the associated GHG emissions forecast, in addition to the municipal operations inventory (2022 Municipal GHG Inventory). Municipal GHG emissions are a subset of community GHG emissions and are included in the community GHG inventory and associated forecast.

The 2022 Community GHG Inventory completed for Campbell includes GHG emissions from communitywide activities within the jurisdictional boundaries of Campbell during 2022. Based on the inventory, Rincon developed a forecast for 2030, 2035, 2040, and 2045. The forecast provides an up-to-date projection of how GHG emissions are expected to change in the future based on population growth, employment growth, and State legislation. This document also presents a gap analysis to help identify GHG emissions reduction levels that will be needed to achieve the State GHG emissions reduction targets. Like all GHG inventories, forecasts, and targets, the analysis in this document relies on the best available data and calculation methodologies currently available.

This report includes the following information by section:

- **Section 1:** Campbell's 2022 Community GHG Inventory methodology, activity data, emissions factors, and results by sector.
- **Section 2:** City's 2022 Municipal GHG Inventory methodology, activity data, emissions factors, and results by sector.

[1] AB 1279 defines net zero GHG emissions as reducing GHG emissions at least 85 percent below 1990 levels. California also set a goal to reach 1990 levels by 2020, as established by AB 32, The 2020 goal set by AB 32 was achieved by the State in 2016. CARB. Frequently Asked Questions – California's 2022 Climate Scoping Plan. Accessed November 14, 2022, at: https://ww2.arb.ca.gov/sites/default/files/2022-06/2022_Scoping_Plan_FAQ_6.21.22.pdf

[2] CARB. California's 2017 Climate Change Scoping Plan. Accessed November 14, 2022, at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf

- **Section 3:** Campbell's forecast for the years 2030, 2035, 2040, and 2045, and alignment with State targets based on a 1990 backcast.

1.1 Legislative Context

The State has developed statewide legislative goals and programs to reduce GHG emissions. CARB has issued guidance concerning the establishment of GHG emissions reduction targets for local CAPs so municipalities can contribute their fair share towards the State's goals. In CARB's first Climate Change Scoping Plan (hereafter referred to as the 2008 Scoping Plan), the Board encouraged local governments to adopt a reduction target for their own community emissions that parallels the State's commitment to reduce GHG emissions.[3] In 2017, CARB published and updated Scoping Plan (hereafter referred to as the 2017 Scoping Plan Update) outlining the strategies the State will employ to reach the additional targets set by SB 32.[4]

In December 2022, the 2022 California Climate Change Scoping Plan Update was published and includes recommendations for achieving the goal of carbon neutrality by 2045, codified in the California Health and Safety Code Section 38562.2, as amended by AB 1279.[5]

Legislative Targets

The State of California has adopted legislation and policies to address climate change, the most relevant of which are summarized below.

- **Executive Order S-3-05**, signed in 2005, established statewide GHG emissions reduction goals to achieve long-term climate stabilization as follows: by 2020, reduce GHG emissions to 1990 levels and by 2050, reduce GHG emissions to 80 percent below 1990 levels. This 2050 goal was accelerated by the 2045 carbon neutral goal established by EO B-55-18 and AB 1279, as discussed below.
- **Assembly Bill 32**, known as the Global Warming Solutions Act of 2006, required California's GHG emissions be reduced to 1990 levels by the year 2020 (approximately a 15 percent reduction from 2005 to 2008 levels). The 2008 Scoping Plan identified mandatory and voluntary measures to achieve the statewide 2020 GHG emissions limit.
- **Senate Bill 32**, signed in 2016, established a statewide mid-term GHG emissions reduction goal of 40 percent below 1990 levels by 2030. CARB formally adopted the 2017 Scoping Plan Update in December 2017, laying the roadmap to achieve 2030 goals and giving guidance to achieve substantial progress toward the 2050 State goals. The 2022 Scoping Plan Update provided further guidance for reaching the State's SB 32 goal.
- **Executive Order B-55-18**, signed in 2018, expanded upon EO S-3-05 by creating a statewide GHG emissions goal of carbon neutrality by 2045. EO S-55-18 identified CARB as the lead agency to develop a framework for implementation and progress tracking toward this goal in the 2022 Climate Change Scoping Plan Update.

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[3] CARB. Climate Change Scoping Plan: A Framework for Change. Dec. 2008. Accessed November 14, 2022 at: ww2.arb.ca.gov/sites/default/files/classic//cc/scopingplan/document/adopted_scoping_plan.pdf

[4] CARB. California's 2017 Climate Change Scoping Plan. Accessed November 14, 2022, at: https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf

[5] CARB. 2022 Scoping Plan Update. Accessed November 14, 2022, at: https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf

- **Assembly Bill 1279**, known as the California Climate Crisis Act, signed by the governor in 2022, codified the GHG emissions reduction goals of achieving carbon neutrality by 2045. It expanded the definition of carbon neutrality to reducing direct emissions 85 percent below 1990 levels and removing the remaining 15 percent of emissions though carbon sequestration and other technologies. The 2022 Scoping Plan Update, adopted in December 2022, provided the pathway for reaching the State's AB 1279 goal.

1.2 Climate Science Context

Greenhouse Gases

GHG emissions quantification frameworks have been developed over decades in an effort to standardize GHG accounting. The International Council for Local Government Initiatives (ICLEI) protocols for community and municipal inventories (discussed further in Section 2 and Section 3, respectively) assess emissions associated with the six internationally recognized GHGs, as outlined in Table 1. Campbell's inventory focuses on the three GHGs most relevant to the City: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The other gases (hydrofluorocarbons, perfluorocarbons, and sulfur hexafluorides) are omitted from the inventory as they are emitted primarily in private sector manufacturing and electricity transmission. This approach is consistent with typical community and municipal inventory approaches, as industrial emissions are typically outside of the City's jurisdictional control. Table 1 also includes the 100-year global warming potential (GWP) for each gas—consistent with the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report[6] and used by the State's latest GHG emissions inventory. GWP refers to the ability of each gas to trap heat in the atmosphere. For example, one pound of methane gas has 28 times more heat capturing potential than one pound of carbon dioxide gas. GHG emissions are reported in metric tons of CO_2 equivalent (MT CO_2e).

Table 1 2022 Inventory GHGs and GWPs

Greenhouse Gas	Primary Source	100-year GWP
Carbon dioxide (CO_2)	Combustion	1
Methane (CH_4)	Combustion, anaerobic decomposition of organic waste (e.g., in landfills, wastewater treatment plants)	28
Nitrous Oxide (N_2O)	Leaking refrigerants and fire suppressants	265
Hydrofluorocarbons	Leaking refrigerants and fire suppressants	4 - 12,400
Perfluorocarbons	Aluminum production, semiconductor manufacturing, HVAC equipment manufacturing	6,630 - 11,100
Sulfur Hexafluoride (SH6)	Transmission and distribution of power	23,500

Source: Intergovernmental Panel on Climate Change (IPCC). 2014. AR5 Synthesis Report: Climate Change 2014. Available at: https://www.ipcc.ch/report/ar5/syr/

[6] Intergovernmental Panel on Climate Change (IPCC). 2014. AR5 Synthesis Report: Climate Change 2014. Accessed January 5, 2023, at: https://www.ipcc.ch/report/ar5/syr/

2 Community GHG Emissions Inventory

Conducting a community GHG emissions inventory serves to provide a comprehensive understanding of GHG emissions within a jurisdiction, and may be developed to serve the following purposes:

- Provide an understanding of where the highest sources of emissions originate, and where the greatest opportunities for reduction exist.
- Create a baseline from which the jurisdiction can establish a forecast, reduction targets, and evaluate future progress.
- Help the jurisdiction understand how best to meet legislative requirements.
- Enable the jurisdiction to follow accounting and reporting principles.

GHG inventories are developed by identifying the sources and sinks by sector for GHGs within the geographic boundary of interest (e.g., Campbell city limits), establishing activity data for each sector, and applying an emissions factor to determine the carbon dioxide equivalence (CO_2e). While there are often many potential sectors contributing to the jurisdiction's GHG emissions, only a select few sectors are typically considered the major contributors. The sectors used for Campbell's GHG inventory are identified in the sections below.

2.1 Methodology

Protocol

Campbell's 2022 Community GHG Inventory was developed in alignment with accounting protocols provided by ICLEI. ICLEI protocols are designed for local-scale accounting of GHG emissions and provide authoritative guidance for accuracy and consistency. The ICLEI U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions Version 1.2 (Community Protocol) serves to guide the measurement and reporting of GHG emissions in a standardized way and is used by other jurisdictions to support their own inventory, forecast, and climate action planning efforts. The Community Protocol also includes steps to evaluate the relevance, completeness, consistency, transparency, and accuracy of data used in the GHG inventory.

Emissions Boundary

Campbell's 2022 Community GHG Inventory covers emissions sources within city limits. The inventory reflects emissions sectors over which the local government (i.e., City of Campbell) has jurisdictional control and influence, while other sectors that the City does not have control over are excluded. This approach aligns with general GHG inventory accounting principles, as well as methods set forth by the Community Protocol.

Scope

The Community Protocol recommends reporting GHG emissions from five basic reporting activities:

- Use of electricity by the community
- Use of fuel in residential and commercial stationary combustion equipment

- On-road passenger and freight motor vehicle travel
- Use of energy in potable water and wastewater treatment and distribution
- Generation of solid waste by the community

The Community Protocol also provides recommendations for additional GHG emissions source reporting for activities that can be influenced by the accounting agency. Based on reporting practices in California, it is recommended that GHG emissions from off-road equipment fuel combustion and wastewater treatment processes are also included in community GHG emissions inventories. Emissions from industrial sources and operations are covered under the State's Cap-and-Trade program and are not included in the inventory.[7] Additionally, emissions sources from agriculture are not included in the inventory as there are not significant agricultural land uses/production in Campbell.

The GHG emissions sources for this inventory can be categorized more generally into the following five activity sectors:

- Electricity
- Natural Gas
- Transportation
- Water and Wastewater
- Solid Waste

Campbell's 2022 Community GHG Inventory includes an assessment of the community-wide GHG emissions associated with the five sectors listed above which serve as the basis for the GHG emissions forecast and target setting. Emissions from industrial sources and operations are covered under the State's Cap and Trade program, and therefore not included in the inventory.[8] Additionally, emissions sources from agriculture are not included in the inventory as there are no agricultural land uses/production in Campbell.

2.2 2022 Community GHG Emissions Inventory

Generally, GHG emissions are calculated by multiplying the activity data in each sector (e.g., electricity, transportation, solid waste) by an associated emission factor. Activity data refer to the relevant measured or estimated energy usage or GHG-generating process data. Emission factors are observation-based conversion factors used to equate activity data to generated GHG emissions. The 2022 Community GHG Inventory leverages the latest available models and best available data in accordance with the Community Protocol. The inventory serves to provide a comprehensive understanding of the community's current GHG emissions, and as the basis for the forecast and target setting. The following sections contain further information on the inventory approach, calculation methodologies, data used, and results.

[7] https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program

[9] https://svcleanenergy.org/residential-rates/

2.2.1 Energy

Energy: Residential and Commercial Electricity

Campbell sources electricity from Pacific Gas & Electric (PG&E) and Silicon Valley Clean Energy (SVCE). SVCE is the community choice aggregator for 13 communities across Silicon Valley, meaning that it is a public, not-for-profit agency providing clean electricity to their service territory. SVCE is the official electricity provider for Campbell, unless customers have 'opted-out' and instead purchase electricity from PG&E. The opt-out provided by SVCE is three percent of residential accounts and five percent of nonresidential accounts (e.g., commercial, industrial). SVCE has two tiers – GreenPrime (100 percent renewable) and GreenStart (around 45 percent renewable).[9]
Certain commercial accounts purchase what is known as 'direct access' electricity, where customers purchase electricity from a competitive non-utility entity called an Energy Service Provider (ESP). Direct access electricity is typically less expensive, but more carbon intensive, than electricity options on the California grid.[10]

Emissions from residential and commercial electricity were calculated using Community Protocol Equation BE.2.1. Electricity use from EVs are captured under the transportation sector to provide a more thorough differentiation between building energy and transportation emissions. The equation has been adjusted to remove passenger car EV electricity use from residential electricity consumption and commercial and bus EV electricity consumption from commercial consumption. commercial. More information regarding electric vehicle energy use can be found in Section 2.2.2.

Equation 2-1 and Table 2 provide the adjusted equation, associated parameters, and data sources used to quantify GHG emissions associated with community electricity consumption.

EQUATION 2-1

BE.2.1 RESIDENTIAL/COMMERCIAL ELECTRICITY SECTOR EMISSIONS

$$CO_2e_{electricity,j} = \sum_{i} \left(Elec_{i,j} - EV_{i,j}\right) \times EF_{elec,i,j}$$

[9] https://svcleanenergy.org/residential-rates/

[10] https://www.cpuc.ca.gov/consumer-support/consumer-programs-and-services/electrical-energy-and-energy-efficiency/community-choice-aggregation-and-direct-access-/direct-access

Table 2 Emissions Parameters and Data Sources – Community Electricity Use

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from electricity consumption per building type	$CO_2e_{electricity,j}$	See Table 4	MT CO_2e/year	Calculated
Electricity consumption per building type per energy provider	$Elec_{i,j}$	See Table 3	kWh/year	SVCE 2022 Electricity Report; PG&E Community Report[1]
Attributed electric vehicle electricity consumption	$EV_{i,j}$	See Table 3	kWh/year	EMFAC2021[2]
Electricity emission factor based on energy provider	$EF_{elec,i,j}$	See Table 4	MT CO_2e/kWh	SVCE 2022 Electricity Report; PG&E community Report
Energy Providers	i	GWP	Categorical	
Building type	j	Residential Commercial	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; MWh = megawatt hour

[1] Silicon Valley Clean Energy (SVCE) 2022 Electricity Report, provided by the City via SharePoint and revised via email on May 29, 2024. PG&E Community Report for 2022 provided by the City via SharePoint.

[2] California Air and Resources Board. 2023. Emission Factor (EMFAC2021 v1.0.1) Model. Available at: https://arb.ca.gov/emfac/emissions-inventory/5e0cb7d6006cc10661f4b3ffb9c120a486d46ea6

Table 3 below shows the original electricity activity data, allocated electric vehicle adjustment, and subsequent adjusted activity data used to determine GHG emissions for the community's electricity consumption.

Table 3 Community Residential and Commercial Electricity Activity Data Adjustment

Sector	Provider	Original Activity Data [kWh]	Attributed EV[1] [kWh]	Adjusted Activity Data [kWh]
Residential	PG&E	3,701,979	288,761	3,413,218
Residential	SVCE GreenPrime	1,579,728	123,222	1,456,507
Residential	SVCE GreenStart	83,588,699	6,520,062	77,068,637
Direct Access	Direct Access	18,509,670	0	18,509,670
Commercial	PG&E	44,535	1	44,534
Commercial	SVCE GreenPrime	1,762,625	44	1,762,581
Commercial	SVCE GreenStart	93,266,368	2,343	93,264,025

Notes: kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent; EV = electric vehicles

[1] EV kWh usage from passenger vehicles is removed from residential electricity, while commercial and bus EV kWh usage is removed from commercial electricity. If multiple providers exist for a community, attributed EV allocates electric vehicle kWh consumption to each provider based on the proportion of electricity provided by each provider per building type.

Resulting activity data, emissions factors, and GHG emissions by building type and provider are summarized in Table 4.

Table 4 Community Residential and Commercial Electricity GHG Emissions Calculations

Sector	Provider	Adjusted Activity Data [kWh]	Emission Factor [MT CO_2e/kWh]	GHG Emissions [MT CO_2e]
Residential	PG&E	3,413,218	0.00002630	90
Residential	SVCE GreenPrime	1,456,507	0.00002132	31
Residential	SVCE GreenStart	77,068,637	0.00003266	2,517
Direct Access	Direct Access	18,509,670	0.00022654	4,193
Commercial	PG&E	44,534	0.00002630	1
Commercial	SVCE GreenPrime	1,762,581	0.00002132	38
Commercial	SVCE GreenStart	93,264,025	0.00003266	3,046

Notes: kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent

Energy: Electricity Transmission and Distribution Losses

Electricity transmission and distribution (T&D) losses occur in the transmission of electricity and in the distribution system. Because these losses are upstream of the endpoints (i.e., buildings located within Campbell), this electricity is not captured in the activity data. T&D losses are recommended for inclusion in community GHG inventories by the Community Protocol, as these losses are associated with energy usage and directly impacted by the community's electricity consumption. Equation 2-2 and Table 5 provide the calculation method, associated parameters, and data sources used to quantify GHG emissions associated with community T&D losses from electricity consumption. As T&D losses associated with EV electricity use are considered negligible and, therefore, are included in the quantification of residential and commercial electricity T&D.

