Glendale Climate Action / Adaptation Plan

Greenhouse Gas Inventory, Forecast, Targets Report

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1 Introduction

This document presents the data, methods, and results for the 2021 greenhouse gas (GHG) emissions inventory and forecast for the City of Glendale (the City). Included is an analysis of findings and trends in the City's GHG emissions developed to support the City's GHG emissions reduction targets and ultimately the City's 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% 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 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 government policies can influence high-emissions behavior and mitigate climate change effects.[2] To this end, the City is developing a CAAP to align with SB 32 and AB 1279 goals, increase resilience and climate change preparedness, maintain healthy air and water resources, and improve community health and the local economy. The forthcoming CAAP update will include the 2021 GHG inventory for the community (2021 Community GHG Inventory) and the associated GHG emissions forecast, in addition to the municipal operations inventory (2021 Municipal GHG Inventory). Municipal GHG emissions are a subset of community GHG emissions and are therefore included in the community GHG inventory and associated forecast.

The 2021 Community GHG Inventory completed for the City includes GHG emissions from activities within the City's jurisdictional boundaries during 2021. Based on the inventory, Rincon developed a back-cast of the City's GHG emissions to 1990 as well as a forecast to 2030, 2035, 2040, and 2045. The forecast provides an up-to-date projection of how GHG emissions are expected to change for the City in the future based on changes in population and employment, as well as existing State and federal legislation aimed at reducing GHG emissions through 2045. This document also presents provisional GHG targets and a gap analysis, developed to help identify GHG emissions reduction activities that will be needed to achieve the provisional 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.

[1] AB 1279 defines net zero GHG emissions as reducing GHG emissions at least 85% 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

2 Background

2.1 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 local communities can contribute their fair share towards the States achievement of the GHG emissions reductions goals. In the first Climate Change Scoping Plan (hereafter referred to as the 2008 Scoping Plan), CARB encouraged local governments to adopt a reduction target for their own community emissions that parallels the State commitment to reduce GHG emissions.[3] In 2017, CARB published the 2017 Climate Change Scoping Plan (hereafter referred to as the 2017 Scoping Plan Update) outlining the strategies the State will employ to reach the additional State targets set by SB 32.[4]

On May 10th, 2022, the Draft 2022 California Climate Change Scoping Plan Update was published for public comment and includes recommendations for achieving the goal of carbon neutrality by 2045 codified 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, establishes 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% below 1990 levels. The 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, requires California's GHG emissions be reduced to 1990 levels by the year 2020 (approximately a 15 % reduction from 2005 to 2008 levels). The 2008 Scoping Plan identifies mandatory and voluntary measures to achieve the statewide 2020 GHG emissions limit.
- **Senate Bill 32**, signed in 2016, establishes a statewide mid-term GHG emissions reduction goal of 40% 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 Draft 2022 Scoping Plan Update provides 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 identifies 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. Draft 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, codifies the GHG emissions reduction goals of achieving carbon neutrality by 2045 and expands upon this goal to define carbon neutrality as reducing direct emissions 85% below 1990 levels and removing the remaining 15% of emissions via other technologies and practices, like carbon sequestration. The 2022 Scoping Plan Update (November 2022 provides the pathway for reaching the State's AB 1279 goal.

2.2 Climate Science Context

Greenhouse Gases

GHGs are chemical compounds found in the earth's atmosphere which affect climate conditions by trapping infrared radiation from sunlight which can serve to raise global temperatures. Emissions can occur from natural processes as well as human activities which release excess GHGs into the atmosphere. GHG emissions quantification frameworks have been developed over the years in an effort to standardize GHG accounting, particularly for those generated from human activities. The ICLEI International Council for Local Government Initiatives (ICLEI) protocols for community and municipal inventories (discussed further in Section 3 and Section 4, respectively) assess GHG emissions associated with the six internationally recognized GHGs, as outlined in Table 1. The 2021 inventories focus on the three GHGs most relevant to the City's operations: carbon dioxide (CO_2), nitrogen dioxide (N_2O), methane (CH_4). The other gases (hydrofluorocarbons, perfluorocarbons, and sulfur hexafluorides) are emitted primarily in private sector manufacturing and electricity transmission and are therefore omitted from the inventory. 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 global warming potentials (GWP) for each gas. The 2021 inventories used 100-year global warming potentials (GWP) for each gas that are consistent with the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report,[6] which were also used by the State in their latest GHG emissions inventory. The 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).

[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/

Table 1 2021 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/

3 GHG Emissions Inventory - Community

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

- Establishes perspective of GHG emissions conditions in the applicable inventory year.
- Provide an understanding of where the highest sources of GHG emissions in the jurisdiction originate and where the greatest opportunities for emissions reduction exist.
- Create a GHG emissions baseline from which the jurisdiction can establish a forecast, reduction targets, and track progress over time.

GHG inventories are developed by identifying the sources and sinks (sectors) for GHGs within the geographic or system boundary of interest (e.g., the City of Glendale), establishing activity data for each sector, and applying an emissions factor to determine the carbon dioxide equivalence (CO_2e). On the level of cities or counties, there are often many potential sectors contributing to the jurisdiction's GHG emissions. However only a select few sectors are typically considered the major contributors to the jurisdiction's GHG inventory are considered. The GHG emissions sectors used for the City's GHG inventory are identified in Section 3.

3.1 Methodology

The City's 2021 Community GHG Inventory was developed in alignment with accounting protocols provided by the International Council for Local Government Initiatives (ICLEI). ICLEI protocols are designed for local-scale accounting of GHG emissions that contribute to climate change and provide authoritative guidance to account for GHG emissions accurately and consistently. 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

The City's community inventory covers the relevant emissions sources within the boundary of the City of Glendale. The inventory thereby reflects emissions over which the City has direct control.

Scope

The Community Protocol recommends reporting GHG emissions from five basic reporting activities in a community inventory, which include:

- 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. The full selection GHG emissions sources can be categorized more generally into the following five activity sectors:

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

The City's 2021 Community GHG Inventory includes an assessment of the community-wide GHG emissions associated with these five sectors which serve as the basis for the GHG emissions forecast and target setting.

3.2 2021 Community GHG Emissions Inventory

Generally, GHG emissions were calculated by multiplying the activity data in each GHG emissions sector (e.g., transportation, energy, waste, water) 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 2021 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. The following sections contain further information on the inventory approach, calculation methodologies, data used, and results.

3.2.1 Energy

Energy: Residential and Nonresidential Electricity

The community's residential and nonresidential sectors source electricity from Glendale Water and Power (GWP) which is owned and operated by the City. GWP provided the activity data through electricity usage reports for the residential sector and nonresidential sector (including commercial, and industrial sectors). In general, industrial GHG emissions are assumed to be covered by the State Cap and Trade program. Therefore, industrial electricity reported by GWP was excluded from the 2021 Community GHG Inventory. GWP also provided information regarding total electricity generation, electricity purchases, and associated GHG emissions which were used to determine GWP's emissions factor.

Emissions from residential and nonresidential electricity were calculated using Community Protocol Equation BE.2.1. The equation has been adjusted to remove electricity consumed by electric vehicles (EVs) by removing passenger car EV electricity use from residential electricity consumption and commercial and bus EV electricity consumption from nonresidential consumption. Electricity use from passenger, commercial, and bus EVs are added back into the inventory under the transportation sector to provide a more thorough differentiation between building and transportation sector emissions. More information regarding electric vehicle energy use can be

found in Section 3.2.2. Equation 3.1 and Table 2 provide the adjusted equation, associated parameters, and data sources used to quantify GHG emissions associated with community electricity consumption.

EQUATION 3.1

BE.2.1 RESIDENTIAL/NONRESIDENTIAL ELECTRICITY SECTOR EMISSIONS

$$CO_2e_{electricity,j} = \sum_i \left(Elec_{i,j} - EV_{i,j}\right) \times EF_{elec,i,j} \quad 3.1$$

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	GWP 2021 Electricity 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	GWP 2021 Electricity Report
Energy Providers	i	GWP	Categorical	
Building type	j	Residential Nonresidential[3]	Categorical	

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

1. Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

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

3. Nonresidential includes kWh consumption from commercial sources and excludes energy consumption from industrial sources.

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 Nonresidential Electricity Activity Data Adjustment

Sector	Provider	Original Activity Data [kWh]	Attributed EV[1] [kWh]	Adjusted Activity Data [kWh]
Residential	GWP	426,523,449	11,350,951	415,172,498
Nonresidential[2]	GWP	258,150,763	135,816	258,014,947

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

1. EV kWh usage from passenger vehicles are removed from residential electricity, while commercial and bus EV kWh usage is removed from nonresidential 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.

2. Nonresidential includes kWh consumption from commercial sources and excludes energy consumption from industrial and sources.