EQUATION 2-2

BE.4 ELECTRICITY T&D LOSS SECTOR EMISSIONS

$$CO_2e_{T\&D,j} = \sum_i Elec_{i,j} \times L_{T\&D} \times EF_{elec,i,j}$$

Table 5 Emissions Parameters and Data Sources – Community Electricity T&D Loss

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from transmission and distribution losses per building type	$CO_2e_{T\&D,i}$	See Table 6	MT CO_2e/year	Calculated
Electricity consumption per energy provider and building type	$Elec_{i,j}$	See Table 6	MWh/year	SVCE 2022 Electricity Report; PG&E Community Report[1]
Electricity emissions factor per energy provider and building type	$EF_{elec,i,j}$	See Table 6	MT CO_2e/MWh	SVCE 2022 Electricity Report; PG&E Community Report
Electricity loss factor	$L_{T\&D}$	5.10%	Percent	EPA eGRID[2]
Energy Providers	i	GWP	Categorical	
Building type	j	Residential Commercial[3]	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; MWh = megawatt hour

[1] Silicon Valley Clean Energy (SVCE) 2022 Electricity Report, provided by the City via SharePoint and revised via email on May 29, 2024. PG&E Community Report provided to the City via SharePoint in May 2022.

[2] Environmental Protection Agency (EPA). 2023. Data Explorer, grid loss rates, 2016. Available at: https://www.epa.gov/egrid/data-explorer

The activity data, emissions factors, and GHG emissions associated with electricity T&D losses are summarized in Table 6 per building type and electricity provider.

Table 6 Community Electricity T&D Loss GHG Emissions Calculations

Sector	Provider	Activity Data [kWh]	T&D Losses [kWh][1]	Emission Factor [MT CO_2e/kWh][2]	GHG Emissions [MT CO_2e]
Residential	PG&E	3,701,979	188,801	0.000026	5
	SVCE (GreenPrime)	1,579,728	80,566	0.000021	2
	SVCE (GreenStart)	83,588,699	4,263,024	0.000033	139
Commercial	PG&E	44,535	2,271	0.000026	<1
	SVCE (GreenPrime)	1,762,625	89,894	0.000021	2
	SVCE (GreenStart)	93,266,368	4,756,585	0.000033	155
	Direct Access	18,509,670	943,993	0.000227	214

Notes: kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent

[1] T&D losses include the kWh consumption associated with EV charging.

Energy: Residential and Commercial Natural Gas

GHG emissions from natural gas result from stationary combustion in both residential and commercial buildings. Like industrial electricity use, industrial use of natural gas is excluded from the GHG inventory as these emissions are regulated by the Cap-and-Trade program.

PG&E supplies Campbell's natural gas and provided activity data to the City through its 2022 Community Report. Emissions from residential and commercial natural gas use were calculated using Community Protocol Equation BE.1.1.

Though the majority of natural gas emissions come from combustion, not all the natural gas used is combusted. Natural gas leaks – from processing plants, pipes, fittings, and appliances – are primarily methane, which has a higher GWP and therefore a larger GHG impact compared to combusted natural gas Therefore, the Community Protocol has been adjusted to remove this small percentage of "behind the meter" natural gas from the combustion calculation, and instead count it as leakage. More information regarding emissions associated with natural gas leaks can be found under the Energy: Natural Gas Methane Leaks subsection below. Equation 2-3 and Table 7 provide the adjusted equation, associated parameters, and data sources used to quantify GHG emissions associated with community natural gas consumption in residential and commercial buildings.

EQUATION 2-3

BE.1.1 RESIDENTIAL/COMMERCIAL NATURAL GAS SECTOR EMISSIONS

$$CO_2e_{NatGas,i} = \left(Fuel_{NG,i} - [1 - L_{enduse}]\right) \times \left[\left(EF_{NG,CO_2} \times GWP_{CO_2}\right) + \left(EF_{NG,CH_4} \times GWP_{CH_4}\right) + \left(EF_{NG,N_2O} \times GWP_{N_2O}\right)\right] \times 10^{-1} \times 10^{-3}$$

Table 7 Emissions Parameters and Data Sources – Community Natural Gas Use

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from stationary combustion of natural gas per building type	$CO_2e_{NatGas,i}$	See Table 8	MT CO_2e/year	Calculated
Natural gas consumed per building type	$Fuel_{NG,i}$	See Table 8	therms/year	PG&E Community Report[1]
Percent natural gas lost during consumer end-use	L_{enduse}	0.50%	Percent	Environmental Defense Fund[2]
Carbon dioxide emission factor for natural gas combustion	EF_{NG,CO_2}	53.06	kg CO_2e/mmBTU natural gas	EPA Emission Factors Hub[3]
Methane emission factor for natural gas combustion	EF_{NG,CH_4}	.001	kg CH_4/mmBTU natural gas	EPA Emission Factors Hub
Nitrous oxide emission factor for natural gas combustion	EF_{NG,N_2O}	.0001	kg N_2O/mmBTU natural gas	EPA Emission Factors Hub
Global warming potential of carbon dioxide	GWP_{CO_2}	1		IPCC Fifth Assessment Report[4]
Global warming potential of methane	GWP_{CH_4}	28		IPCC Fifth Assessment Report
Global warming potential of nitrous oxide	GWP_{N_2O}	265		IPCC Fifth Assessment Report
Conversion factor	10^{-1}	0.1	mmBTU/therm	
Conversion factor	10^{-3}	.001	MT/kg	
Building type (i.e., residential, or commercial)	i	Residential Commercial[5]	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; therms = thermal unit; mmBTU = metric million British thermal unit; kg = kilograms

[1] PG&E Community Report Provided by the City via SharePoint in May 2024.

[2] Environmental Defense Fund USER GUIDE FOR NATURAL GAS LEAKAGE RATE MODELING TOOL. Available at: https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf

[3] Environmental Protection Agency (EPA). Emission Factors Hub. April 1, 2022. Available at: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

[4] Intergovernmental Panel on Climate Change (IPCC). 2014. AR5 Synthesis Report: Climate Change 2014. Available at: https://www.ipcc.ch/report/ar5/syr/

The total natural gas consumption, combusted natural gas activity data, emissions factors, and GHG emissions associated with community natural gas use are summarized per building type and provider in Table 8.

Table 8 Community Residential and Commercial Natural Gas GHG Emissions Calculations

Sector	Activity Data [therms]	End-use Leakage [therms]	Combustion Activity Data [therms]	Emissions Factor [MT CO_2e/therm]	GHG Emissions [MT CO_2e]
Residential	5,813,399	29,067	5,784,332	0.005311	30,723
Commercial	2,813,524	14,068	2,799,456	0.005311	14,869

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

Energy: Natural Gas Methane Leaks

Natural gas methane leaks occur during delivery to the buildings and during associated end-uses in the community. Gas methane leaks from delivery occur in the pipeline distribution system and are, therefore, upstream of the delivery endpoints and not reflected in reported total natural gas usage. While natural gas pipeline distribution leakage is technically outside of Campbell's jurisdictional boundaries, the leakage is still directly impacted by natural gas consumption in the community. As leakage is directly connected to the community's natural gas consumption, it is best practice to include leakage as an emissions sector in the Campbell's 2022 Community GHG Inventory. Methane leaks from end-use – discussed previously – occur at the point-of-use in the city and occur within Campbell's jurisdictional boundaries.

Though a recommended source of emissions, the Community Protocol does not provide a specific calculation methodology for determining GHG emissions from natural gas leakage. Therefore, emissions from natural gas leaks were calculated using Equation 2-4, which estimates emissions in alignment with energy calculation principles set forth by the Community Protocol and the guidance provided under Community Protocol Section BE.5 Upstream Emissions from Energy Use. Table 9 shows the parameters and data sources associated with Equation 2-4, which were used to quantify GHG emissions from natural gas distribution and end-use leakage.

EQUATION 2-4

NATURAL GAS LEAKAGE SECTOR EMISSIONS

$$CO_2e_{leak,i} = Fuel_{NG,i} \times EF_{NG\ leak} \times (L_{enduse} + L_{dist})$$

Table 9 Emissions Parameters and Data Sources – Community Natural Gas Leaks

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from natural gas distribution leakage per building type	$CO_2e_{leak,i}$	See Table 10	MT CO_2e/year	Calculated
Natural gas consumed per building type	$Fuel_{NG,i}$	See Table 10	therms/year	PG&E Community Report[1]
Emission factor for natural gas leakage	$EF_{NG\ leak}$	0.053067	MT CO_2e/therm	Calculated[2]
Percent natural gas lost during distribution	L_{dist}	2.3%	Percent	Alvarez, Ramón et al. (2018)[3]
Percent natural gas lost during consumer end-use	L_{enduse}	0.5%	Percent	Environmental Defense Fund[4]
Building type (i.e., residential, or commercial)	i	Residential Commercial	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; therms = thermal unit

[1] 2022 PG&E Community Report Provided by the City on May 2024 via SharePoint.

[2] Emission factor is calculated using the following equation:

$$2.85\,\frac{cubic\ meters}{therm} * 95\%\ methane\ content * 0.7\,\frac{kg}{cubic\ meter} * 28\,\frac{CO_2e}{CH_4} * 0.001\,\frac{MT}{kg}$$

[3] Alvarez, Ramón et al. (2018). Assessment of methane emissions from the U.S. oil and gas supply chain. Science. 361. Accessed January 12, 2023, at: https://www.science.org/doi/abs/10.1126/science.aar7204

[4] Environmental Defense Fund USER GUIDE FOR NATURAL GAS LEAKAGE RATE MODELING TOOL. Accessed January 12,2023 at: https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf

The total natural gas use and resulting leakage activity data, emissions factors, and GHG emissions per building type are summarized in Table 10.

Table 10 Community Natural Gas Methane Leaks GHG Emissions Calculations

Natural Gas Sector	Leakage Source	Activity Data [therms]	Methane Leakage [therms]	Emissions Factor [MT CO_2e/therm]	GHG Emissions [MT CO_2e]
Residential	Distribution	5,813,399	133,708	0.053067	8,638
	End-use	5,813,399	29,067	0.053067	
Commercial	Distribution	2,813,524	64,711	0.053067	4,181
	End-use	2,813,524	14,068	0.053067	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

2.2.2 Transportation

Transportation: On-Road

On-road vehicles produce GHG emissions from the mobile combustion of fossil fuels (i.e., internal combustion engines) and from the production of electricity used by EVs. GHG emissions from the on-road transportation sector were calculated in accordance with Community Protocols TR.1.A and TR.2.B. The methodology leverages on-road transportation data from CARB's 2021 Emission Factor (EMFAC2021) model.[11] EMFAC2021 provides data at the countywide level.

The Community Protocol recommends the use of regional travel demand models to differentiate activity data by passenger, commercial, and bus vehicle miles travelled (VMT). This assessment utilizes data provided by Replica.[12] Replica uses big data sources such as GPS, cell phone, credit card transactions, real estate data, and ground-truthing, along with powerful machine learning techniques, to generate a statewide land use and VMT model that is updated quarterly. For this assessment, Replica provided origin–destination average daily, weekday, and weekend VMT for each quarter of 2022 within Campbell. Quarterly daily VMT provided by Replica was averaged and scaled[13] to determine 2022 VMT activity data. Replica does not have Bus VMT data for 2022. Because of COVID-19 impacts to ridership, 2019 is considered the best proxy. VMT rates were averaged and scaled using the same techniques described above. The bus category includes EMFAC defined bus types such as school bus, urban bus, and other bus, which encompasses transit vehicles. 2019 bus data is considered to be the best proxy for 2022, as factors impacting bus ridership in 2019 and 2022 are most alike. Equation 2-5 and Table 11 define the equations, parameters, and data sources used to convert resulting Replica VMT activity data to GHG emissions from on-road transportation fuel combustion.

EQUATION 2-5

TR.1.A & TR.2.B ON-ROAD TRANSPORTATION COMBUSTION EMISSIONS

$$CO_2e_{onroad,i} = \left(T_i + \frac{1}{2}T_{O,i} + \frac{1}{2}T_{D,i}\right) \times EF_{auto,i}$$

[11] California Air and Resources Board. 2023. Emission Factor (EMFAC2021 v1.0.1) Model. Available at: https://arb.ca.gov/emfac/emissions-inventory/5e0cb7d6006cc10661f4b3ffb9c120a486d46ea6

[12] https://www.replicahq.com/

[13] Weekend daily VMT is scaled assuming 104 weekend days in a year, while weekday daily VMT was scaled assuming 261 weekdays in a year.

Table 11 Emissions Parameters and Data Sources – Community On-Road Transportation

Definition	Parameter	Value	Unit	Data Source
Total annual community on-road GHG emissions per vehicle class	$CO_2e_{Onroad,i}$	See Table 14	MT CO_2e/year	Calculated
VMT occurring within jurisdictional boundaries per vehicle class	T_i	See Table 14	miles	Replica Model[1]
VMT originating within and terminating outside of jurisdictional boundaries per vehicle class	$T_{O,i}$	See Table 14	miles	Replica Model
VMT originating outside of and terminating within jurisdictional boundaries per vehicle class	$T_{D,i}$	See Table 14	miles	Replica Model
Emissions factor for on-road vehicles per vehicle class	$EF_{auto,i}$	See Table 14	MT CO_2e/mile	EMFAC2021 v1.0.1[2]
Vehicle class	i	Passenger Commercial Bus	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; VMT = vehicle miles travelled

[1] Replica VMT data for the City of Campbell provided via email in May 2024

[2] California Air Resources Board (CARB). 2023. Emission Factor (EMFAC2021 v1.0.1) Model. Available at: https://arb.ca.gov/emfac/emissions-inventory/5e0cb7d6006cc10661f4b3ffb9c120a486d46ea6

In addition to mobile combustion emissions accounted under Community Protocol Equations TR.1.A and TR.2.B, GHG emissions from electric vehicles were included in the City's 2022 Community GHG Inventory for more accurate accounting of on-road transportation trends. This was achieved through modifications to Equation 2-5 to account for local EV modeshare estimates. Because EMFAC2021 considers EV vehicles to have an emissions factor of zero, Equation 2-6 is used to account for the emissions associated with electricity for those EV vehicles. The adjusted equation, parameters, and data sources used to estimate GHG emissions attributable to on-road EV activity are provided in Equation 2-6 and Table 12 below.

EQUATION 2-6

ON-ROAD TRANSPORTATION ELECTRIC VEHICLE EMISSIONS

$$CO_2e_{onroad,EV,i} = \left(T_i + \frac{1}{2}T_{O,i} + \frac{1}{2}T_{D,i}\right) \times EV_{share,i} \times EPM_i \times EF_{elec,j}$$

Table 12 Emissions Parameters and Data Sources – Community On-Road Transportation

Definition	Parameter	Value	Unit	Data Source
Total annual community on-road EV GHG emissions per vehicle class	$CO_2e_{Onroad,EV,i}$	See Table 14	MT CO_2e/year	Calculated
VMT occurring within jurisdictional boundaries per vehicle class	T_i	See Table 13	miles	Replica Model[1]
VMT originating within and terminating outside of jurisdictional boundaries per vehicle class	$T_{O,i}$	See Table 13	miles	Replica Model
Vehicle miles travelled originating outside of and terminating within jurisdictional boundaries per vehicle class	$T_{D,i}$	See Table 13	miles	Replica Model
Percent share of VMT attributable to EVs	$EV_{share,i}$	See Table 13	%	EMFAC2021 v1.0.1[2]
Average rate of electricity consumption per EV-mile per vehicle class	EPM_i	See Table 13	kWh/mile	EMFAC2021 v1.0.1
Weighted average electricity emissions factor per building type	$EF_{elec,j}$	See Table 13	MT CO_2e/kWh	SVCE 2022 Electricity Report; PG&E Community Report[3]
Vehicle class	i	Passenger Commercial Bus	Categorical	
Building type	j	Residential Commercial	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; EV = electric vehicles; VMT = vehicle miles travelled; kWh = kilowatt hour

[1] Replica VMT data for the City of Campbell provided via email May 2024 via Replica (and aggregated/ processed by Rincon for annualization, as described above).

[2] California Air Resources Board (CARB). 2023. Emission Factor (EMFAC2021 v1.0.1) Model. Available at: https://arb.ca.gov/emfac/emissions-inventory/5e0cb7d6006cc10661f4b3ffb9c120a486d46ea6

[3] Silicon Valley Clean Energy (SVCE) 2022 Electricity Report, provided by the City via SharePoint and revised via email on May 29, 2024. PG&E Community Report

Table 13 shows the VMT activity data for by vehicle class, as well as the EV share of VMT used to determine the electricity consumption associated with EV activity.

Table 13 Community On-Road EV Activity Data Calculations

Vehicle Class	VMT Activity Data [miles]	EV Share [%]	EVMT [miles]	EPM [kWh/mile]	EV Activity Data [kWh]
Passenger	320,297,745	5.78%	18,523,456	0.37	6,932,044
Commercial	10,981,011	0.00%	0	0.00	0
Bus	1,096,229	0.12%	1,370	1.74	2,389

Notes: VMT = vehicle miles travelled; EV = electric vehicle; EPM = electricity per mile; EVMT = electric vehicle miles traveled; kWh = kilowatt hour

The activity data, emissions factors, and resulting GHG emissions from on-road transportation quantified in accordance with Equation 2-5 and Equation 2-6 are summarized in Table 14 below.

Table 14 Community On-Road Transportation GHG Emissions Calculations

Sector	Activity Data[1]		Emission Factor[4]		GHG Emissions [MT CO_2e]
Passenger VMT	320,297,745	VMT	0.000321	MT CO_2e/mile	102,702
Commercial VMT	10,981,011	VMT	0.001293	MT CO_2e/mile	14,195
Bus VMT	1,096,229	VMT	0.001324	MT CO_2e/mile	1,451
Passenger EVMT[1]	6,932,044	kWh	0.000032	MT CO_2e/kWh	223
Commercial EVMT[2]	0	kWh	0.000032	MT CO_2e/kWh	0
Bus EVMT[2]	2,389	kWh	0.000032	MT CO_2e/kWh	<1
Total					**118,571**

Notes: VMT = vehicle miles traveled; EVMT = electric vehicle miles traveled; kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent

[1] EV activity data does not include kWh associated with T&D losses as these emissions are considered negligible and are included under energy sector emissions.

[2] Emissions factor for on-road passenger EV electricity use is weighted according to the portion of electricity supplied per provider in the residential electricity sector (see Table 4)

[3] Emissions factor for on-road commercial and bus EV electricity use is weighted according to the portion of electricity supplied per provider in the residential electricity sector (see Table 4)

[4] Emission factor does not account for electricity emissions for EVs (counts EV VMT as zero), and therefore applying this emission factor to total activity data does not result in double counting.

Transportation: Off-Road

Off-road equipment and vehicles – such as those used in agriculture, construction, lawn and garden, or recreational equipment – generate GHG emissions from the combustion of fossil fuels. Community Protocol Equation TR.8 was used to quantify GHG emissions from off-road fuel consumption and is shown in Equation 2-7 below. Table 15 lists the parameters, values, and data sources used to quantify emissions in accordance with the Community Protocol.

EQUATION 2-7

TR.8 OFF-ROAD EQUIPMENT SECTOR EMISSIONS

$$CO_2e_{offroad,j} = EF_j \times \sum_i Fuel_{offroad,i,j} \times AF_i$$

Table 15 Emissions Parameters and Data Sources – Community Off-Road Equipment

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from offroad equipment	$CO_2e_{offroad,j}$	See Table 17	MT CO_2e/year	Calculated
Annual fuel consumption in the County per sector per fuel type	$Fuel_{offroad,i,j}$	See Table 17	Gallons/year	OFFROAD2021[1]
Fuel attribution factor per equipment type	AF_i	See Table 16	Percent	Plan Bay Area 2050;[2] Department of Finance[3] 6th Cycle 2023-2031 Housing Element[4]
Emission factor per fuel type	EF_j	See Table 17	MT CO_2e/gallon	EPA Emission Factors Hub[5]
Equipment Type	i	See Table 16	Categorical	OFFROAD2021
Fuel type	j	Gasoline Diesel Natural Gas	Categorical	OFFROAD2021

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

[1] California Air Resource Board (CARB). 2023. Mobile Source Emissions Inventory Off-road (OFFROAD2021 v1.0.3). Available at: https://arb.ca.gov/emfac/emissions-inventory/5e0cb7d6006cc10661f4b3ffb9c120a486d46ea6

[2] Plan Bay Area 2050. 2021. Growth Pattern, Projected Household and Job Growth, by County. Available at: https://planbayarea.org/sites/default/files/FinalBlueprintRelease_December2020_GrowthPattern_Jan2021Update.pdf

[3] Department of Finance (DOF). 2024. E-5 Population and Housing Estimates for Cities, Counties, and the State, 2020-2024. Available at: https://dof.ca.gov/forecasting/demographics/estimates/e-5-population-and-housing-estimates-for-cities-counties-and-the-state-2020-2024/

[4] City of Campbell. 2023. 6th Cycle 2023-2031 Housing Element. Available at: https://www.campbellca.gov/ArchiveCenter/ViewFile/Item/2953

[5] Environmental Protection Agency (EPA). 2022. GHG Emission Factors Hub. Available at: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

Table 16The data used for off-road equipment fuel consumption was at the countywide level. These values were scaled based on Campbell’s population, jobs, and land use. The demographic attribution metrics and percent attribution used for each off-road equipment type is shown in Table 16.

Table 16 Community Off-Road Equipment Sector Attributions

Equipment Type	Attribution Metric	Attribution	Data Source
Agricultural	Excluded - Other	0.0000	Not Applicable
Airport	Excluded - Other	0.0000	Not Applicable
Cargo	Excluded - Other	0.0000	Not Applicable
Commercial	Excluded - Other	0.0000	Not Applicable
Construction	Employment	0.0248	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[2]
Industrial	Employment	0.0248	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[2]
Lawn	Population	0.0232	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[3]
Light	Employment	0.0248	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[2]
Locomotive	Excluded - Not Under Jurisdictional Control	0.0000	Not Applicable
Ocean	Excluded - Other	0.0000	Not Applicable
Oil	Excluded - Not Under Jurisdictional Control	0.0000	Not Applicable
Outboard	Excluded - Not Under Jurisdictional Control	0.0000	Not Applicable
Pleasure	Population	0.0232	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[3]
Portable	Employment	0.0248	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[2]
Transport	Employment	0.0248	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[2]
Recreational	Households	0.0249	Plan Bay Area 2050; Department of Finance; 6th Cycle 2023-2031 Housing Element[4]
Military	Excluded - Other	0.0000	Not Applicable
Forestry	Excluded - Other	0.0000	Not Applicable

[1] Agriculture and forestry were excluded due to lack of activity within Campbell's city limits. Same for ocean-related values (Campbell is land-locked) as well as Military bases.

[2] Employment allocation was determined based on county job projects in Plan Bay Area 2050 and estimating Campbell employment estimated based on 1.62 jobs per housing unit and applying 2022 number of households as forecasted based on the City's 6th Cycle 2023-2031 Housing Element.

[3] Population allocation was determined based on county population data in the county provided by the Department of finance and forecasting the City's 2022 population using population data provided in the 6th Cycle 2023-2031 Housing Element.

[4] Household allocation was calculated using county-level household data from Plan Bay Area 2050. To estimate the number of households in the City for 2022, the 2019 persons-per-household rate, determined from the 6th Cycle 2023-2031 Housing Element, was applied to the City's estimated 2022 population

The allocated and aggregated activity data by fuel type, emission factors, and emissions results for Campbell's off-road equipment sector are provided in Table 17.

Table 17 Community Off-Road GHG Emissions Calculations

Fuel Type	Activity Data (gallons)	Emission Factor ($MT\ CO_2e$/gallon)[1]	GHG Emissions ($MT\ CO_2e$)
Diesel	433,117	0.010469	4,534
Gasoline	492,352	0.009202	4,530
Natural Gas	402,977	0.005862	2,362
Total			**11,427**

Notes: $MT\ CO_2e$ = Metric tons of carbon dioxide equivalent; Values may not add due to rounding

[1] Emission factors per fuel type represent a weighted average based on the emissions factor and fuel consumption per off-road equipment type as determined according to EPA's Emissions Factor Hub available at: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

2.2.3 Solid Waste

GHG emissions associated with the waste sector result from the decomposition of waste at a landfill. Emissions from landfill processes were not available and were excluded. West Valley Collection and Recycling, LLC. (WVC&R) provides hauling for residential and commercial solid waste, recycling, and organics collection services. WVC&R is governed by the West Valley Solid Waste Authority (WVSWA), which is a joint power authority comprising the City of Campbell, Town of Los Gatos, City of Saratoga, and City of Monte Sereno. WVSWA contracts with Waste Management, which runs the Guadalupe Landfill located in San Jose, California. Recycling and organics recovery are sent offsite for processing, as per the most recent agreement signed between WVSWA and Waste Management in 2021.[14]

GHG emissions from waste decomposition were calculated using Community Protocol Method SW.4. Equation 2-8 and Table 18 provide the calculation method, associated parameters, and data sources used to quantify GHG emissions in accordance with Community Protocol SW.4. As the City of Campbell did not have a waste categorization study to inform the proportion of total waste material per material type, the default ICLEI factor was used.

EQUATION 2-8

SW.4.1 SOLID WASTE FUGITIVE EMISSIONS

$$CO_2e_{Waste,fugitive} = GWP_{CH_4} \times (1 - CE) \times (1 - OX) \times M \times \sum_i P_i \times EF_i$$

[14] https://www.wvswma.org/uploads/2/5/7/3/25736194/2021_wm_disposal_agreement.pdf

Table 18 Emissions Parameters and Data Sources – Community Solid Waste

Definition	Parameter	Value	Unit	Data Source
Annual community generated waste GHG emissions	$CO_2e_{Waste,fugitive}$	9,388	MT CO_2e/year	Calculated
Methane global warming potential	GWP_{CH_4}	28		IPCC Fifth Assessment Report[1]
Default LFG collection efficiency	CE	0.75	Fraction	ICLEI Community Protocol
Oxidation rate	OX	0.10	Fraction	ICLEI Community Protocol
Total mass of waste entering landfill	M	24,835	Tons	West Valley Solid Waste Management Authority[2]
Proportion of total waste material per material type	P_i	1	Fraction	
Emission factor per material type[4]	EF_i	0.060	MT CH_4/ton	ICLEI Community Protocol
Material type	i	Multiple	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

[1] Intergovernmental Panel on Climate Change (IPCC). 2014. AR5 Synthesis Report: Climate Change 2014. Available at: https://www.ipcc.ch/report/ar5/syr/

[2] Tons of waste activity data provided by the City of Campbell via SharePoint in May 2024

Guadalupe Landfill is located outside of Campbell. Therefore, energy consumption for landfill processes is not incorporated under the energy sector of Campbell's 2022 GHG Inventory. Instead, Landfill process emissions were quantified according to Community Protocol SW.5, which is outlined in Equation 29 and Table 19 below and are included in the solid waste sector of this inventory.

Landfill processing uses either compressed natural gas (CNG) or diesel. As information was not available, the Rincon team conservatively assumed diesel is being used for processes at the landfill, as diesel has a more intensive GHG emission factor.

EQUATION 2-9

SW.5 Solid Waste Process Emissions

$$CO_2e_{Waste,process} = M \times EF_p$$

Table 19 Emissions Parameters and Data Sources – Community Solid Waste

Definition	Parameter	Value	Unit	Data Source
Annual landfill process GHG emissions	$CO_2e_{Waste,process}$	407	MT CO_2e/year	Calculated
Total mass of solid waste that enters the landfill in the inventory year	M	24,835	Wet short tons/year	WVC&R
Emissions factor for landfill process emissions	EF_p	0.0164	MT CO_2e/wet short ton	ICLEI Community Protocol- Assumed Diesel

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

[1] Tons of waste activity data provided by the City of Campbell Via SharePoint in May 2024.

The total GHG emissions from solid waste emissions sources are summarized in Table 20.

Table 20 Community Solid Waste Tonnage Allocation

Emissions Source	GHG Emissions [MT CO_2e/year]
Landfill Fugitive Emissions	9,388
Landfill Process Emissions[1]	407
Total	**9,795**

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

[1] As Scholl Canyon Landfill is within city boundaries and is owned and operated by the City, process related emissions are anticipated to be included under energy sector GHG emissions and thus are excluded from total GHG emissions attributable to the solid waste sector.

2.2.4 Water

Campbell receives all water from the San Jose Water Company (SJWC), which is located outside of Campbell. As a result, this water is considered imported/purchased, rather than local. Rincon accounted for the energy used for water conveyance, treatment, and delivery to Campbell using SJWC reported energy intensity and total water consumed by Campbell. SJWC purchases electricity from Silicon Valley Clean Energy (GreenStart) and from San Jose Clean Energy (GreenValue).[15] The energy intensity provided as part of its most recent (2020) Urban Water Management Plan provided lifecycle kWh intensity values for water delivered to SJWC customers.

Table 21 shows the parameters and data sources associated with Equation 2-10, which were used to quantify GHG emissions from imported water sources.

EQUATION 2-10

WW.14 WATER SECTOR EMISSIONS

$$CO_2e_{Water,i} = Vol_i \times \sum_j EI_{i,j} \times EF_{elec,i,j}$$

[15] Assumed GreenStart and GreenValue as SJWC documentation did not confirm that the rate was 100% renewable. Accordingly, the less renewable intensive value was chosen. As there was no breakdown in kWh by electricity provider, an average was taken of both providers' emissions factors.

Table 21 Emissions Parameters and Data Sources – Community Water

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from water consumption	$CO_2e_{Water,i}$	98	MT CO_2e/year	Calculated
Volume of water supplied to the community per water district	Vol_i	1,493	MG [million gallon]	SJWC 2022 Report[1]
Energy intensity of water distribution	$EI_{i,j}$	1,031	kWh/MG	SJWC 2020 UWMP[2]
Electricity emissions factor per water process stage per source type	$EF_{elec,i,j}$	0.0000639566[4]	MT CO_2e/kWh	SJWC Correspondence[3] SJWC 2020 UWMP SVCE & SJCE
Water process stage	j	Distribution	Categorical	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; AF = acre-feet; kWh = kilowatt hour; UWMP = Urban Water Management Plan

[1] San Jose Water Company 2022 Report Provided by the City in May 2024

[2] San Jose Water Company UWMP Section 6.11- Energy Use (Lifecycle): https://www.sjwater.com/sites/default/files/2021-06/2020%20UWMP%20FINAL%20with%20Appendices.pdf

[3] May correspondence with City and San Jose Water Company confirms renewable energy purchase claim made in 2020 UWMP, leading to use of SVCE GreenStart emissions factor. SJCE emissions factor obtained via published 2022 power content label: https://sanjosecleanenergy.org/wp-content/uploads/2023/09/SJCE-2022-Power-Content-Label.pdf

[4] Note that as reported data did not articulate the kwh split between SJWC, and SJCE, a 50/50 split was assumed, and an average was taken between both emissions factors.

2.2.5 Wastewater

Management of wastewater can produce emissions through every stage of the process—from collection to final use or discharge. The City of Campbell contracts with the West Valley Sanitation District (WVSD) for wastewater collection, transport, and disposal services. WVSD operates and maintains the wastewater collection system serving Campbell, Los Gatos, Monte Sereno, and a portion of unincorporated Santa Clara County. Because WVSD uses gravity to convey wastewater, there are no conveyance-related emissions.[16]

WVSD contracts with the Santa Clara Regional Wastewater Facility (SCRWF) for wastewater treatment and disposal, thereby conveying all collected wastewater to the SCRWF plant. SCRWF is a centralized water treatment plant featuring anaerobic digestion and nitrification and denitrification for processing wastewater. The outfall from SCRWF is then discharged to South San Francisco Bay through the outfall channel after tertiary treatment. Currently, SCRWF processes wastewater for 1.4 million customers and 17,000 businesses in total. As the community of Campbell only represents a portion of this, the GHG emissions attributable to Campbell's community inventory are based on Campbell's proportion of the total population served by the District (a population of 42,462 Campbell residents in 2022).[17]

GHG emissions from SCRWF operations are a result of process emissions from the combustion of anaerobic digester gas, (see Equation 2-11 and Equation 2-12, which are respectively described in

[16] May 2024 Email Correspondence with City of Campbell.

[17] https://www.sanjoseca.gov/your-government/departments-offices/environmental-services/water-utilities/regional-wastewater-facility- note that the WWTP initially supplied an estimate of 42,800 customers, which is higher than the estimated number of residents in 2022 based on the City's 2023 Housing Element (https://www.campbellca.gov/ArchiveCenter/ViewFile/Item/2953). As a conservative estimate of GHG emissions associated with wastewater and to maintain consistency with population data used in the 2022 Community Inventory, 2023 Housing Element population estimates were used to allocate emissions to the City, where appropriate.

Table 22 and Table 23), nitrification/denitrification (see Equation 2-13and Table 24), wastewater outfall into San Francisco Bay (see Equation 2-14 and Table 25). Additionally, SCRWF provided electricity and natural gas consumption data, which were accounted for as well under Equation 2-15, Equation 2-16, Table 26, and Table 27.