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

Table 4 Community Residential and Nonresidential Electricity GHG Emissions Calculations

Sector	Provider	Adjusted Activity Data [kWh]	Emission Factor [MT CO2e/kWh]	GHG Emissions [MT CO2e]
Residential	GWP	415,172,498	0.000218	90,318
Nonresidential	GWP	258,014,947	0.000218	56,129

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 arise from electricity lost during delivery to the buildings and associated end-uses in the City. Electricity T&D losses occur in the electricity transmission and distribution system and are therefore upstream of the delivery endpoints located within the City's jurisdictional boundaries. This means this electricity is lost before it is counted. However, T&D losses are estimated and included in the 2021 Community GHG Inventory as they are associated with energy usage in the City and thereby directly impacted by the community's electricity consumption. Additionally, emissions from T&D losses are recommended for inclusions in community GHG inventories by the Community Protocol. Equation 3.2 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 nonresidential electricity T&D.

EQUATION 3.2

BE.4 ELECTRICITY T&D LOSS SECTOR EMISSIONS

$$CO_2e_{T\&D,j} = \sum_i Elec_{i,j} \times L_{T\&D} \times EF_{elec,i,j} \quad 3.2$$

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	GWP 2021 Electricity Report[1]
Electricity emissions factor per energy provider and building type	$EF_{elec,i,j}$	See Table 6	MT CO_2e/MWh	GWP 2021 Electricity Report
Electricity loss factor	$L_{T\&D}$	4.40%	Percent	EPA eGRID[2]
Energy Providers	i	GWP	Categorical	
Building type	j	Residential	Categorical	

Definition	Parameter	Value	Unit	Data Source
		Nonresidential[3]		

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

1. Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

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

3. Nonresidential includes kWh consumption from commercial sources and excludes energy consumption from industrial sources.

The activity data, emissions factors, and GHG emissions associated with electricity T&D losses is summarized in Table 4 per building type and 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	GWP	426,523,449	18,767,032	0.000218	4,083
Nonresidential	GWP	258,150,763	11,358,634	0.000218	2,471

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 Nonresidential Natural Gas

GHG emissions from natural gas result from the stationary combustion of natural gas in both the residential and nonresidential building sectors. Glendale's natural gas is supplied by Southern California Gas Company (SoCalGas) which provided activity data through natural gas usage reports. GHG emission calculations are based on natural gas used in residential and nonresidential buildings (i.e., commercial and industrial). 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.

Emissions from residential and nonresidential natural gas use were calculated using Community Protocol Equation BE.1.1. Though the majority of GHG emissions result from the combustion of natural gas, not all the natural gas used is combusted. Natural gas that leaks from pipes and processing plants has a larger GHG impact compared to combusted natural gas due to the higher global warming potential of methane. Some natural gas also leaks from fittings and appliances within a building, after the natural gas meter which is used to quantify total gas usage. Therefore, 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 "Energy: Natural Gas Methane Leaks" subsection below. Equation 3.3 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 nonresidential buildings.

EQUATION 3.3

BE.1.1 RESIDENTIAL/NONRESIDENTIAL NATURAL GAS SECTOR EMISSIONS

$$CO_2e_{NatGas,i} = (Fuel_{NG,i} - [1 - L_{enduse}]) \times \left[(EF_{NG,CO_2} \times GWP_{CO_2}) + (EF_{NG,CH_4} \times GWP_{CH_4}) + (EF_{NG,N_2O} \times 10^{-1} \times 10^{-3}\right. \quad 3.3$$

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	SoCalGas Natural Gas 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_2/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 nonresidential)	i	Residential Nonresidential[5]	Categorical	

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

1. Southern California Gas (SOCALGAS) Natural Gas Report provided by the City via Sharepoint on March 20, 2023

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/

5. Nonresidential includes natural gas use from commercial sources and excludes energy consumption from industrial and sources.

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

Table 8 Community Residential and Nonresidential Natural Gas GHG Emissions Calculations

Sector	Activity Data [therms]	End-use Leakage [therms]	Adjusted Activity Data [therms]	Emissions Factor [MT CO_2e/therm]	GHG Emissions [MT CO_2e]
Residential	26,190,181	130,951	26,059,230	0.005311	138,412
Nonresidential	9,862,627	49,313	9,813,314	0.005311	52,123

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 located in Glendale and not reflected in reported total natural gas usage. While natural gas pipeline distribution leakage is technically outside of the City'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 and is therefore included in the City's 2021 Community GHG Inventory. Methane leaks from end-use discussed previously occur at the point of use in the City and therefore occur within the City'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 3.4 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 3.4 which were used to quantify GHG emissions from natural gas distribution and end-use leakage.

EQUATION 3.4

NATURAL GAS LEAKAGE SECTOR EMISSIONS

$$CO_2e_{leak,i} = Fuel_{NG,i} \times EF_{NG\ leak} \times (L_{enduse} + L_{dist}) \quad 3.4$$

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	SoCalGas Natural Gas Report[1]
Emission factor for natural gas leakage	$EF_{NG\ leak}$	0.053067	MT CO_2e/therm	Calculated[2]

Definition	Parameter	Value	Unit	Data Source
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 nonresidential)	i	Residential Nonresidential[5]	Categorical	

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

1. Southern California Gas (SoCalGas) Natural Gas Report provided by the City via Sharepoint on March 20, 2023

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

5. Nonresidential includes natural gas use from commercial sources and excludes energy consumption from industrial and sources.

The total natural gas use and resulting leakage activity data, emissions factors, and GHG emissions per building type is 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	26,190,181	602,374	0.053067	38,915
	End-use	26,190,181	130,951	0.053067	
Nonresidential	Distribution	9,862,627	226,840	0.053067	14,655
	End-use	9,862,627	49,313	0.053067	

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

3.2.2 Transportation

Transportation: On-road

On-road vehicles in the community produce GHG emissions from the mobile combustion of fossil fuels (i.e., internal combustion engines) and up-stream from the production of electricity (i.e., electric vehicles). GHG emissions from the on-road transportation sector were calculated in accordance with Community Protocol TR.1.A and TR.2.B. The methodology leverages on-road transportation data from CARB's 2021 EMission FACtor (EMFAC2021) model.[7] EMFAC2021 provides data on the county-wide data level and does not differentiate data according to cities.

The Community Protocol recommends use of regional travel demand models to differentiate passenger, commercial, and bus vehicle miles travelled activity data. This assessment utilizes data

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

provided by Replica.[8] The Replica model 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 then scaled with census data and updated on a quarterly basis. For this assessment, Replica provided origin-destination average daily weekday and weekend VMT for each quarter of the year for the City of Glendale. Quarterly daily VMT provided by Replica was averaged and scaled[9] to determine 2021 VMT activity data for the City. Equation 3.5 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 3.5

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

$$CO_2e_{onroad,i} = \left(T_i + \frac{1}{2}T_{O,i} + \frac{1}{2}T_{D,i}\right) \times EF_{auto,i} \quad 3.5$$

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 Glendale provided via email on February 6, 2023.

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 2021 Community GHG Inventory for more accurate accounting of on-road transportation trends. This was achieved through modifying Equation 3.5 to account for EV modeshare estimates based on total VMT. Note

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

[9] Weekend daily VMT is scaled assuming 104 weekends in a year, while weekday daily VMT was scaled assuming 261 weekdays in a year.

that EV activity data is not deducted from Equation 3.5 due to the use of EMFAC2021 emissions factors which account for EV activity but attribute GHG emissions to be zero, and therefore should not result in double counting. The adjusted equation, parameters, and data sources used to estimate GHG emissions attributable to on-road EV activity is provided in Equation 3.6 and Table 12 below.

EQUATION 3.6

ON-ROAD TRANSPORTATION ELECTRIC VEHICLE EMISSIONS

$$CO_2e_{onroad,EV,i} = \left(T_i + \frac{1}{2}T_{O,i} + \frac{1}{2}T_{D,i}\right) \times EV_{share,i} \times EPM_i \times EF_{elec,j} \quad 3.6$$

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	GWP 2021 Electricity Report[3]
Vehicle class	i	Passenger Commercial Bus	Categorical	
Building type	j	Residential Nonresidential	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 Glendale provided via email on February 6, 2023.
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. Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

Table 13 shows the VMT activity data for community vehicles per vehicle class as well as the EV share of VMT and EVMT used to determine EV activity data expressed as electricity consumption.

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	1,230,370,632	2.54%	31,251,414	0.36	11,350,951
Commercial	47,569,751	0.00%	0	0.00	0
Bus	12,605,474	0.51%	64,288	2.11	135,816

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 3.5 and Equation 3.6 is summarized in Table 14 below.

Table 14 Community On-road Transportation GHG Emissions Calculations

Sector	Activity Data[1]		Emission Factor		GHG Emissions [MT CO_2e]
Passenger VMT	1,230,370,632	VMT	0.000354	MT CO2e/mile	435,551
Commercial VMT	47,569,751	VMT	0.001198	MT CO2e/mile	56,989
Bus VMT	12,605,474	VMT	0.002123	MT CO2e/mile	26,761
Passenger EVMT[1]	11,350,951	kWh	0.000218	MT CO2e/kWh	2,469
Commercial EVMT[2]	0	kWh	0.000218	MT CO2e/kWh	0
Bus EVMT[2]	135,816	kWh	0.000218	MT CO2e/kWh	30
Total					**521,800**

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)

Transportation: Off-road

Off-road equipment and vehicles in the community generate GHG emissions from the mobile combustion of fossil fuels. Off-road fuel usage results from equipment operation for sectors such as agricultural, construction, lawn and garden, or recreational equipment. Community Protocol Equation TR.8 was used to quantify GHG emissions from off-road equipment fuel consumption and is shown under Equation 3.7 below. Table 15 lists the parameters, values, and data sources used to quantify emissions in according with the Community Protocol.

EQUATION 3.7

TR.8 OFF-ROAD EQUIPMENT SECTOR EMISSIONS

$$CO_2e_{offroad,j} = EF_j \times \sum_i Fuel_{offroad,i,j} \times AF_i \quad 3.7$$

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	SCAG Growth Forecast[2]
Emission factor per fuel type	EF_j	See Table 17	MT CO_2e/gallon	EPA Emission Factors Hub[3]
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. Southern California Association of Governments (SCAG). 2023. 2016-2040 RTP/SCS Final Growth Forecast by Jurisdiction. Available at: https://scag.ca.gov/sites/main/files/file-attachments/2016_2040rtpscs_finalgrowthforecastbyjurisdiction.pdf?1605576071

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

Locally applicable activity data in alignment with ICLEI protocol standards reports off-road equipment fuel consumption on a county-wide basis. Attribution factors per equipment type used to allocate City off-road fuel usage were determined based on demographic data and land use data relating to population size, number of jobs, and agricultural acreage where applicable. 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[1]	0.00%	Not Applicable
Airport Ground Support	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Cargo Handling Equipment	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Commercial Harbor Craft	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Construction and Mining	Employment	2.56%	SCAG Growth Forecast[2]
Industrial	Employment	2.56%	SCAG Growth Forecast

Equipment Type	Attribution Metric	Attribution	Data Source
Lawn and Garden	Population	1.93%	SCAG Growth Forecast
Light Commercial	Employment	2.56%	SCAG Growth Forecast
Locomotive	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Ocean Going Vessel	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Oil Drilling	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Outboard Marine Tanks	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Pleasure Craft	Population	1.93%	SCAG Growth Forecast
Portable Equipment	Employment	2.56%	SCAG Growth Forecast
Transport Refrigeration Unit	Employment	2.56%	SCAG Growth Forecast
Recreational	Population	1.93%	SCAG Growth Forecast
Military Tactical Support	Excluded – Not Under Jurisdictional Control	0.00%	Not Applicable
Forestry	Excluded – Other[3]	0.00%	Not Applicable

Notes:

1. Agricultural off-road equipment was excluded to remain consistent with the scope of the City's 2021 Community Inventory which excludes agricultural electricity and natural gas sector GHG emissions due to aggregation rules.

2. Southern California Association of Governments. 2023. 2016-2040 RTP/SCS Final Growth Forecast by Jurisdiction. Available at: https://scag.ca.gov/sites/main/files/file-attachments/2016_2040rtpscs_finalgrowthforecastbyjurisdiction.pdf?1605576071

3. Though forestry occurs withing the County of Los Angeles, there appears to be minimal opportunity for forestry within the City's boundaries. Therefore, it is assumed that offroad fuel consumption for forestry activities is negligible and thereby excluded.

The allocated and aggregated activity data by fuel type, emission factors, and emissions results for the inventory'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	2,227,013	0.010470	23,317
Gasoline	2,109,767	0.009189	19,386
Natural Gas	1,369,734	0.005862	8,030
TOTAL			**50,732**

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 offroad equipment type as determined according to EPA's Emissions Factor Hub available at: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

3.2.3 Solid Waste

GHG emissions associated with the waste sector result from the decomposition of waste at a landfill as well as landfill operation processes. Scholl Canyon Landfill is the primary landfill utilized by the City of Glendale and is owned and operated by the City. GHG emissions from waste decomposition

were calculated using Community Protocol Method SW.4. Equation 3.8 and Table 18 provide the calculation method, associated parameters, and data sources used to quantify GHG emissions in accordance with Community Protocol SW.4.

EQUATION 3.8

SW.4.1 SOLID WASTE FUGITIVE EMISSIONS

$$CO_2e_{Waste,fugitive} = GWP_{CH_4} \times (1 - CE) \times (1 - OX) \times M \times \sum_i P_i \times EF_i \quad 3.8$$

Table 18 Emissions Parameters and Data Sources – Community Solid Waste

Definition	Parameter	Value	Unit	Data Source
Annual community generated waste GHG emissions	$CO_2e_{Waste,fugitive}$	75,067	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	244,904	Wet short tons	City of Glendale[2]
Proportion of total waste material per material type	P_i	See Table 19	Fraction	Go2Zero Strategies[3]
Emission factor per material type[4]	EF_i	See Table 19	MT CH_4/wet short 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 Glendale via SharePoint on March 9, 2023

3. Go2Zero Strategies. 2019. City of Glendale Waste Characterization Study. Provided by the City via SharePoint on March 9, 2023

While the Glendale Waste Characterization Study conducted by Go2Zero[10] provides an extensive assessment of the community's waste, the material types identified do not directly correlate with those identified in the Community Protocol. Default emissions factors provided in the Community Protocol per material type were thus determined by cross-referencing material types between the City's waste characterization study and the Community Protocol. Where multiple material types were found to be applicable, an average emissions factor was calculated based on Community Protocol default values. Table 19 provides the proportion of solid waste per material type, identified material cross-references, and the resulting average methane emissions factors.

10 https://go2zero.net/

Table 19 Community Solid Waste Proportions and Emissions Factors

Glendale Material Types	Proportion	Protocol Cross-Reference	Average Methane Emissions Factor[1] [MT CH_4/ton]
Green Waste	13.00%	Grass Leaves Branches Lumber	0.0433
Compostable Paper	4.00%	Newspaper	0.0429
Food	18.00%	Food Waste	0.0776
Liquid	2.00%	Food Waste	0.0776
Corrugated	3.00%	Corrugated Cardboard	0.1200
Mixed Paper	9.00%	Office Paper Coated Paper	0.1257
Plastic Containers	2.00%	N/A	0.0000
Durable Plastics	4.00%	N/A	0.0000
Glass	3.00%	N/A	0.0000
Metal	5.00%	N/A	0.0000
Inorganics	4.00%	Construction and Demolition	0.0121
Textiles	6.00%	Textiles	0.0726
Other Plastics	7.00%	N/A	0.0000
Mixed Residue	6.00%	Coated Paper Corrugated Cardboard Diapers	0.0804
HHW & E-waste	10.00%	N/A	0.0000
Bulky & Special Waste	3.00%	Medical Waste Sludge and Manure Lumber	0.0403
Weighted Average[2]			**0.0487**

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

1. Average methane emissions are calculated by cross-refencing material types between Glendale's Waste Characterization Study conducted by Go2Zero with those identified in the Community Protocol and averaging applicable default emissions factors per material type.

2. The weighted average methane emissions factor is calculated based on the average emissions factor per material type and the proportion of material in the solid waste stream as identified in Glendale's Waste Characterization Study conducted by Go2Zero.

Landfill process emissions result in GHG emissions due to the consumption of energy to power the equipment necessary to manage the landfill. However, as Scholl landfill is located within the City's boundaries, energy consumption for landfill processes are anticipated to be included under the nonresidential energy sector of Glendale's 2021 Community GHG Inventory. To avoid the risk of double counting, GHG emissions associated with energy use at Scholl landfill were not included in the City's 2021 Community GHG Inventory, but are quantified below for informational purposes. Landfill process emissions were quantified according to Community Protocol SW.5 which is outlined in Equation 3.10 and Table 19 below.

EQUATION 3.9

SW.5 SOLID WASTE PROCESS EMISSIONS

$$CO_2e_{Waste,process} = M \times EF_p \quad 3.10$$

Table 20 Emissions Parameters and Data Sources – Community Solid Waste

Definition	Parameter	Value	Unit	Data Source
Annual landfill process GHG emissions	$CO_2e_{Waste,process}$	2,694	MT CO_2e/year	Calculated
Total mass of solid waste that enters the landfill in the inventory year	M	244,904	Wet short tons/year	City of Glendale[1]
Emissions factor for landfill process emissions	EF_p	0.011	MT CO_2e/wet short ton	ICLEI Community Protocol

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

1. Tons of waste activity data provided by the City of Glendale via Sharepoint on March 9, 2023

The total GHG emissions from solid waste emissions sources is summarized in Table 21.