EQUATION 2-11

WW.1.B WASTEWATER DIGESTER GAS STATIONARY COMBUSTION EMISSIONS (CH_4) – WHEN BTU CONTENT IS KNOWN

$$Annual\ CH_4\ emissions = (Digester\ Gas\ \times BTU_{digester\ Gas}\ \times\ 10^{-6} \times EF_{CH4}\ \times 10^{-3}$$

Table 22 Emissions Parameters and Data Sources – Community Wastewater WW.1B

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by devices designed to combust digester gas	$Annual\ CH_4\ emissions$	See Table 28	MT CO_2e/year	Calculated
Standard cubic feet of digester gas produced per day (std ft³/day)	$Digester\ Gas$	53,422	std ft^3/day	San Jose-Santa Clara Regional Wastewater Facility Provided Data – Scaled Using Campbell 2022 Population[1]
BTU content of digester gas, higher heating value	$BTU_{Digester\ Gas}$	597	BTU/scf	San Jose- Santa Clara Regional Wastewater Provided Data[2]
Conversion factor	10^{-6}	0.000001	mmBTU/BTU	ICLEI Community Protocol
Methane emissions factor	EF_{CH4}	0.0032	kg CH_4/ mmBTU	ICLEI Community Protocol
Conversion factor	365.25	365.25	Days/year	ICLEI Community Protocol
Conversion factor	10^{-3}	0.001	MT/kg	ICLEI Community Protocol
Global warming potential of methane	GWP_{CH4}	28		IPCC Fifth Assessment Report

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; std ft^3 = standard cubic feet; BTU = British thermal unit; mmBTU = one million British thermal units; kg = kilograms.

[1] Standard cubic feet of gas produced per day for entire wastewater operation provided by the San Jose Santa Clara Wastewater Facility and scaled to the size of Campbell (based on population) which was determined based on 6th Cycle 2023-2031 Housing Element population data and county-level population data provided by the Department of Finance E-5 report. Campbell's population comprises approximately 3.03% of the entire population served by the wastewater treatment plant.

[2] Provided to City staff and Project Team via email in April 2024.

EQUATION 2-12

WW.2.B WASTEWATER DIGESTER GAS STATIONARY COMBUSTION EMISSIONS (N_2O) – WHEN BTU CONTENT IS KNOWN

$$Annual\ N2O\ emissions = (Digester\ Gas\ \times BTU_{digester\ Gas}\ \times\ 10^{-6} \times EF_{N20}\ \times 10^{-3}$$

Table 23 Emissions Parameters and Data Sources – Community Wastewater WW.2.B

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by devices designed to combust digester gas	$Annual\ N2O\ emissions$	See Table 28	MT CO_2e/year	Calculated
Standard cubic feet of digester gas produced per day (std ft^3/day)	$Digester\ Gas$	53,422	std ft^3/day	San Jose-Santa Clara Regional Wastewater Facility Provided Data – Scaled Using Campbell 2022 Population[1]
BTU content of digester gas, higher heating value	$BTU_{Digester\ Gas}$	597	BTU/scf	San Jose-Santa Clara Regional Wastewater Provided Data[2]
Rate of digester gas volume production	$Digester\ Gas$	1.00	std ft^3/ person/day	ICLEI Community Protocol
Conversion factor	10^{-6}	0.000001	mmBTU/BTU	ICLEI Community Protocol
Nitrous Oxide Emission Factor	EF_{N2O}	0.00063	kg CH_4/ mmBTU	ICLEI Community Protocol
Conversion factor	365.25	365.25	Days/year	ICLEI Community Protocol
Conversion factor	10^{-3}	0.001	MT/kg	ICLEI Community Protocol
Global warming potential of nitrous oxide	GWP_{N2O}	265		IPCC Fifth Assessment Report

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; std ft^3 = standard cubic feet; BTU = British thermal unit; mmBTU = one million British thermal units; kg = kilograms.

[1] Standard cubic feet of gas produced per day for entire wastewater operation provided by the San Jose Santa Clara Wastewater Facility and scaled to the size of Campbell (based on population) which was determined based on 6th Cycle 2023-2031 Housing Element population data and county-level population data provided by the Department of Finance E-5 report. Campbell's population comprises approximately 3.03% of the entire population served by the wastewater treatment plant.

[2] Provided to City staff and Project Team via email in April 2024.

EQUATION 2-13

WW.7 CENTRALIZED WWTP WITH NITRIFICATION/DENITRIFICATION

$$CO_2e_{WW,nit/denit,i} = ((P \times F_{ind-com}) \times EF_{nit/denit} \times 10^{-6}) \times GWP_{N2O}$$

Table 24 Emissions Parameters and Data Sources – Community Wastewater WW.7

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by WWTP processes	$CO_2e_{WW,nit/denit,i}$	See Table 28	MT CO_2e/year	Calculated
Population served[1]	P	42,462	People	6th Cycle 2023-2031 Housing Element[1]
Factor for insignificant industrial or commercial discharge	$F_{ind-com}$	1.00	–	ICLEI Community Protocol
Emissions factor for a WWTP without nitrification or denitrification	$EF_{w/o\ nit/denit}$	7.00	g N_2O/person/ year	ICLEI Community Protocol
Conversion factor	10^{-6}	0.000001	Mt/g	–
Global warming potential of nitrous oxide	GWP_{N2O}	265		IPCC Fifth Assessment Report

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; std ft^3 = standard cubic feet; BTU = British thermal unit; mmBTU = one million British thermal units; kg = kilograms.

[1] City of Campbell. 2023. 6th Cycle 2023-2031 Housing Element. Available at: https://www.campbellca.gov/ArchiveCenter/ViewFile/Item/2953

Community Protocol Equation WW.12 was used to quantify emissions associated with the San Jose-Santa Clara Regional Wastewater Treatment Facility effluent discharge into the South San Fransisco Bay. Like all other parts of the wastewater treatment facility emissions, activity data has also been scaled to represent Campbell's proportional contribution to total GHG emissions (3.14 percent of total). The equation is provided in Equation 2-14, as shown below.

EQUATION 2-14

WW.12 FUGITIVE NITROUS OXIDE EMISSIONS FROM EFFLUENT DISCHARGE

$$CO_2e_{WW,effluent} = N\ Load \times EF_{effluent,i} \times \frac{44}{28} \times 365.25 \times 10^{-3} \times GWP_{N2O}$$

Table 25 Emissions Parameters and Data Sources – Community Wastewater WW.12

Definition	Parameter	Value	Unit	Data Source
Annual N_2O emitted by effluent processes	$CO_2e_{WW,effluent}$	See Table 28	MT CO_2e/year	Calculated
Average total nitrogen per day	$N\ Load$	106	kg N/day	SJSCWWTP Report– Scaled Using Campbell 2022 Population[1,2]
Emissions factor of discharge to water body type (ocean)	$EF_{effluent,i}$	0.0025	kg N_2O-N/kg sewage-N discharged	ICLEI Community Protocol, selected for 'Ocean Discharge' as discharge point is San Francisco Bay
Molecular weight ratio of N_2O to N_2	$\frac{44}{28}$	1.57	Fraction	
Conversion factor	365.25	365.25	Days/year	
Conversion factor	10^{-3}	0.001	MT/kg	
Global warming potential of nitrous oxide	GWP_{N2O}	265	–	IPCC Fifth Assessment Report

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; std ft^3 = standard cubic feet; kg = kilograms

[1] Report provided to the City via Email and Project Team via SharePoint in April 2024.

[2] Average total nitrogen per day provided by the San Jose Santa Clara Wastewater Facility and scaled to the size of Campbell (based on population) which was determined based on 6th Cycle 2023-2031 Housing Element population data and county-level population data provided by the Department of Finance. Campbell's population comprises approximately 3.03% of the entire population served by the wastewater treatment plant.

The SJSCWWTP is located outside of Campbell, which means that electricity and natural gas used at the WRP is not captured under community commercial energy use. Community Protocol Equation WW.15 was used to determine SJSCWWTP emissions from electricity and natural gas, adjusted to allocate emissions attributable to the Campbell community. It should be noted that ICLEI does not provide a specific formula to calculate natural gas use for WWTP operations, so the same methodology used for the rest of the community inventory was repeated here as a variation on WW.15, coded as WW.15-NG.

According to data provided by SJSCWWTP, both electricity and natural gas are purchased from PG&E, rather than SVCE. Accordingly, PG&E's emission factor is used to calculate energy emissions from consumption of electricity and natural gas at the plant.

EQUATION 2-15

WW.15 ENERGY-RELATED EMISSIONS ASSOCIATED WITH WASTEWATER COLLECTION AND TREATMENT – ELECTRICITY

$$CO_2e_{WWelec} = (Elec_{WW,i} + (Elec_{WW,i}\ \times\ TD) \times EF_{elec,i})$$

Table 26 Emissions Parameters and Data Sources – Community Wastewater WW.15

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by WWTP electricity use	CO_2e_{WWelec}	See Table 28	MT CO_2e/year	Calculated
Electricity use of WWTP	$Elec_{WW,i}$	464,682	kWh	WWTP Utility Data, allocated to Campbell Population[1]
T&D Loss Factor	TD	5.1%	Percentage	EPA[2]
PG&E electricity emission factor	EF_{elec}	0.0000263	MT CO_2e/kWh	PG&E[3]

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; MG = million gallons; AF = acre-feet; kWh = kilowatt hour

[1] Annual kWh purchased from PG&E provided to City via email in May 2024. Population data determined using 2023 6th Cycle housing element to forecast the City's 2022 population, as well as county-level data provided by the Department of Finance E-5 report. Original PG&E purchased electricity = 15,321 kWh, scaled by 3.03% allocated to Campbell population as a percentage of total WWTP population served.

[2] Environmental Protection Agency (EPA). 2023. Data Explorer, grid loss rates, 2016. Available at: https://www.epa.gov/egrid/data-explorer

[3] PG&E 2022 vie The Climate Registry: https://theclimateregistry.org/resources/carbon-footprint-registry/

EQUATION 2-16

WW.15-NG ENERGY-RELATED EMISSIONS ASSOCIATED WITH WASTEWATER COLLECTION AND TREATMENT – NATURAL GAS

$$CO_2e_{WWng} = (NG_{WWcons} \times EF_{ngcom}) + (NG_{WWleak} \times EF_{ngleak})$$

Table 27 Emissions Parameters and Data Sources – Community Wastewater WW.15

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by WWTP natural gas use	CO_2e_{WWng}	See Table 28	MT CO_2e/year	Calculated
Natural gas use of WWTP – consumed natural gas	$NG_{WW}cons$	114,753	therms	WWTP Utility Data, allocated to Campbell Population[1]
Natural gas use of WWTP – combusted natural gas [minus upstream leakage]	$NG_{WW}comb$	114,179	therms	WWTP Utility Data, allocated to Campbell Population; minus upstream leakage percentage[2]
Natural gas allocated leakage from WWTP	$NG_{WW}leak$	3,213	therms	WWTP Utility Data, calculated to include upstream and downstream emissions[3]
Natural gas combustion emission factor	EF_{ngcom}	0.0053115	MT CO_2e/therm	Alvarez, Ramón et al. (2018) & Environmental Defense Fund[4]
Methane leak emission factor	EF_{ngleak}	0.05307	MT CO_2e/therm	Alvarez, Ramón et al. (2018) & Environmental Defense Fund

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; MG = million gallons; AF = acre-feet; kWh = kilowatt hour

[1] PG&E purchased therms by WWTP provided to City via email in May 2024. The original 3,785,505 therms were then scaled to reflect Campbell's share of this overall total (3.03%).

[2] This value subtracts out 0.5% end-use to reflect the percentage of natural gas actually combusted in end-use. See natural gas community inventory emissions factor for full source description.

[3] This value calculates end-use leakage (0.5%) and adds it to pipeline leakage (2.3%) in order to calculate total methane leaked throughout therms consumed by the WWTP.

[4] Alvarez, Ramón et al. (2018). Assessment of methane emissions from the U.S. oil and gas supply chain. Science. 361. https://www.science.org/doi/abs/10.1126/science.aar7204.; Environmental Defense Fund USER GUIDE FOR NATURAL GAS LEAKAGE RATE MODELING TOOL. Available at: https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf

Table 28 summarizes wastewater sector activity data, emissions factors, and GHG emissions per WWTP.

Table 28 Community Wastewater GHG Emissions Calculations

Emissions Source	Protocol Equation	Activity Data & Unit		Emissions Factor[1]		GHG Emissions [MT CO_2e/year]
San Jose- Santa Clara Regional Wastewater Facility						
Stationary Combustion/ Anaerobic Digestion CH_4 and N_2O Emissions	WW.1.B; WW.2.B	20,187,204	std ft^3/yr	0.0000002	MT CO_2e/std ft^3	3
Nit/Denit Process N_2O	WW.7	43,930	service persons	0.0018550	MT CO_2e/ service pop	79
Effluent Discharge	WW.12	109	kg N/day	0.3799057	MT CO_2e/kg N/day	40
Electricity Use	WW.15	480,749	kWh	0.0000263	MT CO_2e/kWh	12
Electricity T&D Loss	WW.15	24,518	kWh	0.0000263	MT CO_2e/kWh	1
NG Use	WW.15-NG	118,127	therms	0.0053115	MT CO_2e/ therm	606
NG Leakage	WW.15-NG	3,324	therms	0.0530670	MT CO_2e/ therm	171
Total						**912**

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; kg = kilograms; kWh = kilowatt hour

2022 Community GHG Emissions Inventory Results

The inventory provides the current GHG emissions estimates that follow the Community Protocol and current best practices for GHG accounting. The results of the GHG inventory are summarized in Figure 1 and Figure 2, and shown in detail in Table 29.

Figure 1 Community Inventory GHG Emissions by Sector

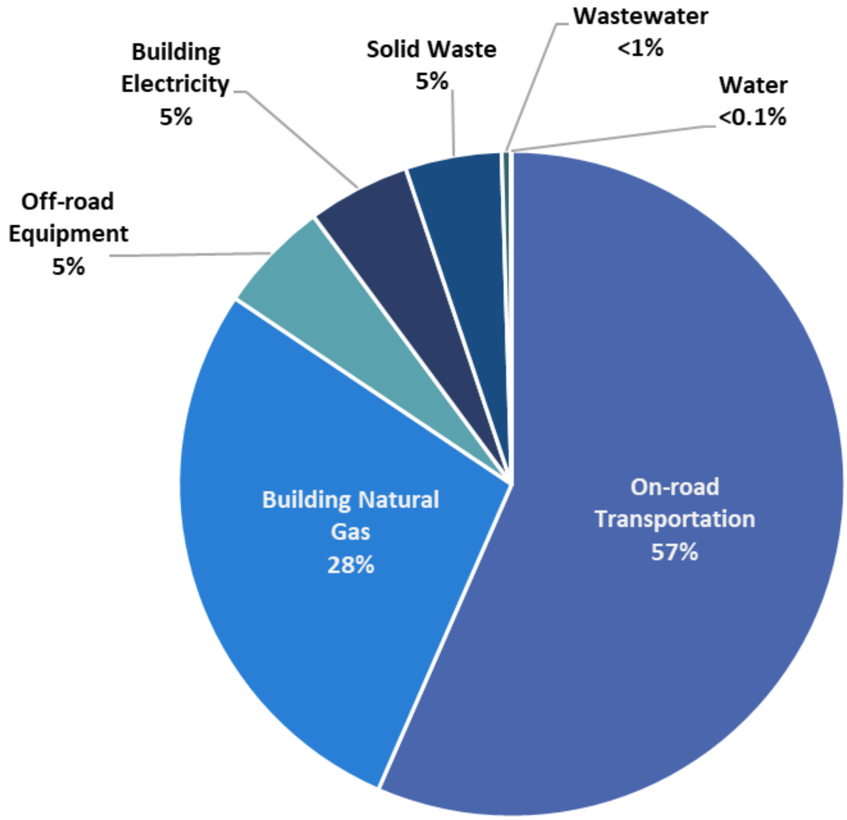


Figure 2 Community Inventory GHG Emissions by Subsector

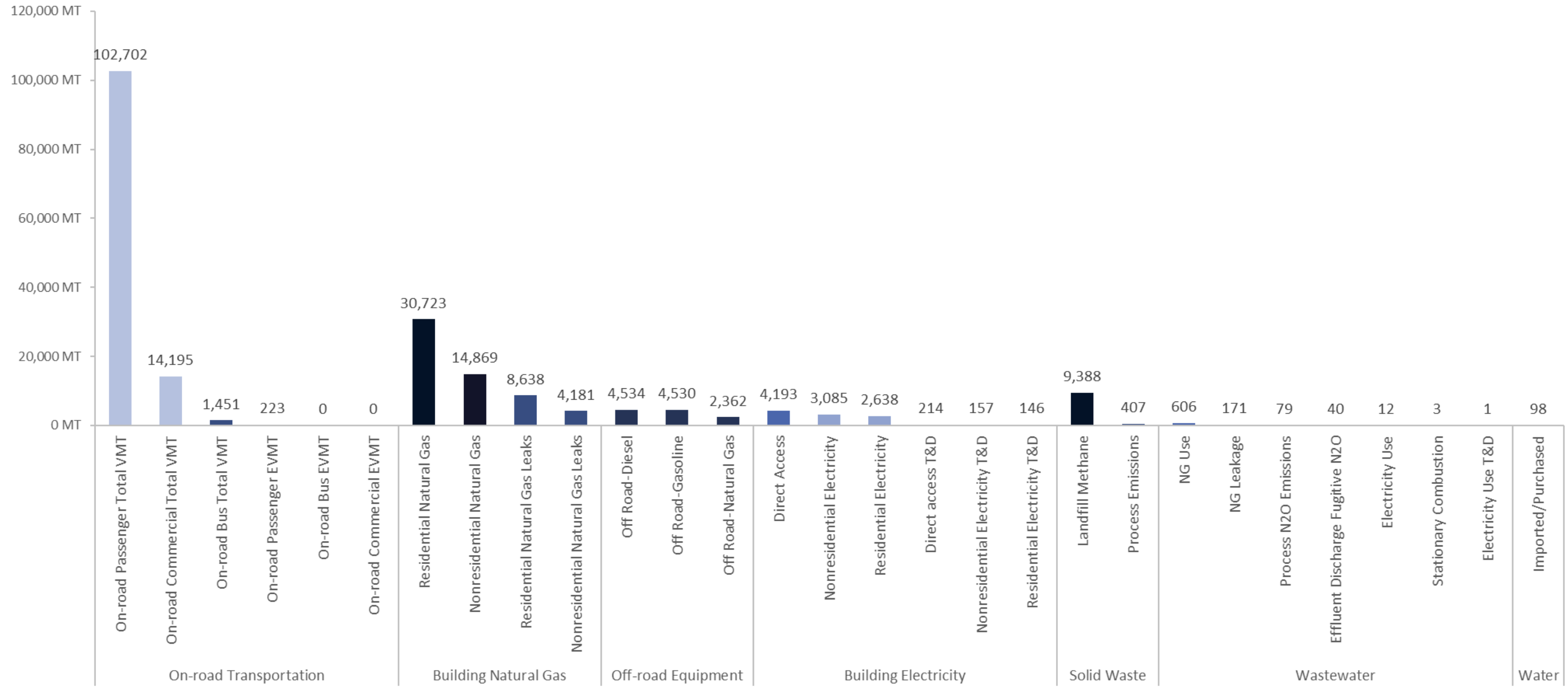


Table 29 2022 Community GHG Emissions Inventory

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
Energy	Residential Electricity	81,938,362	kWh	0.0000322	MT CO_2e/kWh	2,638
	Residential Electricity T&D	4,532,391	kWh	0.0000322	MT CO_2e/kWh	146
	Commercial Electricity	95,071,139	kWh	0.0000324	MT CO_2e/kWh	3,085
	Commercial Electricity T&D	4,848,750	kWh	0.0000324	MT CO_2e/kWh	157
	Direct Access	18,509,670	kWh	0.0002265	MT CO_2e/kWh	4,193
	Direct access T&D	943,993	kWh	0.0002265	MT CO_2e/kWh	214
	Residential Natural Gas	5,784,332	therms	0.005311	MT CO_2e/therm	30,723
	Residential Natural Gas Leaks	162,775	therms	0.053067	MT CO_2e/therm	8,638
	Commercial Natural Gas	2,799,456	therms	0.005311	MT CO_2e/therm	14,869
	Commercial Natural Gas Leaks	78,779	therms	0.053067	MT CO_2e/therm	4,181
Transportation	On-road Passenger Total VMT	320,297,745	VMT	0.000321	MT CO_2e/mile	102,702
	On-road Commercial Total VMT	10,981,011	VMT	0.001293	MT CO_2e/mile	14,195
	On-road Bus Total VMT	1,096,229	VMT	0.001324	MT CO_2e/mile	1,451
	On-road Passenger EVMT	6,932,044	kWh	0.000032	MT CO_2e/kWh	223
	On-road Commercial EVMT	0	kWh	0.000032	MT CO_2e/kWh	0.0
	On-road Bus EVMT	2,389	kWh	0.000032	MT CO_2e/kWh	0.1
	Off Road-Diesel	433,117	Gallons	0.010469	MT CO_2e/Gallon	4,534
	Off Road-Gasoline	492,352	Gallons	0.009202	MT CO_2e/Gallon	4,530
	Off Road-Natural Gas	402,977	Gallons	0.005862	MT CO_2e/Gallon	2,362
Solid Waste	Landfill Methane	24,835	tons	0.378000	MT CO_2e/ton	9,388
	Process Emissions	24,835	tons	0.016400	MT CO_2e/ton	407
Water	Imported/Purchased	1,539,283	kWh	0.000064	MT CO_2e/kWh	98

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
Wastewater	Stationary Combustion	19,512,530	std ft^3/yr	0.000000	MT CO_2e/std ft^3	3
	Process N_2O Emissions	42,462	service persons	0.001855	MT CO_2e/service pop	79
	Effluent Discharge Fugitive N_2O	106	kg N/day	0.379906	MT CO_2e/kg N/day	40
	Electricity Use	464,682	kWh	0.000026	MT CO_2e/kWh	12
	Electricity Use T&D	23,699	kWh	0.000026	MT CO_2e/kWh	1
	NG Use	114,179	therms	0.005311	MT CO_2e/therm	606
	NG Leakage	3,213	therms	0.053067	MT CO_2e/therm	171
Total						**209,646**

Notes: VMT = vehicle miles traveled; EVMT = electric vehicle miles traveled; kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent; gal = gallons

3 Municipal GHG Emissions Inventory

3.1 Methodology

The City's 2022 Municipal GHG Inventory was completed using the Local Government Operations Protocol[18] (LGOP) developed by Local Governments for Sustainability (ICLEI), California Air Resources Board (CARB), California Climate Action Registry, and The Climate Registry (TCR). The LGOP methodology includes the calculation of GHG emissions that can be attributed directly to City operations in the given inventory year. The municipal inventory allows the City to track its GHG emissions resulting from its facilities, vehicles, and any equipment over which it can exert control with policies.

This means that the municipal inventory is a subset of the community inventory and can be used by the City for guidance to reduce emissions directly under the City's control (e.g., electrifying municipal fleets and buildings, conducting internal outreach to improve landfill diversion).

The results of GHG emission calculations are presented by emissions scope, relating to the degree of control the City has over emissions sources. Emissions sources are categorized as direct (i.e., Scope 1) or indirect (i.e., Scope 2 or Scope 3), in accordance with the World Resources Institute and the World Business Council for Sustainable Development's Greenhouse Gas Protocol Corporate Standard, which are summarized below:

- **Scope 1:** Direct GHG emissions from sources within a local government's operations that it owns and/or controls. This includes stationary combustion to produce electricity, steam, heat, and power equipment; mobile combustion of fuels; process emissions from physical or chemical processing; fugitive emissions that result from production, processing, transmission, storage, and use of fuels; and other sources.
- **Scope 2:** Indirect GHG emissions associated with the consumption of electricity, steam, heating, or cooling that are purchased from a utility provider that also provides energy to other jurisdictions and/or is located outside the boundaries of the city.
- **Scope 3**: All other indirect GHG emissions not covered in Scope 2, such as emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the City (e.g., employee commuting and business travel, outsourced activities, waste disposal, etc.).

Scope

Similar to the community inventory, the GHG emissions sources and sectors for the municipal operations inventory are categorized into various sectors and subsectors to match the GHG emissions reporting of the community GHG emissions inventory, with the granularity required by the LGOP. The primary sectors of GHG emissions sources include:

[18] ICLEI. May 2010. Local Government Operations Protocol for the quantification and reporting of greenhouse gas emissions inventories.

- Electricity
- Natural Gas
- Transportation
- Water and Wastewater
- Solid Waste

Further granularity can be achieved by also reporting GHG emissions sources by the following subsectors when possible:

- Buildings and other facilities*
- Streetlights and traffic signals*
- Water delivery facilities*
- Port Facilities
- Airport Facilities
- Vehicle fleet*
- Transit fleet
- Power Generation Facilities
- Solid Waste Facilities
- Wastewater facilities

All categories coded with an "*" were included in the municipal inventory as they are relevant to the City of Campbell. All other categories have not been included as they are not applicable to municipal services found within jurisdictional boundaries.

The following LGOP recommended sectors have also been included in the City's 2022 Municipal GHG Inventory:

- Employee commute

The City's 2022 Municipal GHG Inventory includes an assessment of the City's operational GHG emissions according to the above subsectors and categorized by scope.

Emissions Boundary

The 2022 Municipal GHG Inventory includes all emissions occurring within the City of Campbell's direct jurisdictional authority (i.e., sources of emissions resulting from facilities that the City owns and/or operates). The City of Campbell operates and maintains multiple buildings and facilities, such as City Hall, the Campbell Community Center, and Corporate Yards. As the City does not own any utilities, emissions from purchased electricity, natural gas, and water/wastewater are treated as Scope 2 emissions.

3.2 2022 Municipal GHG Emissions Inventory

3.2.1 Buildings and Other Facilities

Buildings and facilities generate emissions that relate to the stationary combustion of natural gas (Scope 1) and the use of electricity (Scope 2) in City facilities.

Natural gas – which is used for heating and cooling buildings and facilities – is provided by PG&E. The same equations used to calculate emissions from both combusted and leaked natural gas (Equation 2-3 and Equation 2-4) are the same as described above in the Community GHG Inventory. The GHG emission calculation details associated with City facilities' natural gas usage and leakage are provided in Table 30.

Table 30 Municipal Buildings and Facilities Sector Natural Gas GHG Emissions Calculations

GHG Emissions Source	Adjusted Activity Data [therms]	Emissions Factor [MT CO_2e/therm]	Emissions [MT CO_2e]	Scope
Natural Gas Consumption	107,817	0.005311	573	Scope 1
Natural Gas Methane Leaks	3,034	0.053067	161	Scope 1
Total			**734**	**Scope 1**

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

The City purchases its electricity from the same providers described in the Community Inventory (PG&E and SVCE). The 2022 Municipal GHG Inventory considers the electricity consumed to operate City-owned buildings and facilities as a subset of the 2022 Community GHG Inventory and is thereby included as Scope 2 emissions. Additionally, T&D electricity losses are included in the City's 2022 Municipal GHG Inventory to align with the 2022 Community GHG Inventory.

Emissions factors for PG&E, SVCE GreenStart, and SVCE GreenPrime were provided by PG&E and SVCE. SVCE additionally provided a 2022 municipal report with addresses and coding for service type, as well as NAICS codes further describing end-uses for each City account. According to SVCE, all City buildings and facilities used SVCE GreenStart and SVCE GreenPrime, while streetlights and traffic signals used PG&E, SVCE GreenPrime, and SVCE GreenStart. Electricity T&D losses were calculated based on a 5.1 percent loss rate as specified by eGRID.[19] The GHG emission calculation details associated with buildings and other facilities' electricity usage are provided in Table 31.

[19] Environmental Protection Agency (EPA). 2023. eGRID Data Explorer 2022 Western Energy Grid. Available at: https://www.epa.gov/egrid/data-explorer

Table 31 Municipal Buildings and Facilities Sector Electricity GHG Emission Calculations

GHG Emissions Source	Utility Provider	Activity Data [kWh]	Emissions Factor [MT CO_2e/kWh][1]	Emissions [MT CO_2e]	Scope
Electricity Consumption	SVCE GreenPrime & GreenStart	2,161,896	0.000021	46	Scope 2
Electricity Consumption T&D	SVCE GreenPrime & GreenStart	110,257	0.000021	2	Scope 2
Total				**49**	**Scope 2**

Notes: kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent

[1] Emissions factor is a weighted average of SVCE GreenPrime and GreenStart rates. Note that over 99% of energy use is allocated to SVCE GreenPrime.

3.2.2 Streetlights and Traffic Signals

The City's streetlights and traffic signals also generate Scope 2 emissions and T&D losses. Activity data and emissions factors were included in the SVCE municipal report provided to the City.[20] Electricity T&D loss was calculated based on a 5.1 percent loss rate as specified by eGRID.[21] The GHG emission calculation details associated with streetlights and traffic signals are provided in Table 32.

Table 32 Municipal Streetlights and Traffic Signals Sector Electricity GHG Emission Calculations

GHG Emissions Source	Utility Provider	Activity Data [kWh]	Emissions Factor [MT CO_2e/kWh][1]	Emissions [MT CO_2e]	Scope
Streetlights & Traffic Signals	PG&E; SVCE GreenPrime & GreenStart	630,171	0.000022	14	Scope 2
Streetlights & Traffic Signals T&D	PG&E; SVCE GreenPrime and GreenStart	32,139	0.000022	0.7	Scope 2
Total				**14**	**Scope 2**

Notes: kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent

[1] Note that emission factor is a weighted average that reflects kwh consumption split across electricity providers.

3.2.3 Water Delivery

Water consumption typically generates Scope 3 GHG emissions from the electricity used to deliver water to City-owned facilities, as well as the energy used to treat and convey the water prior to delivery. All water is purchased from the San Jose Water Company (SJWC), consistent with the Community GHG Inventory. Water delivery by SJWC is considered Scope 3 as the City does not control the electricity used to extract, convey, treat, and transport water. The municipal inventory uses the same energy intensity [kWh/MG] as the Community GHG Inventory, along with the SVCE

[20] Municipal report is a separate spreadsheet from SVCE, while emissions factors use the same values used by the Community Inventory provided by SVCE and PG&E

[21] Environmental Protection Agency (EPA). 2023. eGRID Data Explorer 2021 Western Energy Grid. Available at: https://www.epa.gov/egrid/data-explorer

GreenStart and San Jose Clean Energy weighted emissions factor, as described in the Community Inventory. Specific 2022 MG usage was provided by San Jose Water, and validated using data provided by the Campbell Finance Department (water bills paid in Fiscal Years 2022 and 2023).

The GHG emission calculations details are provided in Table 33.

Table 33 Municipal Water Consumption GHG Emissions Calculations

Water District	Activity Data [MG]	Energy Intensity Factor [kWh/MG]	Electricity Usage [kWh]	Emission Factor [MT CO_2e/kWh]	GHG Emissions [MT CO_2e]	Emission Source Scope
Imported/Purchased Water	42	1,031	43,302	0.000064	3	Scope 3
Total					**3**	**Scope 3**

Notes: kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent; MG= million gallons Values may not add due to rounding

3.2.4 Vehicle Fleet

Vehicle fleet emissions include Scope 1 sources that relate to the mobile combustion of fossil fuels in the City's fleet vehicles. Information was not available for Scope 2 emissions from the charging of EVs and is not included in the total. Fleet vehicles include light- and medium-duty vehicles and trucks. The data provided by the Public Works Department represents fuel usage of diesel and gasoline in 2022, as well as an estimate of percentage of vehicles which were on-road vs. off-road. Approximately 85 percent of vehicles were estimated as on-road and 15 percent as off-road. Emission factors for diesel, gasoline, and compressed natural gas were obtained from the EPA Emission Factors for Greenhouse Gas Inventories report.[22] The GHG emission calculation details associated with vehicle fleet sources are provided in Table 34.

As the City does own a transit fleet (e.g., buses, light rail), there were no emissions calculated from this sector. Employee commutes account for emissions generated by City employees' trips to and from work and is treated as separate from the use of personal vehicles for work, as discussed in the section below.

[22] Environmental Protection Agency (EPA). 2022. GHG Emission Factors Hub. Available at: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

Table 34 Municipal Vehicle Fleet Sector GHG Emission Calculations

GHG Emission Source	Activity Data		Emissions Factor		Emissions [MT CO_2e]	Scope
On-Road Diesel[1]	2,550	Gallons	0.010254	MT CO_2e/gal	26	Scope 1
On-Road Gasoline[1]	43,333	Gallons	0.008808	MT CO_2e/gal	382	Scope 1
Off-Road Diesel[2]	450	Gallons	0.010467	MT CO_2e/gal	5	Scope 1
Off-Road Gasoline[2]	7,647	Gallons	0.009207	MT CO_2e/gal	70	Scope 1
Total					**483**	**Scope 1**

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; gal = gallons; kWh = kilowatt hour; Values may not add due to rounding

[1] On-road diesel and gasoline were calculated by taking EPA estimates of MPG and emissions factors/gas and diesel and applying the average of model years to the mpg calculated x gallons of fuel provided.