Table 21 Community Solid Waste Tonnage Allocation

Emissions Source	GHG Emissions [MT CO_2e/year]
Landfill Fugitive Emissions	75,067
Landfill Process Emissions[1]	2,694
Total	**75,067**

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.

3.2.4 Water

Water consumption generates GHG emissions from the electricity used to deliver water to the community, as well as the energy used to treat and convey the water prior to delivery. GWP provides ground water to the City and is classified as locally sourced water in this assessment. The majority of water supplied to the City is imported from Municipal Water District of Southern California (MWD). Table 22 shows the parameters and data sources associated with Equation 3.11 which were used to quantify GHG emissions from local and imported water sources.

EQUATION 3.11

WW.14 WATER SECTOR EMISSIONS

$$CO_2e_{Water,i} = Vol_i \times \sum_j EI_{i,j} \times EF_{elec,i,j} \quad 3.11$$

Table 22 Emissions Parameters and Data Sources – Community Water

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from water consumption per water district	$CO_2e_{Water,i}$	See Table 26	MT CO_2e/year	Calculated
Volume of water supplied to the community per water district	Vol_i	See Table 23	AF	GWP 2021 Water Production Report[1]
Energy intensity of water distribution per water district	$EI_{i,j}$	See Table 24	kWh/AF	1. GWP 2021 Water Production Report 2. ICLEI Community Protocol 3. GWP 2020 UWMP[2] 4. MWD 2020 UWMP[3]
Electricity emissions factor per water process stage per source type	$EF_{elec,i,j}$	See Table 25	MT CO_2e/kWh	1. GWP 2021 Electricity Report[4] 2. EPA eGRID[5]
Water district	i	See Table 23	Categorical	
Water process stage	j	Extraction Conveyance Treatment Distribution	Categorical	

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

1. Glendale Water and Power (GWP) 2021 Water Production Report provided by the City via Sharepoint on March 8, 2023

2. City of Glendale. 2021. Urban Water Management Plan, Appendices, Table O-1A. Available at: https://www.glendaleca.gov/home/showpublisheddocument/62414/637623899860970000

3. Municipal Water District of Southern California (MWD). 2021. 2020 Urban Water Management Plan (UWMP)Table A.10-5 2018 Treated and Untreated Water Energy Intensity. Available at: https://www.mwdh2o.com/media/21641/2020-urban-water-management-plan-june-2021.pdf

4. Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

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

Table 23 shows the total water supplied to the City by each water district or provider and classifies the activity data as local vs imported sources of water.

Table 23 Community Water Activity Data

Water Districts	Activity Data [AF]
Local Water Supply	
Glendale Water and Power (GWP)	8,586.11
Imported Water Supply	
Municipal Water District of Southern California (MWD)	14,816.00

Notes: AF = acre-feet

The energy intensities and emissions factors per water district or provider are summarized in Table 24 and Table 25, respectively. As MWD's operations occur outside of the City's jurisdictional boundaries and is anticipated to be supplied by multiple electricity providers, the CAMX grid mix emissions factor provided by eGRID was used to estimate emissions. However, at the distribution to consumer stage of water management, imported water is managed within the City's boundaries using Glendale's water infrastructure and therefore GWP's emissions factor is utilized.

Table 24 Community Water Energy Intensities Per Water District

	Energy Intensities [kWh/AF]					
Water District	**Extraction**	**Conveyance**	**Treatment**	**Distribution (Purveyor)**	**Distribution (Consumer)**	**All Stages**
Local Water Supply						
GWP[1]	309.70	—	120.00	—	384.70	814.40
Imported Water Supply						
MWD[2]	—	1,919.90	69.70	-152.60	384.70	2,221.70

Notes: kWh = kilowatt hour; AF = acre-feet

1. Energy Intensity information for Glendale Water and Power (GWP) was acquired from the following sources:

   1.a. Extraction: Calculated based on electricity consumption and AF produced from GWP wells as reported in the GWP 2021 Water Production Report.

   1.b. Conveyance: Included under Extraction energy intensity

   1.c. Treatment: Based on ICLEI Community Protocol default factor as provided under Appendix F Wastewater and Water Emissions Activities and Sources, Table WW.14.4: Energy Intensities for Water Treatment

   1.d. Distribution: Based on the City's 2020 UWMP, Appendix E Table O-1A available at: https://www.glendaleca.gov/home/showpublisheddocument/62414/637623899860970000

2. Energy Intensity information for Municipal Water District (MWD) was sourced from the company's 2020 Urban Water Management Plan available at: https://www.mwdh2o.com/media/21641/2020-urban-water-management-plan-june-2021.pdf

   2.a. Distribution: Due to the high elevations from which MWD water is sourced, MWD's distribution system to purveyors relies primarily on gravity with minimal electricity input. Additionally, MWD's distribution system is lined with hydroelectric generation plants along the pipelines. Therefore, the energy intensity for MWD distribution to purveyors is negative as the energy input combined with electricity generation results in a net production, rather than consumption, of power.

Table 25 Community Water Emissions Factors Per Water District

Water District	Emissions Factors [MT CO_2e/kWh]					
	Extraction	Conveyance	Treatment	Distribution (Purveyor)	Distribution (Consumer)	All Stages
Local Water Supply						
GWP[1]	0.000218	0.000218	0.000218	0.000218	0.000218	0.000218
Imported Water Supply						
MWD[2]	0.000242	0.000242	0.000242	0.000242	0.000218	0.000238

Notes: kWh = kilowatt hour; AF = acre-feet
1. Emissions factors are sourced from Glendale Water and Power's (GWP) 2021 Electricity Report
2. As Municipal Water District (MWD) operation are outside of City boundaries, the CAMX grid mix emissions factor provided by eGRID was used to estimate emissions. Information on CAMX emissions factor for 2021 is available at: https://www.epa.gov/egrid/data-explorer

Table 26 shows the City's water sector GHG emissions and total GHG emissions added to Glendale's 2021 Community GHG Inventory. MWD imported water is distributed to City residents using water infrastructure, such as pumps, which are owned and operated by GWP. Therefore, the energy used to distribute imported water was accounted for in the energy section and and is thus excluded from total water sector emissions to avoid double counting.

Table 26 Community Water GHG Emissions and Inclusions

Water District		Emissions [MT CO_2e/year]					
		Extraction	Conveyance	Treatment	Distribution (Purveyor)	Distribution (Consumer)	All Stages
Local Water Supply							
GWP	Emissions	578	—	224	—	719	1,521
	Inclusion	No	—	No	—	No	No
Imported Water Supply							
MWD	Emissions	6,886	—	250	-547	1,240	7,828
	Inclusion	Yes	Yes	Yes	Yes	No[1]	—
Total Water Supply							
Total							**6,588**

Notes: kWh = kilowatt hour; AF = acre-feet
1. As MWD is distributed to consumers within City boundaries using the City's water infrastructure, distribution GHG emissions are anticipated to be accounted in energy sector emissions and are thereby excluded from total water sector GHG emissions.

3.2.5 Wastewater

Management of wastewater produces emissions through every stage of the process from collection to final use or discharge. Glendale's wastewater is treated by the Los-Angeles-Glendale Water Reclamation Plant (LAGWRP) which is equitably co-owned by the City of Glendale and the City of Los Angeles, though it lies outside of Glendale's city boundaries. The wastewater reclamation plant (WRP) uses tertiary treatment nitrification/denitrification processes to produce recycled water for

irrigation and industrial re-use.[11] Glendale is entitled to 50% of recycled water produced by LAGWRP but currently only uses 25-33% of the City's entitlement. Recycled water not utilized by the City is discharged into the Los Angeles River. [12]

The LAGWRP is part of an integrated system of wastewater treatment plants (WRP) which include the Tillman WRP, Burbank WRP, and the Hyperion WRP. The four water treatment facilities are known as the North Outfall Sewer (NOS). Biosolids and excess flows from Tillman WRP, LAGWRP, and Burbank WRP are diverted to the Hyperion WRP for treatment and disposal.[12] Hyperion WRP utilizes a primary and secondary treatment process using digester tanks to treat wastewater for reclamation purposes or discharge to the Santa Monica Bay.[13] Currently, Hyperion WRP processes an average of 260 million gallons (MG) per day with approximately 220 MG being discharged into the sea.[14]

GHG emissions from LAGWRP operations are a result of process emissions from nitrification/denitrification (see Equation 3.14 and Table 29), excess recycled water discharge into the LA River (see Equation 3.15 and Table 30), and electricity use (see Equation 3.16 and Table 33). As primarily only biosolids are sent from LAGWRP to Hyperion WRP for treatment, only stationary combustion emissions from combustion of digester gas was included with relation to Hyperion WRP operations in this assessment. The set of methods used to quantify stationary combustion emissions is outlined in Equation 3.12 and Table 27 as well as Equation 3.13 and Table 28 below.

EQUATION 3.12

WW.1.(ALT) WASTEWATER DIGESTER GAS STATIONARY COMBUSTION EMISSIONS (CH_4)

$$CO_2e_{WW,Stat,CH4,i} = \left(P_i \times Digester\ Gas \times f_{CH4} \times BTU_{CH4} \times 10^{-6} \times EF_{CH4} \times \right. \\ \left. \times GWP_{CH4}\right. \quad (3.12)$$

Table 27 Emissions Parameters and Data Sources – Community Wastewater WW.1.(alt)

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by devices designed to combust digester gas	$CO_2e_{WW,Stat,CH4}$	See Table 34	MT CO_2e/year	Calculated
Population served[1]	P_i	320,787	People	1. SCAG Growth Forecast[2]
Rate of digester gas volume production	$Digester\ Gas$	1.00	std ft^3/person/day	ICLEI Community Protocol
Fraction of methane in digester gas	f_{CH4}	0.65	Fraction	ICLEI Community Protocol
Default higher heating value of methane	BTU_{CH4}	1,028	BTU/ft^3	ICLEI Community Protocol

[11] City of Los Angeles Sanitation. 2023. Los Angeles-Glendale Water Reclamation Plant. Available at: https://www.lacitysan.org/san/faces/home/portal/s-lsh-wwd/s-lsh-wwd-cw/s-lsh-wwd-cw-p/s-lsh-wwd-cw-p-lagwrp?_adf.ctrl-state=t7b1utnjj_5&_afrLoop=12857866421655975#!

[12] City of Glendale. 2020. 2020 Urban Water Management Plan (UWMP). Available at: https://www.glendaleca.gov/home/showpublisheddocument/62412/637623898692530000

[13] City of Los Angeles Sanitation. 2023. Hyperion Reclamation Plant. Available at: https://www.lacitysan.org/san/faces/home/portal/s-lsh-wwd/s-lsh-wwd-cw/s-lsh-wwd-cw-p/s-lsh-wwd-cw-p-hwrp?_adf.ctrl-state=t7b1utnjj_752&_afrLoop=12859331002222320#!

[14]

Definition	Parameter	Value	Unit	Data Source
Conversion factor	10^{-6}	0.000001	mmBTU/BTU	
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	
Global warming potential of methane	GWP_{CH4}	25		IPCC Fifth Assessment Report
Wastewater treatment plant (WWTP)	i	Hyperion WRP	Categorical	

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. Population serviced (or service population) is the sum of population and employment

2. Southern California Association of Governments. 2023. 2016-2040 RTP/SCS Final Growth Forecast by Jurisdiction. Available at: https://scag.ca.gov/sites/main/files/file-attachments/2016_2040rtpscs_finalgrowthforecastbyjurisdiction.pdf?1605576071

EQUATION 3.13

WW.2.(ALT) WASTEWATER DIGESTER GAS STATIONARY COMBUSTION EMISSIONS (N_2O)

$$CO_2e_{WW,Stat,N2O,i} = \left(P_i \times Digester\ Gas \times f_{CH4} \times BTU_{CH4} \times 10^{-6} \times EF_{N2O} \times 365 \times GWP_{N2O}\right) \quad 3.13$$

Table 28 Emissions Parameters and Data Sources – Community Wastewater WW.2.(alt)

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by devices designed to combust digester gas	$CO_2e_{WW,Stat,N2O}$	See Table 34	MT CO_2e/year	Calculated
Population served[1]	P_i	320,787	People	1. SCAG Growth Forecast[2]
Rate of digester gas volume production	$Digester\ Gas$	1.00	std ft^3/person/day	ICLEI Community Protocol
Fraction of methane in digester gas	f_{CH4}	0.65	Fraction	ICLEI Community Protocol
Default higher heating value of methane	BTU_{CH4}	1,028	BTU/ft^3	ICLEI Community Protocol
Conversion factor	10^{-6}	0.000001	mmBTU/BTU	
Nitrous Oxide emissions factor	EF_{N2O}	0.0006	kg N_2O/mmBTU	ICLEI Community Protocol
Conversion factor	365.25	365.25	Days/year	ICLEI Community Protocol
Conversion factor	10^{-3}	0.001	MT/kg	
Global warming potential of nitrous oxide	GWP_{N2O}	265		IPCC Fifth Assessment Report
Wastewater treatment plant (WWTP)	i	Hyperion WRP	Categorical	

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. Population serviced (or service population) is the sum of population and employment

Definition	Parameter	Value	Unit	Data Source
2. Southern California Association of Governments. 2023. 2016-2040 RTP/SCS Final Growth Forecast by Jurisdiction. Available at: https://scag.ca.gov/sites/main/files/file-attachments/2016_2040rtpscs_finalgrowthforecastbyjurisdiction.pdf?1605576071				

EQUATION 3.14

WW.7 CENTRALIZED WWTP W/ NITRIFICATION/DENITRIFICATION

$$CO_2e_{WW,nit/denit,i} = P_i \times F_{ind-com} \times EF_{nit/denit} \times 10^{-6} \times GWP_{N2O} \quad 3.14$$

Table 29 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 34	MT CO_2e/year	Calculated
Population served[1]	P_i	320,787	People	1. SCAG Growth Forecast[2]
Factor for insignificant industrial or commercial discharge	$F_{ind-com}$	1.25		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	mmBTU/BTU	
Global warming potential of nitrous oxide	GWP_{N2O}	265		IPCC Fifth Assessment Report
Wastewater treatment plant (WWTP)	i	LAGWRP	Categorical	

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. Population serviced (or service population) is the sum of population and employment

2. Southern California Association of Governments. 2023. 2016-2040 RTP/SCS Final Growth Forecast by Jurisdiction. Available at: https://scag.ca.gov/sites/main/files/file-attachments/2016_2040rtpscs_finalgrowthforecastbyjurisdiction.pdf?1605576071

Community Protocol Equation WW.12 used to quantify emissions associated with LAGWRP effluent discharge into the Los Angeles River we modified to account for the proportion of Glendale's wastewater processed by LAGWRP and the proportion of recycled water used by the City. The adjusted equation is provided in Equation 3.15 with associated parameters and data sources identified in Table 30.

EQUATION 3.15

WW.12 NITROUS OXIDE EMISSIONS FROM EFFLUENT DISCHARGE

$$CO_2e_{WW,effluent,i} = N\ Load \times Per_{vol} \times Per_{effluent} \times EF_{effluent,i} \times \frac{44}{28} \times 365.25 \times GWP_{N2O} \quad 3.15$$

Table 30 Emissions Parameters and Data Sources – Community Wastewater WW.12

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by WWTP processes	$CO_2e_{WW,w/o\ nit/denit,i}$	See Table 34	MT CO_2e/year	Calculated
Average total nitrogen per day	$N\ Load$	See Table 31	kg N/day	LAGWRP Effluent Quality Report[1]
Percentage of total reclaimed water attributable to the City	Per_{vol}	See Table 32	%	City of Glendale 2020 UWMP[2]
Percentage of reclaimed water discharged as effluent into designated water body	$Per_{effluent}$	See Table 32	%	City of Glendale 2020 UWMP
Emissions factor of discharge to water body type (river)	$EF_{effluent,i}$	0.005	kg N_2O-N/kg sewage-N discharged	ICLEI Community Protocol
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
Wastewater treatment plant (WWTP)	i	LAGWRP	Categorical	

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

1. Los-Angeles-Glendale Water Reclamation Plant (LAGWRP) Summary of Overall Treatment Plant Effluent Quality Report provided by the City via email on March 15, 2023

2. City of Glendale. 2020. 2020 Urban Water Management Plan (UWMP). Available at: https://www.glendaleca.gov/home/showpublisheddocument/62412/637623898692530000

The Effluent Quality Report provided by LAGWRP reports the minimum, maximum, and average volume of wastewater effluent processed per day as well as the concentration of NH_3-N, NO_2-N, and NO_3-N in the effluent. Summarized data from this report used to determine the total nitrogen load is provided in Table 31.

Table 31 Community Wastewater WW.12 Nitrogen Load Activity Data Calculations

Month	Effluent Processed[1] [gal/month]	Nitrogen Concentration[2] [kg N/gal]	Nitrogen Load [kg N/month]
January	498,864,100	0.00002217	11,062
February	438,241,900	0.00001943	8,514
March	503,650,000	0.00002197	11,064
April	515,708,500	0.00002043	10,534
May	527,492,500	0.00002414	12,736
June	501,357,000	0.00002313	11,596
July	500,676,800	0.00002309	11,561
August	492,802,000	0.00002214	10,912
September	472,441,800	0.00002316	10,942
October	485,735,000	0.00002144	10,412
November	468,319,000	0.00002290	10,726
December	483,537,100	0.00002263	10,942

Notes: kg = kilograms; gal = gallons

1. Effluent processed per month was determined by summing the reported daily average volume processed per month in LAGWRP's Effluent Quality Report.