[2] Off-Road diesel emissions factors were taken by applying the kg CO2 factors provided by the EPA for Diesel and Gasoline. The values from EPA average emissions factors by fuel type and off-road equipment type were then taken for both gasoline and diesel for 'light commercial' categories and applied.

3.2.5 Solid Waste from City Facilities

Emissions calculations from solid waste from City facilities uses the same methodologies and emissions factors as detailed above in the Community Inventory in Equation 2-8 and Equation 2-9.

The GHG emissions calculations for municipal solid waste fugitive emissions and process emissions are shown in Table 35.

Table 35 Municipal Solid Waste GHG Emission Calculations

Sector	Activity Data [wet short ton]	Emission Factor [MT CO_2e/wet short ton]	GHG Emissions [MT CO_2e]	Emission Source Scope
Municipal landfill Decomposition	694	0.3780	262	Scope 3
Municipal landfill Process	694	0.0164	11	Scope 3
Total			**274**	**Scope 3**

3.2.6 Wastewater from City Facilities

Wastewater management and processing at SCRWF are considered Scope 3 emissions, as they are located outside of Campbell's boundaries and are not owned or operated by the City. Although West Valley Sanitation District (WVSD) does have offices in Campbell and could be considered Scope 1 emissions, wastewater is conveyed to SCRWF with gravity and, thus, does not have any associated emissions.

GHG emissions for wastewater treatment were calculated using the same Community Protocol methodology described above in the Community Inventory in Wastewater. Like the Community Inventory, total wastewater emissions from SCRWF were attributed to City operations.[23]

[23] Total 2022 FTE employees for 2022 were used to scale emissions to reflect the share of wastewater emissions borne by municipal staff: 219. This is equal to 0.5% of the total Campbell population used to calculate community wastewater emissions (43,930).

Table 36 Municipal Wastewater GHG Emissions

GHG Emission Source	Adjusted Activity Data[1]		Emissions Factor		Emissions [MT CO_2e]	Scope
Stationary Combustion	100,638	std ft^3/yr	0.0000002	MT CO_2e/std ft^3	0.01	Scope 3
Process N_2O Emissions	219	service persons	0.0018550	MT CO_2e/ service pop	0.40	Scope 3
Effluent Discharge Fugitive N_2O	1	kg N/day	0.3799057	MT CO_2e/kg N/day	0.20	Scope 3
Electricity Use	2,397	kWh	0.0000263	MT CO_2e/kWh	0.06	Scope 3
Electricity Use T&D	122	kWh	0.0000263	MT CO_2e/kWh	<0.00	Scope 3
NG Use	589	therms	0.0053115	MT CO_2e/ therm	3.12	Scope 3
NG Leakage	17	therms	0.0530670	MT CO_2e/ therm	0.87	Scope 3
Total					**4.7**	**Scope 3**

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; AF = acre-feet; kg = kilogram; kWh = kilowatt hour; Values may not add due to rounding

[1] Adjusted activity data reflects 0.5% of the total activity data to account for the contribution of FTE City employes to the community total.

3.2.7 Employee Commute

Emissions from employee commutes include Scope 3 GHG emissions sources from the mobile combustion of fossil fuels generated by the City of Campell's employee vehicles as employees commute to and from work. The City provided underpinning data in the form of employee type, schedule (Flexible 9/80[24] and telework) and estimated one-way trip to commute into the City of Campbell.[25] Average daily commute was scaled to working days in a year (including 9/80 employees). The community emission factor for 2022 passenger vehicles was then applied to annual milage to calculate MT CO_2e/Year.

The GHG emissions associated with the employee commute sector are provided in Table 37.

[24] A 9/80 work schedule is a two-workweek schedule of eight 9-hour days, one 8-hour day, and one day off.

[25] One-way trip lengths were calculated by City staff from the middle of the provided zip code on Google Maps. Zip codes 95228, 95321, and 95678 were excluded as outliers due to a calculated daily trip of over 100 miles.

Table 37 Municipal Employee Commute GHG Emissions

GHG Emission Source	City Employees – FTW	Average Daily Round Trip Distance [mi/vehicle/ day]	Workdays [commuting days] per Year[1]	Annual Mileage	Emissions Factor [MT CO_2e/mi][2]	Emissions [MT CO_2e]	Emission Source Scope
Single Occupancy – 9/80 Employees	30	107	171	550,124	0.00032	176	Scope 3
Single Occupancy – Non-9/80 Employees	189	107	234	4,742,648	0.00032	1,521	Scope 3
Total						**1,697**	**Scope 3**

[1] Assumed that 9/80 employees worked 171 days (commuted); non-9/80 employees worked 234 days (commuted). Note that the City does not have a telework policy, and an estimated 30-35 employees work a 9/80 schedule.

[2] Emissions factor uses on-road emissions factor used in Community inventory.

3.3 2022 Municipal GHG Emissions Inventory Results

The inventory provides the City with current GHG emissions estimates that follow the Community Protocol and current best practices for GHG accounting at the municipal level. The results of the GHG inventory are summarized in Figure 3 and shown in detail in Table 38.

Figure 3 Municipal 2022 GHG Inventory

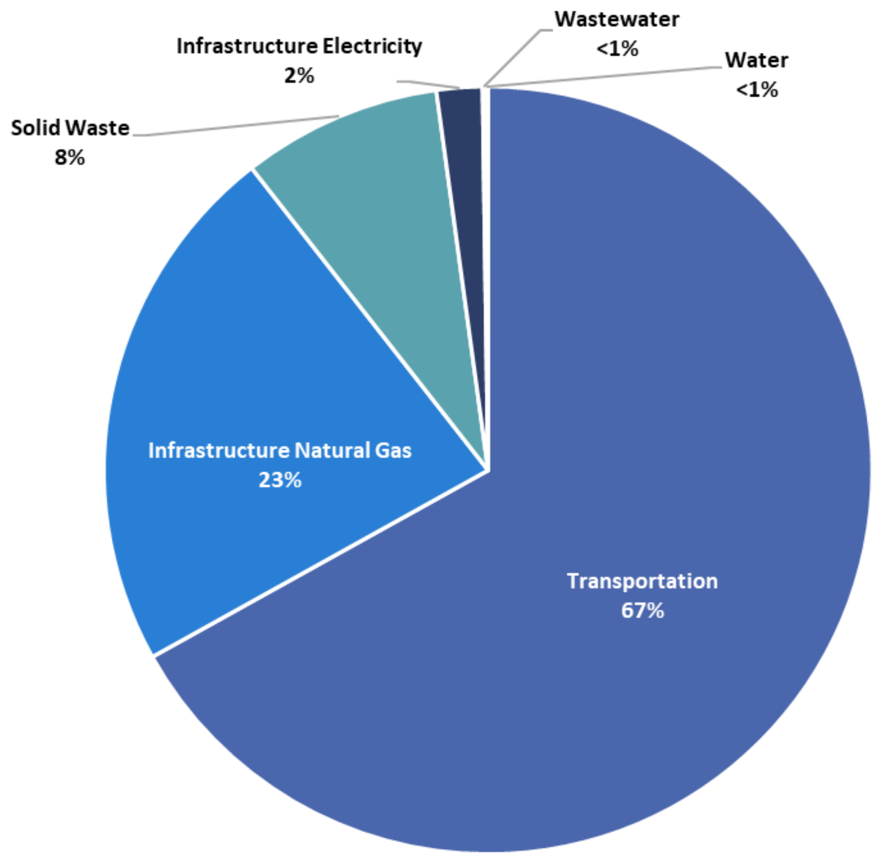


Figure 4 2022 Municipal GHG Inventory Subsector Breakdown

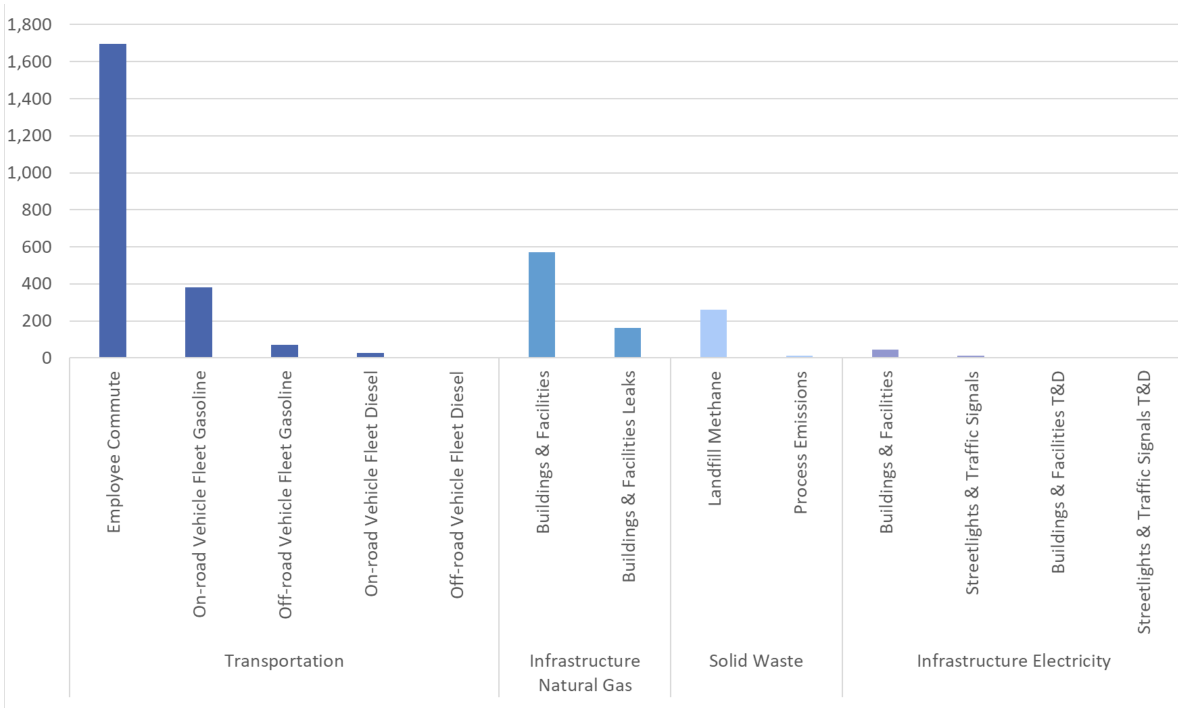


Table 38 2022 Municipal GHG Inventory

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
Energy	Electricity – Buildings & Facilities	2,161,896	kWh	0.000021	MT CO_2e/kWh	46
	Electricity – Buildings & Facilities T&D	110,257	kWh	0.000021	MT CO_2e/kWh	2
	Electricity – Streetlights & Traffic Signals	630,171	kWh	0.000022	MT CO_2e/kWh	14
	Electricity – Streetlights & Traffic Signals T&D	32,139	kWh	0.000022	MT CO_2e/kWh	0.7
	Natural Gas – Buildings & Facilities	107,817	therms	0.005311	MT CO_2e/ therm	573
	Natural Gas – Buildings & Facilities Leaks	3,034	therms	0.053067	MT CO_2e/ therm	161
Transportation	On-road Vehicle Fleet Diesel	2,550	gallons	0.010254	MT CO_2e/gal	26
	On-road Vehicle Fleet Gasoline	43,333	gallons	0.008808	MT CO_2e/gal	382
	Off-road Vehicle Fleet Diesel	450	gallons	0.010467	MT CO_2e/gal	5
	Off-road Vehicle Fleet Gasoline	7,647	gallons	0.009207	MT CO_2e/gal	70
	Employee Commute	5,292,773	miles/ yr	0.000321	MT CO_2e/mile	1,697
Solid Waste	Landfill Methane	694	tons	0.378000	MT CH_4/ton	262
	Process Emissions	694	tons	0.016400	MT CO_2e/ton	11
Water	Imported/Purchased	43,302	kWh	0.000064	MT CO_2e/kWh	3
Wastewater	Stationary Combustion	100,638	std ft^3/ yr	0.000000	MT CO_2e/std ft^3	0.0
	Process N_2O Emissions	219	service persons	0.001855	MT CO_2e/ service pop	0.4
	Effluent Discharge Fugitive N_2O	1	kg N/ day	0.379906	MT CO_2e/kg N/day	0.2
	Electricity Use	2,397	kWh	0.000026	MT CO_2e/kWh	0.1
	Electricity Use T&D	122	kWh	0.000026	MT CO_2e/kWh	0.0
	Natural Gas Use	589	therms	0.005311	MT CO_2e/ therm	3.1
	Natural Gas Leakage	17	therms	0.053067	MT CO_2e/ therm	0.9
Total						**3,258**

Notes: VMT = vehicle miles traveled; EVMT = electric vehicle miles traveled; kWh = kilowatt hour; MT CO_2e = Metric tons of carbon dioxide equivalent; gal = gallons

4 GHG Emissions Forecast

A GHG emissions inventory sets a reference point for a single year; however, annual GHG emissions change over time due to factors such as population and job growth, as well as new technologies and policies. A GHG emissions forecast estimates future GHG emission changes by accounting for projected community growth and changes. Calculating the difference between the GHG emissions forecast and GHG emissions reduction targets determines the gap that needs to be closed through the implementation of local GHG reduction policies. This section includes an estimate of the future emissions for Campbell in the years 2030, 2035, 2040 and 2045 in a business-as-usual scenario (BAU) forecast and a legislative adjusted scenario (adjusted) forecast, which are defined as follows:

- **Business-as-Usual Forecast.** Provides a forecast of how future GHG emissions would change if consumption trends continued as they did in 2022 and projected changes in population, housing, employment, and transportation activity over time consistent with planned projects within Campbell boundaries. The BAU does not include any GHG reductions associated with State regulations.
- **Legislative Adjusted Forecast.** Provides a forecast of how currently adopted state legislation would reduce GHG emissions from the business-as-usual scenario. The legislative adjusted scenario represents the State's contribution to reducing local GHG emissions to meet state goals.

Because the adjusted forecast incorporates the impact of State regulations that provide GHG emission reduction potential, the legislative adjusted scenario offers a more accurate picture of future GHG emission growth and the responsibility of Campbell for GHG reductions through local and regional actions.

4.1 Business-as-Usual Forecast

Demographic projections from 2022 to 2045 for population, employment, and households were developed using data from the City of Campbell's 6th Cycle 2023-2031 Housing Element to align with the City's General Plan.[26] The Housing Element provides population data for 2015 and 2020, household counts for 2019, and job numbers for 2018, along with Regional Housing Needs Allocation (RHNA) requirements for new housing units from 2023 to 2031. Population projections from 2020 to 2023 were calculated by analyzing population trends from 2015 to 2020, which was then applied to the 2019 persons-per-household rate (2.61) to estimate household growth from 2019 to 2023. From 2023 to 2031, the RHNA targets were applied to forecast the number of households needed by 2035. The resulting household data from 2019 to 2035 was then extended to project households through 2045. This household estimate, combined with the 2019 persons-per-household rate, was used to project population figures for 2023-2045. Employment projections were based on the Housing Element's job-to-housing unit ratio of 1.62, allowing for a forecast of employment growth parallel to household development.

A summary of the resulting demographics and projection metrics for each forecast year are provided in Table 39.

[26] https://www.campbellca.gov/DocumentCenter/View/20007/4th-HCD-Submittal-Draft-of-the-6th-Cycle-Housing-Element---Redlines

Table 39 BAU Forecast Demographic and Projection Metrics by Forecast Year

Metric	Data Source	2022	2030	2035	2040	2045
Population	6th Cycle Housing Element[1]	42,462	47,083	50,321	52,568	55,233
Households	6th Cycle Housing Element[1]	16,263	18,033	19,273	20,133	21,154
Employment	6th Cycle Housing Element[1]	26,346	29,213	31,222	32,616	34,270
Population Serviced	Calculated[2]	68,807	76,295	81,543	85,184	89,503
Off-road gasoline usage (gallons)	CARB OFFROAD2021	492,352	546,216	574,944	604,634	614,785
Off-road diesel usage (gallons)	CARB OFFROAD2021	433,117	472,009	502,115	533,476	567,663
Off-road natural gas usage (gallons)	CARB OFFROAD2021	402,977	449,083	479,378	512,912	512,916

[1] City of Campbell. 2023. 6th Cycle 2023-2031 Housing Element. Available at: https://www.campbellca.gov/ArchiveCenter/ViewFile/Item/2953

[2] Service population is equal to jobs + population.

A description of the demographic metrics used to project activity data and associated growth factors for each forecasted GHG emission source in the 2022 Community GHG Inventory are provided in Table 40.