2. Nitrogen concentration was calculated by averaging LAGWRP's reported daily average mg N/L to determine a monthly average, summing across NH3-N, NO2-N, and NO3-N chemical constituents, and converting to kg N/gal

Table 32 shows the calculation method for the percent LAGWRP treated wastewater attributable to Glendale and the percent recycled water which is released as effluent rather than being recycled for reuse.

Table 32 Community Wastewater WW.12 Percent Attribution Calculations

Attribution Metric	Total [AF]	Community Total [AF]	Percent Attribution
Per_{vol}[1]	14,983	6,024	40.21%
$Per_{effluent}$[2]	8,000	2,000	75.00%

Notes: AF = acre-feet

1. Percent of wastewater attributable to the community is based on the total LAGWRP wastewater processed (14,983 AF) and wastewater produced by Glendale (6,024 AF) in 2020 as reported in the City of Glendale's 2020 UWMP, available at: https://www.glendaleca.gov/home/showpublisheddocument/62412/637623898692530000

2. Percent of wastewater effluent is conservatively estimated based on Glendale's current recycled water use (2,000 AF) and the maximum potential recycled water entitlement (8,000 AF) as reported in the City of Glendale's 2020 UWMP, available at: https://www.glendaleca.gov/home/showpublisheddocument/62412/637623898692530000

Though the City of Glendale co-owns LAGWRP, the facility lies outside of the City's boundaries which means that electricity used at the WRP is not captured under community nonresidential energy use. Community Protocol Equation WW.15 was used to determine LAGWRP electricity-based emissions and adjusted to allocate emissions attributable to the Glendale community.

EQUATION 3.16

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

$$CO_2e_{WWelec,i} = Elec_{WW,i} \times Per_{vol} \times EF_{elec,i} \quad 3.16$$

Table 33 Emissions Parameters and Data Sources – Community Wastewater WW.15

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by WWTP electricity use	$CO_2e_{WWelec,i}$	See Table 34	MT CO_2e/year	Calculated
Electricity use of WWTP	$Elec_{WW,i}$	10,018,136	kWh	LAGWRP 2021 Electricity Report[2]
Percentage of total reclaimed water attributable to the City	Per_{vol}	See Table 32	%	City of Glendale 2020 UWMP[2]
Electricity emission factor per WWTP	$EF_{elec,i}$	0.000242	MT CO_2e/kWh	EPA eGRID[3]
Wastewater treatment plant or (WWTP)	i	LAGWRP	Categorical	

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

1. Los-Angeles-Glendale Water Reclamation Plant (LAGWRP) Summary of Overall Treatment Plant Effluent Quality Report provided by the City via email on March 15, 2023

2. Los-Angeles-Glendale Water Reclamation Plant (LAGWRP) 2021 Electricity Report provided by the City via SharePoint on April 5, 2023

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

Table 34 summarizes the City's wastewater sector activity data, emissions factors, and GHG emissions per WWTP.

Table 34 Community Wastewater GHG Emissions Calculations

Emissions Source	Protocol Equation	Activity Data		Emissions Factor[1]		GHG Emissions [MT CO_2e/year]
LAGWRP						
Nit/Denit Process N2O	WW.7	320,787	persons	0.0023188	MT CO_2e/person	744
Effluent Discharge	WW.12	52,669	kg N/year	0.0020803	MT CO_2e/kg N	110
Stationary Combustion	—	—	—	—	—	—
Electricity Use	WW.15	4,027,848	kWh	0.0002421	MT CO_2e/kWh	975
Hyperion WRP						
Nit/Denit Process N2O	—	—	—	—	—	—
Effluent Discharge	—	—	—	—	—	—
Stationary Combustion	WW.1.(alt) WW.2.(alt)	320,787	persons	0.0000626	MT CO_2e/person	20
Electricity Use	—	—	—	—	—	—
All WWTP						

Emissions Source	Protocol Equation	Activity Data		Emissions Factor[1]		GHG Emissions [MT CO_2e/year]
Nit/Denit Process N2O	WW.7	320,787	persons	0.002319	MT $CO2_e$/person	744
Effluent Discharge	WW.12	52,669	kg N/year	0.002080	MT CO_2e/kg N	110
Stationary Combustion	WW.1.(alt) WW.2.(alt)	320,787	persons	0.000063	MT CO_2e/person	20
Electricity Use	WW.15	4,027,848	kWh	0.000242	MT CO_2e/kWh	975
Total						**1,848**

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

2021 Community 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. The results of the GHG inventory are summarized in Figure 1 and Figure 2 and shown in detail in Table 35.