Table 40 GHG Emission Sources and Growth Factors for BAU Scenario Forecast

GHG Emissions Source	Demographic Projection Metric	Growth Factor	Value
Energy			
Residential Electricity	Households	Electricity Consumption (kWh)/Household	5,038.41
Commercial Electricity	Employment	Electricity Consumption (kWh)/Job	3,608.61
Direct Access	Population	Electricity Consumption (kWh)/Job	702.57
Residential Natural Gas	Households	Natural Gas Consumption (therms)/Household	355.68
Residential Natural Gas Leaks	Households	Natural Gas Consumption (therms)/Household	10.01
Commercial Natural Gas	Employment	Natural Gas Consumption (therms)/Job	106.26
Commercial Natural Gas Leaks	Employment	Natural Gas Consumption (therms)/Job	2.99
Transportation			
On-Road Passenger Total VMT	Households	Annual VMT attributed to on-road vehicles using EMFAC2021 and Replica[1]	19,695.20
On-Road Commercial Total VMT	Employment	Annual VMT attributed to on-road vehicles using EMFAC2021 and Replica[1]	416.81
On-Road Bus Total VMT	Service Population	Annual VMT attributed to on-road vehicles using EMFAC2021 and Replica[1]	15.93
Off-Road Emissions[2]	N/A	Modeled by OFFROAD2021 and applied to Campbell populations	
Solid Waste			

GHG Emissions Source	Demographic Projection Metric	Growth Factor	Value
Solid Waste Disposal	Service Population	Solid Waste Emissions (MT CO_2e)/Service Person	0.14
Water			
Water Consumption	Service Population	Water Consumption-Associated Electricity Consumption (kWh)/Service Population	22.37
Wastewater			
Wastewater Treatment	Service Population	Wastewater Emissions (MT CO_2e)/Service Person	0.01
Wastewater Treatment – Electricity	Service Population	Wastewater Emissions (kWh)/Service Person	7.10

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; kWh = kilowatt-hour; VMT = vehicle miles traveled; N/A = Not Applicable; Service Population = the combined total number of employees and residents in Campbell; MG = million gallons

[1] Annual VMT for on-road vehicles are calculated from average weekday VMT data provided by Replica for Campbell and interpolated for the forecast years. Average weekday data is converted to annual VMT using CARB's VMT annualization factor (i.e., 347 days per year). Annual VMT data is then appropriated to each fuel (i.e., gasoline, diesel, and natural gas) using on EMFAC2021 data analysis.

[2] Off-road fuel usage is calculated by applying the attribution metrics from the 2022 GHG inventory to the OFFROAD2021 model outputs for the forecast years to attribute the county-level outputs to Campbell and thus does not have its own growth indicator listed here.

Using the above demographic and projection metrics in Table 39, multiplied by the growth factors in Table 40 and the 2022 Campbell Community GHG inventory emission factors, the BAU forecast can be calculated. In the BAU forecast, GHG emissions are expected to increase through 2045 due to anticipated regional growth from both population and jobs. A summary of the BAU forecast results by GHG emission sector is provided in Table 41 and summarized in Figure 5.

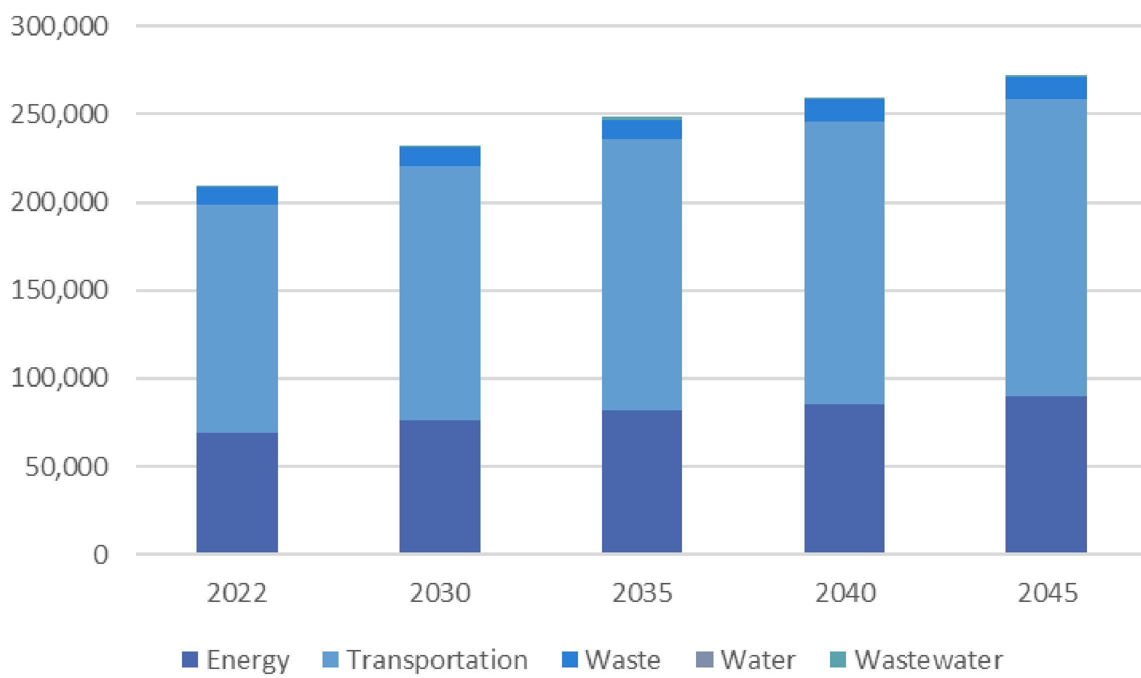
Table 41 BAU Forecast Results Summary by Emission Sector

GHG Emissions Source	2022	2030	2035	2040	2045
Energy	**68,843**	**76,336**	**81,586**	**85,229**	**89,550**
Residential Electricity + T&D	2,784	3,087	3,299	3,446	3,621
Commercial Electricity + T&D	3,242	3,595	3,842	4,014	4,217
Direct Access + T&D	4,407	4,887	5,223	5,456	5,732
Residential Natural Gas	30,723	34,067	36,410	38,036	39,964
Residential Natural Gas Leaks	8,638	9,578	10,237	10,694	11,236
Commercial Natural Gas	14,869	16,487	17,621	18,408	19,341
Commercial Natural Gas Leaks	4,181	4,636	4,954	5,176	5,438
Transportation	**129,998**	**144,075**	**153,875**	**160,947**	**168,840**
On-road Passenger Vehicles	102,925	114,126	121,977	127,422	133,882
On-road Commercial Vehicles	14,195	15,739	16,822	17,573	18,464
On-road Buses	1,451	1,609	1,720	1,796	1,887
Off-road Equipment	11,427	12,600	13,357	14,155	14,607

GHG Emissions Source	2022	2030	2035	2040	2045
Water and Wastewater	**1,010**	**1,120**	**1,197**	**1,251**	**1,314**
Wastewater Process and Fugitive Emissions & Energy Use	912	1,011	1,080	1,129	1,186
Water Conveyance Energy	98	109	117	122	128
Solid Waste	**9,795**	**10,861**	**11,608**	**12,126**	**12,741**
Solid Waste Disposal	9,795	10,861	11,608	12,126	12,741
Total GHG Emissions	**209,646**	**232,391**	**248,267**	**259,553**	**272,445**

Notes: All values are presented in metric tons of carbon dioxide equivalent (MT CO_2e). Totals may not add up due to rounding.

Figure 5 BAU Forecast Results Summary by Emission Sector (MT CO_2e)



4.2 Legislative Adjusted Forecast

Several State regulations have been enacted that would reduce Campell's GHG emissions below the BAU forecasted levels in 2030, 2035, 2040 and 2045. The impact of these regulations was quantified and incorporated into the adjusted forecast to provide a more realistic depiction of future emissions growth and the GHG emission reduction responsibility of local governments. The State legislation included in the adjusted forecast reduces GHG emissions associated with transportation, building energy efficiency, and renewable electricity. A brief description of each regulation and the methodology used to calculate associated reductions is provided in the following, as well as an explanation of any legislation excluded from the analysis.

4.2.1 Legislative Reduction Programs

Additional legislative programs are expected to reduce GHG emissions in specific sectors throughout California, as identified in the 2017 and 2022 Scoping Plans. Many of these programs were incorporated into the forecast analysis and are summarized in the subsections below.

Transportation Legislation

Advanced Clean Cars Programs

Prior to 2012, mobile emissions regulations were implemented on a case-by-case basis for GHG and criteria pollutant emissions separately. In January 2012, CARB approved a new emissions-control program (the Advanced Clean Cars program) combining the control of smog, soot-causing pollutants, and GHG emissions into a single coordinated package of requirements for passenger cars and light trucks model years 2017 through 2025. The Advanced Clean Cars program coordinated the goals of the Low Emissions Vehicles, Zero Emissions Vehicles, and Clean Fuels Outlet programs, and was more stringent than the federal Corporate Average Fuel Economy (CAFE) standards. The new standards will reduce California's GHG emissions by 34 percent in 2025, which is modeled under the CARB Emission Factor (EMFAC) Model and included in the GHG forecast as shown in Table 42.[27]

Advanced Clean Cars II was approved by CARB in August 2022 and expands the program's roadmap so that by 2035 all new cars and passenger trucks will be zero-emission vehicles (ZEV). This regulation effectively binds the State to EO N-79-20. The executive order was passed by the governor in 2020 and requires all new cars and passenger trucks sold in California be ZEV by 2035. While these legislations will lead to an expedited timeline for ZEV adoption in California, modeling data is not yet available in CARB's EMFAC Model. Emissions reductions attributable to the Advanced Clean Cars II program were excluded from the GHG forecast.

Advanced Clean Trucks was approved by CARB in June 2020 and sets a zero-emission vehicle (ZEV) percent-of-sales requirement on medium- and heavy-duty vehicle manufacturers to promote increased truck ZEV sales from 2024 to 2035. The standard is intended to reduce NO_x pollution and GHG emissions – which are disproportionately high in medium- and heavy-duty vehicle classes compared to passenger vehicles – as well as promote first-wave ZEV truck technology penetration in the market.[28] EMFAC models the effect of the Advanced Clean Trucks regulation on ZEV truck penetration and associated GHG emissions and is included in the forecast.

Table 42 Emission Factors Over Time by Vehicle Type (MT CO_2e/VMT)

Metric	2022	2030	2035	2040	2045
Passenger	0.000321	0.000266	0.000249	0.000240	0.000236
Commercial	0.001293	0.001066	0.000897	0.000781	0.000719
Buses	0.001324	0.001167	0.000853	0.000737	0.000644

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; VMT= vehicle miles traveled

[27] California Air and Resource Board (CARB). 2019. Advanced Clean Cars Summary. Available at: https://ww2.arb.ca.gov/sites/default/files/2019-12/acc%20summary-final_ac.pdf

[28] California Air and Resource Board (CARB). 2023. Advanced Clean Trucks. Available at: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/about

Assembly Bill 1493

Signed into law in 2002, AB 1493 (Pavley Standards) required vehicle manufacturers to reduce GHG emissions from new passenger vehicles and light trucks from 2009 through 2016. Regulations were adopted by CARB in 2004 and took effect in 2009 when the United States Environmental Protection Agency (USEPA) issued a waiver confirming California's right to implement the bill. This standard required automakers to reduce GHG emissions from new California passenger vehicles by about 30 percent by 2016, while simultaneously improving fuel efficiency and reducing motorists' costs.[29] The impacts of the Pavley Standards on ZEV market penetration was incorporated into the EMFAC model starting in 2014 and are included in the forecast assessment.

Innovative Clean Transit

Public transit GHG emissions will be reduced in the future through the Innovative Clean Transit (ICT) regulation, which was adopted in December 2018. It requires all public transit agencies to gradually transition to a 100-percent zero-emission bus fleet by 2040. Under ICT, large transit agencies are expected to roadmap towards zero-emission public transit buses.[30] The effects of the ICT regulation on GHG emissions are modeled in EMFAC2021 and are therefore captured in the emissions factor for buses and inherently included in the forecast for the bus category.

Energy Legislation

California Code of Regulations – Title 24

Although it was not originally intended to reduce GHG emissions, California Code of Regulations Title 24, Part 6: California's Energy Efficiency Standards for Residential and Commercial Buildings, was adopted in 1978 to reduce California's energy consumption, which in turn reduced fossil fuel consumption and associated GHG emissions. The standards are updated triennially to allow consideration and possible incorporation of new energy-efficient technologies and methods. Starting in 2020, new residential developments had to include on-site solar generation and near-zero net energy use. For projects implemented after January 1, 2020, the California Energy Commission (CEC) estimated that the 2019 standards would reduce electricity consumption by 53 percent for residential buildings and 30 percent for nonresidential buildings, relative to the 2016 standards. The CEC further estimated residential natural gas efficiency increases of 7 percent for residential end-uses.[31] No efficiency increases were estimated for commercial natural gas end-uses, based on lack of requirements in this sector in the 2019 standards. These percentage savings relate to heating, cooling, lighting, and water heating only and do not include other appliances, outdoor lighting not attached to buildings, plug loads, or other energy uses. In December 2022, the CEC published the new Title 24 2022 Building Efficiency Standards.[32]

Due to the complexity of the new code, there is currently no available model establishing projected efficiency increases. Therefore, the updated 2022 code was not included in the forecast. This

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[29] CARB. Clean Car Standards – Pavley, Assembly Bill 1493. May 2013. Accessed November 14, 2022, at: http://www.arb.ca.gov/cc/ccms/ccms.htm

[30] Innovative Clean Transit. Approved August 13, 2019. Accessed November 14, 2022 at: https://ww2.arb.ca.gov/sites/default/files/2019-10/ictfro-Clean-Final_0.pdf?utm_medium=email&utm_source=govdelivery

[31] California Energy Commission. 2019 Building Energy Efficiency Standards Frequently Asked Questions. January 1, 2020. Accessed November 8, 2022 at: https://www.energy.ca.gov/sites/default/files/2020-03/Title_24_2019_Building_Standards_FAQ_ada.pdf

[32] California Energy Commission (CEC). 2023. 2022 Building Energy Efficiency Standards. Available at: https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

provides a conservative estimate of forecasted GHG emission reductions resulting from efficiency increases.

Renewables Portfolio Standard, Senate Bills 1078, 100, 350, and 1020

Established in 2002 under SB 1078, enhanced in 2015 by SB 350, and accelerated in 2018 under SB 100, California's Renewable Portfolio Standard (RPS) is one of the most ambitious renewable energy standards in the country. The RPS program requires investor-owned utilities, publicly owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 50 percent of total procurement by 2026, and 60 percent of total procurement by 2030. The RPS program further requires that by 2045, 100 percent of total energy procured be a combination of eligible renewable energy resources and zero-carbon resources.

California's RPS was further accelerated in 2022 by SB 1020 which established additional requirements that procurement from eligible renewable energy resources and zero-carbon resources increase to 90 percent of total procurement by 2035 and 95 percent of total procurement by 2040. The requirements of SB 1020 do not affect those previously set forth – they are to be considered additional to the existing RPS requirements. The RPS program and SB 1020 were incorporated into the GHG forecast by adjusting the electricity emissions factors for future years, as discussed in Section 4.4.

PG&E as well as RCEA currently provide electricity to Campbell and are subject to the RPS requirements. Weighted emission factors adjusted for RPS requirements were used to project emissions through 2045. Table 43 provides the estimated electricity emission factors that would result from RPS

Table 43 Forecasted RPS and Weighted Electricity Emission Factor

Metric	2022	2030	2035	2040	2045
Renewables Portfolio Standard Percentage (PG&E)	38%	60%	90%	95%	100%
Renewables Portfolio Standard (SVCE)[1]	46%	65%	90%	95%	100%
SVCE GreenPrime	95%	–	–	–	–
SVCE GreenStart	45%	–	–	–	–
California Grid (eGRID; CAMX)	34%	60%	90%	95%	100%
San Jose Clean Energy Green Value	40%	60%	90%	95%	100%
Residential Weighted EF (MT CO_2e/kWh)	**0.0000321923**	**0.0000208012**	**0.0000059260**	**0.0000029630**	**0.0000000000**
Commercial Weighted EF (MT CO_2e/kWh)	**0.0000324455**	**0.0000209648**	**0.0000059726**	**0.0000029863**	**0.0000000000**
SVCE GreenStart Weighted EF (MT CO_2e/kwh)	0.00003266	0.0000207451	0.0000059272	0.0000029636	0.0000000000
PG&E EF (MT CO_2e/kWh)	0.00002630	0.0000170510	0.0000042627	0.0000021314	0.0000000000

Metric	2022	2030	2035	2040	2045
San Jose Clean Energy GreenValue EF (MT CO_2e/kWh)	0.00009525	0.0000637154	0.0000159288	0.0000079644	0.0000000000
Weighted Water (SJCE and SVCE) EF MT CO_2e)	0.00006396	0.0000422302	0.0000109280	0.0000054640	0.0000000000

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent; kWh = kilowatt-hour; EF = emissions factor.