Figure 1 Community Inventory GHG Emissions by Sector

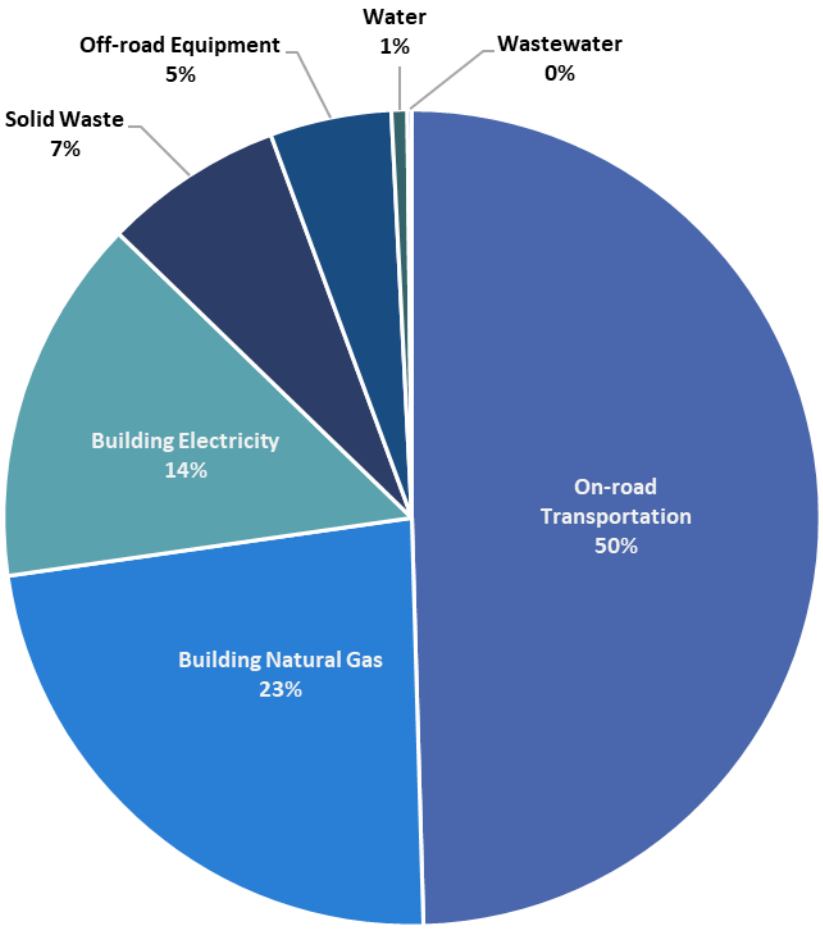

Figure 2 Community Inventory GHG Emissions by Sub-Sector

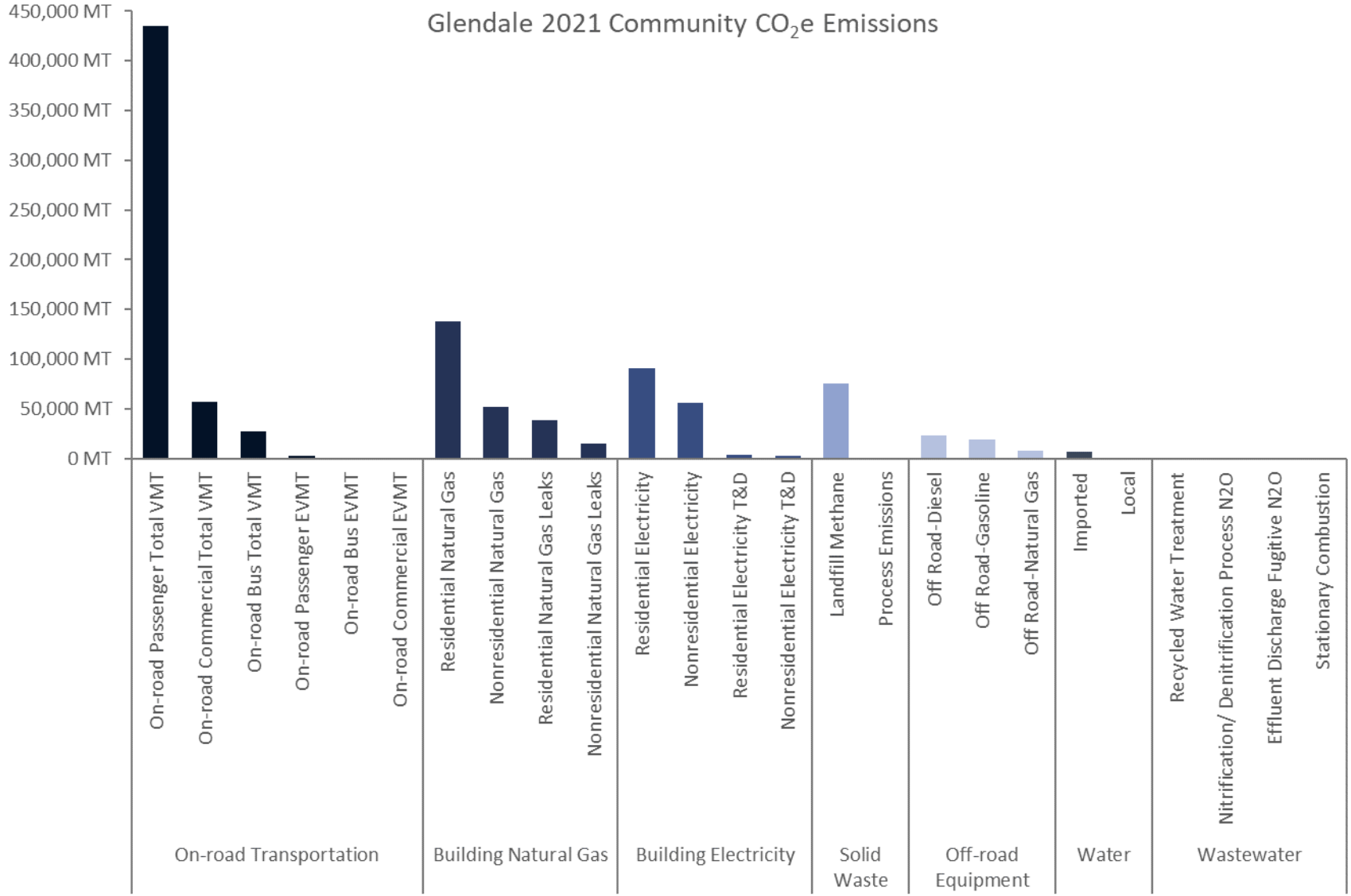

Table 35 2021 Community GHG Emissions Inventory

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
Energy	Residential Electricity	415,172,498	kWh	0.000218	MT CO2e/kWh	90,318
	Residential Electricity T&D	18,767,032	kWh	0.000218	MT CO2e/kWh	4,083
	Nonresidential Electricity	258,014,947	kWh	0.000218	MT CO2e/kWh	56,129
	Nonresidential Electricity T&D	11,358,634	kWh	0.000218	MT CO2e/kWh	2,471
	Residential Natural Gas	26,059,230	therms	0.005311	MT CO2e/therm	138,412
	Residential Natural Gas Leaks	733,325	therms	0.053067	MT CO2e/therm	38,915
	Nonresidential Natural Gas	9,813,314	therms	0.005311	MT CO2e/therm	52,123
	Nonresidential Natural Gas Leaks	276,154	therms	0.053067	MT CO2e/therm	14,655
Transportation	Passenger VMT	1,230,370,632	VMT	0.000354	MT CO2e/mile	435,551
	Commercial VMT	47,569,751	VMT	0.001198	MT CO2e/mile	56,989
	Bus VMT	12,605,474	VMT	0.002123	MT CO2e/mile	26,761
	Passenger EVMT	11,350,951	kWh	0.000218	MT CO2e/kWh	2,469
	Commercial EVMT	0	kWh	0.000218	MT CO2e/kWh	0
	Bus EVMT	135,816	kWh	0.000218	MT CO2e/kWh	30
	Off-road Diesel	2,227,013	Gallons	0.010470	MT CO2e/Gallon	23,317
	Off-road Gasoline	2,109,767	Gallons	0.009189	MT CO2e/Gallon	19,386
	Off-road Natural Gas	1,369,734	Gallons	0.005862	MT CO2e/Gallon	8,030
Solid Waste	Landfill Methane	244,904	tons	0.306515	MT CO2e/ton	75,067
	Process Emissions	-	tons	-	MT CO2e/ton	-
Water	Local	-	kWh	-	MT CO2e/kWh	-
	Imported	27,216,992	kWh	0.000242	MT CO2e/kWh	6,588
Wastewater	Nitrification/ Denitrification Process N2O	320,787	persons	0.002319	MT CO2e/person	744
	Effluent Discharge Fugitive N2O	52,669	kg N/year	0.002080	MT CO2e/kg N	110

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
	Stationary Combustion	320,787	persons	0.000063	MT CO2e/person	20
	Energy Use	4,027,848	kWh	0.000242	MT CO2e/kWh	975
Total						**1,053,141**

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 Inventory - Municipal

4.1 Methodology

The City's municipal GHG inventory (2021 Municipal Inventory) was competed using the Local Government Operations Protocol[15] (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 which can be attributed directly to the City's operations in the given inventory year. The municipal inventory allows the City to track its GHG emissions resulting from the municipally owned facilities, vehicles, and equipment over which it can exert control with GHG reduction policies and ultimately lead by example.

The results of GHG emission calculations are presented by emissions scope, relating to the degree of control the City has over emissions sources, and the specific sources that the emissions are associated with. 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 City boundaries.
- **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 LGO Protocol. The primary sectors of GHG emissions sources include:

- Electricity
- Natural Gas
- Transportation
- Water and Wastewater

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

- 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

The following LGOP recommended sectors have also been included in the City's 2021 Municipal Inventory:

- Employee commute
- Employee business travel

The City's 2021 Municipal Inventory includes an assessment of the City's operational GHG emissions according to the above subsectors and categorized to reflect the City's municipal Scope 1-3 emissions.

Emissions Boundary

The 2021 Municipal GHG Inventory includes all emissions occurring within the City of Glendale's direct jurisdictional authority (i.e., sources of emissions resulting from facilities that the City owns and/or operates). The City of Glendale operates and maintains multiple buildings and facilities across the City such as Glendale Water and Power and the Scholl Canyon Landfill. The City also co-owns the LAGWRP for wastewater management which is located outside of Glendale's city boundaries. Though the wastewater reclamation facility lies outside of the Glendale, emissions associated with LAGWRP are included in the 2021 Municipal GHG Inventory as a direct Scope 1 source of emissions in accordance with LGOP as it is under the City's jurisdictional authority.

4.2 2021 Municipal GHG Emissions Inventory

4.2.1 Buildings and Other Facilities

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

Natural gas which is used for heating and cooling of buildings and facilities is provided to the City by SoCalGas. However, similar to the community natural gas used, not all the natural gas used is

combusted. It's estimated that 2.3% of natural gas is leaked through the distribution pipelines,[16] while about 0.5% of the natural gas delivered is leaked at end-uses and not combusted.[17] The activity data provided by SoCalGas is adjusted to remove end-use leakage and an emission factor from the EPA Emission Factors for Greenhouse Gas Inventories report is applied to calculate GHG emissions from natural gas combustion.[18] Emissions from distribution and end-use methane leaks are calculated separately using the adjusted activity data and a calculated natural gas methane leak emission factor. The GHG emission calculation details associated with the buildings and other facilities sector's natural gas usage and leakage are provided in Table 36.

Table 36 Municipal Buildings and Facilities Sector Natural Gas GHG Emissions Calculations

GHG Emissions Source	Activity Data [therms]	Adjusted Activity Data [therms]	Emissions Factor [MT CO_2e/therm]	Emissions [MT CO_2e]	Scope
Natural Gas Consumption	347,135	345,399	0.005311	1,835	Scope 1
Natural Gas Methane Leaks[1]		9,720	0.053067	516	Scope 1
Total				**2,350**	**Scope 1**

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

1. Emission factor is calculated using the following equation:

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

The City owns and operates Glendale Water and Power (GWP) which provides all of Glendale's electricity utility services. As the City has direct control over GWP and is thereby responsible for all GHG emissions associated with its operations, GHG emissions associated with GWP supplied electricity is already accounted under the City's 2021 Community GHG Inventory. Therefore, the City's 2021 Municipal GHG Inventory only considers the electricity consumed to operate the buildings and facilities that the City owns as a subset of the 2021 Community GHG Inventory and is thereby included as Scope 2 emissions. Additionally, though not recommended under the LGOP, T&D electricity losses are included in the City's 2021 Municipal Inventory to align with sector inclusions of Glendale's 2021 GHG Community Inventory.