[1] Weighted average calculated off kWh split across GreenPrime and GreenStart Rates observed for 2022 Community Inventory.

Waste Legislation

Assembly Bill 939 and Assembly Bill 341

In 2011, AB 341 set the target of 75 percent recycling, composting, or source reduction of solid waste by 2020, calling for the California Department of Resources Recycling and Recovery (also known as CalRecycle) to take a statewide approach to decreasing California's reliance on landfills. This target was an update to the former target of 50 percent waste diversion set by AB 939.

As actions under AB 341 are not assigned to specific local jurisdictions, potential future reductions from the bill were conservatively not included in the GHG forecast analysis.

Assembly Bill 1826

In 2014, AB 1826 set regulations in place requiring California businesses to recycle all their organic waste starting in April 2016. The bill also required jurisdictions across the State to provide organic waste recycling programs to accommodate diverted waste from local businesses. Campbell has already implemented a residential and commercial organics collection program (further described below under Senate Bill 1383).[33] Because of this, AB 1826 compliance is reflected in the community's inventory and is thereby included in the BAU and adjusted forecast.

Senate Bill 1383

SB 1383 established a methane emission reduction target for short-lived climate pollutants in various sectors of the economy, including waste. Specifically, SB 1383 establishes targets to achieve a 50 percent reduction in the level of the statewide disposal of organic waste from the 2014 level by 2020 and a 75 percent reduction by 2025.[34] Additionally, SB 1383 requires a 20 percent reduction in "current" edible food disposal by 2025.[35] Although SB 1383 has been signed into law, compliance with this Senate Bill must occur at the local level. Reductions in organics diversion in 2022 are already included in base data that was used to forecast future emissions from landfilled waste in 2023. As of 2022, 20 percent of Campbell's total generated waste was diverted green waste (17 percent) and mixed organics (2 percent). As only landfilled waste was included in the inventory, the level of organic diversion that occurred in 2022 is captured in both the BAU and Adjusted Forecast. Due to the difficulty of local jurisdictions meeting the organic waste targets set by SB 1838, anticipated emissions reductions attributable to SB 1383 beyond current diversion rates observed in 2022 data are conservatively excluded from the forecast. However, estimated impacts associated with achieving SB 1383 with increased organics diversion will be included in the GHG reduction measures in the CAAP.

4.2.2 Legislative Adjusted Scenario Forecast Results

In the adjusted emissions forecast, all sectors are expected to increase except for water energy conveyance. While electricity shows a downward trend approaching zero in 2045 due to stringent RPS requirements from SB 100 and SB 1020, this is counteracted by natural gas consumption

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33 https://www.campbellca.gov/508/Garbage-Recycling-Services

34 CalRecycle. California's Short-Lived Climate Pollutant Reduction Strategy. https://calrecycle.ca.gov/organics/slcp/

35 SB 1383 does not specify a baseline year for the 20 percent food recovery target; however, CalRecycle's 2018 statewide waste characterization studies will be used to help measure the baseline for the State to meet its SB 1383 goals. See CalRecycle FAQ accessed November 14, 2022 for more information:https://calrecycle.ca.gov/organics/slcp/faq/foodrecovery/#:~:text=SB%201383%20requires%20the%20state,for%20individual%20jurisdictions%20to%20achieve.

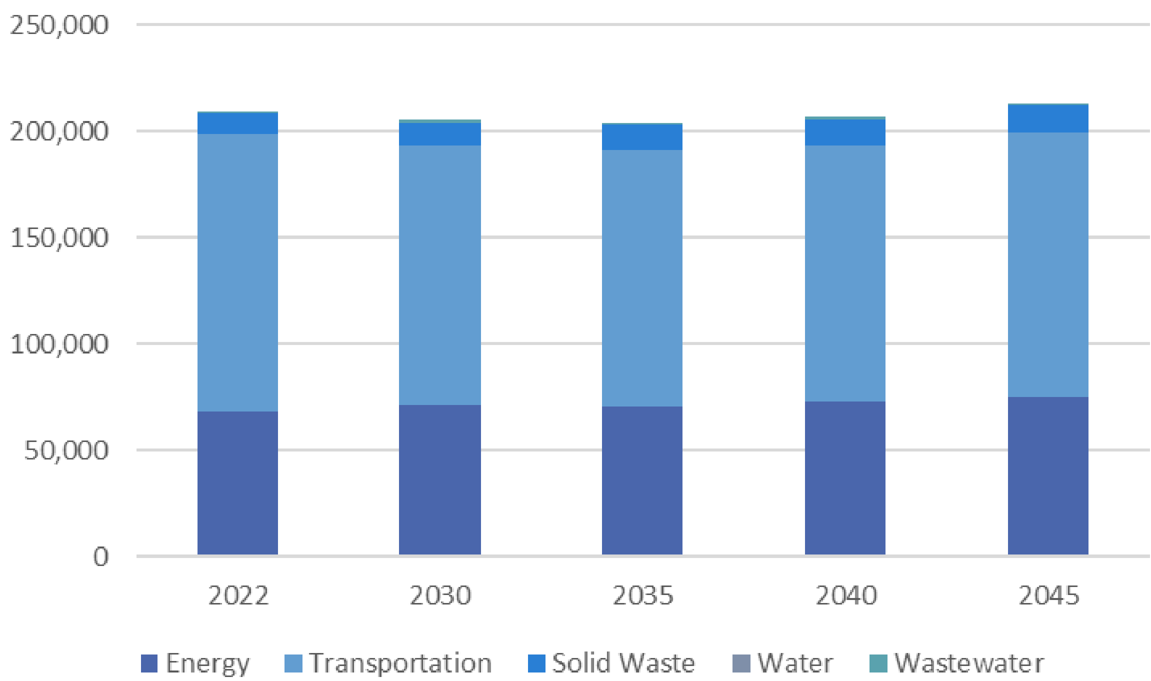
growth. Anticipated decreases in per capita transportation emissions (due to fuel efficiency requirements, fleet turnover rates, and increased electric vehicle penetration) are offset by anticipated population growth. As most current regulations expire in 2025 or 2030, emissions standards will experience diminishing returns while VMT continue to increase. A detailed summary of Campbell's projected GHG emissions by sector under the adjusted forecast through 2045 can be found in Table 44 and shown in a data visualization in Figure 6.

Table 44 Legislative Adjusted Scenario Forecast Results

GHG Emissions Source	2022	2030	2035	2040	2045
Energy	**68,843**	**71,489**	**70,700**	**72,681**	**75,151**
Residential Electricity + T&D	2,784	1,895	559	286	0
Commercial Electricity + T&D	3,242	2,256	675	349	0
Direct Access + T&D	4,407	2,870	753	389	0
Residential Natural Gas	30,723	33,833	36,012	37,524	39,317
Residential Natural Gas Leaks	8,638	9,512	10,125	10,550	11,054
Commercial Natural Gas	14,869	16,487	17,621	18,408	19,341
Commercial Natural Gas Leaks	4,181	4,636	4,954	5,176	5,438
Transportation	**129,998**	**121,820**	**120,728**	**121,019**	**124,224**
On-road Passenger Vehicles	102,925	94,799	94,576	95,234	98,430
On-road Commercial Vehicles	14,195	13,000	11,683	10,627	10,269
On-road Buses	1,451	1,421	1,112	1,002	918
Off-road Equipment	11,427	12,600	13,357	14,155	14,607
Solid Waste	**9,795**	**10,861**	**11,608**	**12,126**	**12,741**
Solid Waste Disposal	9,795	10,861	11,608	12,126	12,741
Water and Wastewater	**1,010**	**1,078**	**1,088**	**1,124**	**1,169**
Wastewater Process and Fugitive Emissions & Energy Use	912	1,006	1,068	1,114	1,169
Water Conveyance Energy	98	72	20	10	0
Total GHG Emissions	**209,646**	**205,248**	**204,124**	**206,951**	**213,285**
Change Since 2022	**0%**	**-2%**	**-3%**	**-1%**	**2%**

Notes: all values are presented in MT CO_2e = Metric tons of carbon dioxide equivalent, N/A = not applicable. Totals may not add up due to rounding.

Figure 6 Adjusted Forecast Results



4.2.3 Legislative GHG Emission Reduction Contribution

A summary of the reductions from the BAU forecast due to the contribution of legislation described above that can be expected under the adjusted forecast are provided in Table 45.

Table 45 Summary of Legislative GHG Emissions Reductions (MT CO_2e)

Legislation	2022	2030	2035	2040	2045
California RPS	0	4,327	10,225	11,683	13,269
Title 24	0	708	1,215	1,563	1,976
Transportation Legislation (Pavley, Innovative Clean Transit, etc.)	0	22,107	32,703	39,356	43,915
Total	**0**	**27,143**	**44,143**	**52,602**	**59,160**

Notes: all values are presented in MT CO_2e = Metric tons of carbon dioxide equivalent. Totals may not add up due to rounding.

5 GHG Emissions Targets

GHG reduction targets are used in climate action planning to help measure a community's commitment and progress. CARB encourages local agencies to take ambitious, coordinated climate action that is consistent with and supportive of the state's reduction goals for 2030 and 2045.[36] CARB has issued several guidance documents concerning the establishment of GHG emission reduction targets for CAPs to comply with California Environmental Quality Act (CEQA) Guidelines § 15183.5(b). Even if a plan is not CEQA-qualified, CARB has long recommended that local targets be a part of the process of developing, monitoring, and updating a CAP.

5.1 1990 Level GHG Emissions Backcast

Campbell does not have a 1990 GHG emissions inventory from which to develop GHG reduction targets consistent with SB 32, however, this can be estimated for the community relative to Campbell's 2022 inventory using a state-level emissions change metric.

As the State's 2022 GHG emissions inventory has not yet been published, Rincon used the 2021 inventory[37] to calculate approximate percent reduction in the Campbell community since 1990.

The calculation is developed using emissions results from CARB[38]—removing emissions from sectors not included in Campbell's inventory (e.g., non-specified, industrial point sources, agricultural and forestry land management practices). This approach assumes that Campbell's community activities and associated GHG emissions have generally tracked with statewide trends as shown in Table 46.

Table 46 1990 Backcast for Campbell

Entity	1990	2021 (State) / 2022 (Campbell)	Percent Difference
State (MMT CO_2e)[1]	255	305	16%
Campbell (MT CO_2e)[2]	250,861	209,646	16%

[1] State Emissions are expressed in Million Metric Tons (MMT) of CO_2e. 2021 emissions inventory source: https://ww2.arb.ca.gov/ghg-inventory-data; 1990 Inventory source: https://ww3.arb.ca.gov/cc/inventory/pubs/reports/staff_report_1990_level.pdf

[2] 2022 Inventory results consistent with community inventory, with a 16% increase applied to back-cast 1990 levels. Units are expressed in MT CO_2e, consistent with the community inventory.

[36] California Air Resources Board. 2022. California's Climate Change Scoping Plan, p.268. https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

[37] The State's 2020 GHG emissions inventory was used as this is the most recently available statewide inventory from CARB. It is assumed that the 1990-2020 Statewide GHG emissions change is similar to the 1990-2021 Statewide GHG emissions change, therefore it can be used to estimate 1990 level GHG emissions for Campbell based on the 2022 Campbell GHG Inventory.

[38] California Air Resources Board. 2023. California GHG Emission Inventory Program. https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

5.2 GHG Emissions Reduction Target Setting

Setting targets can help develop a trajectory that can allow for deep decarbonization in an incremental, cost-effective manner. CARB guidance is for jurisdictions to first strive to exceed the SB 32 targets of reducing GHG emissions 40 percent below 1990 levels, while establishing a policy framework to achieve the long-term target of carbon neutrality by 2045.

Target setting is an iterative process which must be informed by the reductions that can realistically be achieved through the development of feasible GHG reduction measures. As such, the targets identified herein should remain provisional until the quantification and analysis of potential measures have been completed.

Achieving the established targets will require major shifts in how communities within California obtain and use energy, transport themselves and goods, and how the population lives and builds.

Campbell's provisional GHG emission reduction targets are:

- Reduce GHG emissions to 40 percent below 1990 levels by 2030 (SB 32 target year)
- Make substantial progress towards carbon neutrality by 2045 (AB 1279 target year)

Campbell's GHG emissions reduction gap is based on the difference between the Adjusted Forecast, discussed previously, and the established GHG emission reduction targets. Table 47 provides a summary of the GHG emission reduction targets in mass emissions.

Table 47 GHG Emissions Reduction Targets and Gap Analysis

Metric	2022	2030	2035	2040	2045
Adjusted Forecast (State Legislation)	209,646	205,248	204,124	206,951	213,285
SB 32 Mass Emissions Pathway	209,646	150,516	100,344	50,172	0
Remaining Emissions Gap	0	54,731	103,780	156,779	213,285

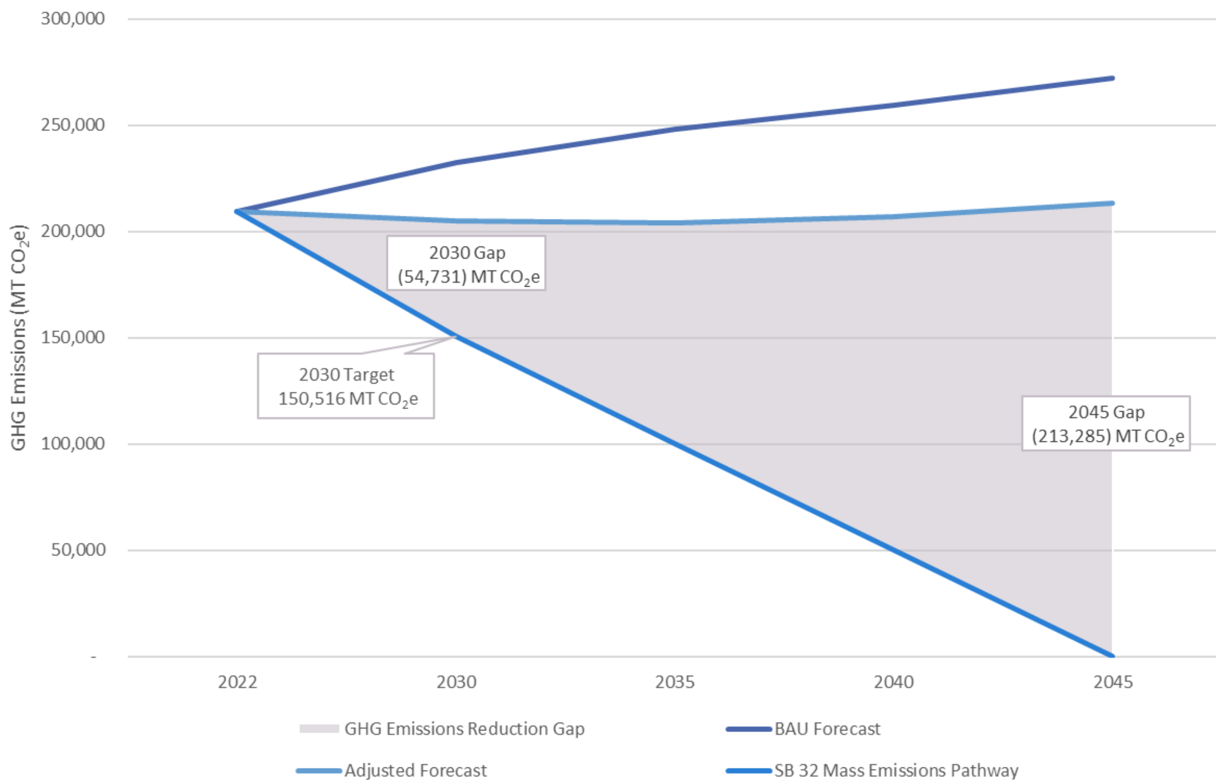
Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

Emissions have been rounded to the nearest whole number and therefore sums may not match.

[1] The target pathway is calculated by reducing 1990 mass emissions by 40% in 2030 and to 0 in 2045. This provisional target pathway is consistent with both SB 32 and a trajectory set forth to achieve AB 1279.

As demonstrated in Figure 7, Campbell will need to reduce 54,731 MT CO_2e by 2030, and 213,285 MT CO_2e by 2045 in order to meet State targets.

Figure 7 GHG Emissions Forecast and Provisional Target Pathways (Mass Emissions)



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