GWP provided the electricity consumption activity data as well as annual electricity and GHG emissions information used to determine GWP's emissions factor.[19] Electricity T&D loss was

[16] 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

[17] 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

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

[19] Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

calculated based on a 4.40% loss rate as specified by eGRID.[20] The GHG emission calculation details associated with buildings and other facilities sector's electricity usage are provided in Table 37.

Table 37 Municipal Buildings and Facilities Sector Electricity GHG Emission Calculations

GHG Emissions Source	Utility Provider	Activity Data [kWh]	Emissions Factor [MT CO_2e/kWh]	Emissions [MT CO_2e]	Scope
Electricity Consumption[2]	GWP	30,753,161	0.000218	6,690	Scope 2
Electricity Consumption T&D[2]	GWP	1,357,214	0.000218	295	Scope 2
Total				**6,985**	**Scope 2**

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

1. Excludes electricity used by GWP for water distribution pumping stations.
2. Electricity consumption T&D includes the T&D associated with electric vehicle charging at City buildings and facilities.

4.2.2 Streetlights and Traffic Signals

The City's buildings and facilities, streetlights and traffic signals generate Scope 2 emissions related to the use of electricity and resulting T&D losses. Activity data and emissions factors were reported in GWP's 2021 Electricity Report provided by the City.[21] Electricity T&D loss was calculated based on a 4.40% loss rate as specified by eGRID.[22] The GHG emission calculation details associated with buildings and other facilities sector's electricity usage are provided in Table 38.

Table 38 Municipal Streetlights and Traffic Signals Sector Electricity GHG Emission Calculations

GHG Emissions Source	Utility Provider	Activity Data [kWh]	Emissions Factor [MT CO_2e/kWh]	Emissions [MT CO_2e]	Scope
Streetlights & Traffic Signals	GWP	9,616,044	0.000218	2,092	Scope 2
Streetlights & Traffic Signals T&D	GWP	423,106	0.000218	92	Scope 2
Total				**2,184**	**Scope 2**

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

4.2.3 Water Delivery Facilities

Water consumption typically generates Scope 3 GHG emissions from the electricity used to deliver water to the City facilities, as well as the energy used to treat and convey the water prior to delivery. A portion of The City's water which is purchased from MWD by GWP is considered Scope 3 as GWP does not control the electricity used to extract, convey, treat, and transport MWD's water prior to delivery into GWP's local distribution system. However, GWP produced water distributed to the City is considered a Scope 2 emissions source as the facility and distribution infrastructure are owned and operated by the City. As the City's 2021 Community GHG Inventory water sector

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

[21] Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

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

includes all GHG emissions associated with GWP water management, the 2021 Municipal GHG Inventory only includes the energy associated with the City's distribution infrastructure and facility water consumption as a subset of the 2021 Community GHG Inventory. The inventory for wastewater delivery facilities also includes T&D losses associated with the City's water pump distribution infrastructure to maintain consistency with the community inventory and the buildings and facilities emissions sectors. This will provide the City a better understanding of GHG emissions attributable to its facility and irrigation activities.

Activity data on the City's water pump station electricity use was provided by the City and excludes the electricity associated with GWP well water extraction and treatment. Electricity T&D loss was calculated based on a 4.40% loss rate as specified by eGRID.[23] The City also provided activity data regarding the total volume of water consumed by City facilities and used for irrigation which was apportioned between GWP and MWD supplied water based on the 2021 Water Production Report provided by GWP.[24] As the electricity use of the City's water pump distribution infrastructure is included in the 2021 Municipal GHG Inventory, only the energy intensities associated with the extraction, conveyance, and treatment of the City's water was included to avoid double counting. The energy intensity for water extraction was provided by GWP and the energy intensity for treatment was estimated based on Community Protocol default values.[25] The emissions factor for GWP supplied water was determined based on annual electricity supply and GHG emissions as reported by GWP.[26]

The energy intensities of MWD's water management was determined according to the 2020 UWMP[27] and emissions factor was approximated according to the eGRID reported CAMX grid mix emissions factor.[28] The GHG emission calculations details are provided in Table 39.

Table 39 Municipal Water Consumption GHG Emissions Calculations

Water District	Activity Data [AF]	Energy Intensity Factor [kWh/AF]	Electricity Usage [kWh]	Emission Factor [MT CO_2e/kWh]	GHG Emissions [MT CO_2e]	Emission Source Scope
City Consumption (GWD)[1,2]	335.28	429.70	144,070	0.000218	31	Scope 2
City Consumption (MWD)[3]	578.56	1,837.00	1,062,807	0.000242	257	Scope 3
Water Pump Stations	—	—	11,095,371	0.000218	2,414	Scope 2

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

[24] Glendale Water and Power (GWP) 2021 Water Production Report provided by the City via Sharepoint on March 8, 2023

[25] ICLEI Community Protocol. Appendix F Wastewater and Water Emissions Activities and Sources, Table WW.14.4: Energy Intensities for Water Treatment.

[26] Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

[27] Municipal Water District of Southern California (MWD). 2021. 2020 Urban Water Management Plan (UWMP)Table A.10-5 2018 Treated and Untreated Water Energy Intensity. Available at: https://www.mwdh2o.com/media/21641/2020-urban-water-management-plan-june-2021.pdf

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

Water Pump Stations T&D	—	—	488,196	0.000218	106	Scope 2
Total					**2,551**	**Scope 2**
Total					**257**	**Scope 3**

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

1. Activity data for GWP supplied City water was calculated based on the total AF of water consumed by City facilities (914 AF) and the proportion of water produced in 2021 by GWP (8,586 AF, 36.69 %) versus the proportion of water purchased from MWD in 2021 (14,816 AF, 63.31%) as specified in GWP's 2021 Water Production Report.

2. The energy intensity of GWP provided water is the sum of the energy intensity of GWP's extraction and conveyance (309.70 kWh/AF) as estimated based on GWP's 2021 Water Production Report and the energy intensity for treatment (120 kWh/AF) as provided in the Community Protocol.

3. Activity data for GWP supplied City water was calculated based on the total AF of water consumed by City facilities (914 AF) and the proportion of water produced in 2021 by GWP (8,586 AF, 36.69 %) versus the proportion of water purchased from MWD in 2021 (14,816 AF, 63.31%) as specified in GWP's 2021 Water Production Report.

4.2.4 Vehicle Fleet

Vehicle fleet emissions include Scope 1 sources that relate to the mobile combustion of fossil fuels in the City's fleet vehicles as well as Scope 2 emissions from the charging of EVs. Fleet vehicles include light and medium-duty vehicles and trucks as well as the use of personal vehicles for work. The employee commute sector accounts for emissions generated by City employees' trips to and from work and is treated as separate from the use of personal vehicles for work and is discussed in the section below. The City tracks data for the vehicle fleet including diesel, gasoline, natural gas use, and electricity consumption from vehicle charging which provided the activity data for this sector. Emission factors for diesel, gasoline, and natural gas were obtained from the EPA Emission Factors for Greenhouse Gas Inventories report.[29] The grid emissions factor for vehicle fleet EV charging was determined based on annual electricity supply and GHG emissions as reported by GWP.[30] The GHG emission calculation details associated with vehicle fleet sector sources are provided in Table 40.

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

[30] Glendale Water and Power (GWP) 2021 Electricity Report provided by the City via Sharepoint on February 16, 2023

Table 40 Municipal Vehicle Fleet Sector GHG Emission Calculations

GHG Emission Source	Activity Data		Emissions Factor		Emissions [MT CO_2e]	Scope
Diesel	74,050	Gallons	0.01024	MT CO_2e/gal	758	Scope 1
Gasoline	294,610	Gallons	0.00881	MT CO_2e/gal	2,596	Scope 1
Natural Gas	279,330	Therms	0.00531	MT CO_2e/therm	1,484	Scope 1
Electric	92,614	kWh	0.000218	MT CO2e/kWh	20	Scope 2
Total					**4,838**	**Scope 1**
Total					**20**	**Scope 2**

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

4.2.5 Transit Fleet

Transit fleet emissions include Scope 1 sources that relate to the mobile combustion of fossil fuels in the City's public transit fleet (e.g., buses and Dial-A-Ride). The City tracks gasoline and natural gas usage for the transit fleet, which provided the activity data for this sector. Emissions factors for gasoline and natural gas were obtained from the EPA Emission Factors for Greenhouse Gas Inventories report.[31] The GHG emission calculation details associated with transit fleet sector sources are provided in Table 41.

Table 41 Municipal Transit Fleet Sector GHG Emission Calculations

GHG Emission Source	Activity Data		Emissions Factor		Emissions [MT CO_2e]	Scope
Natural Gas	307,021	Therms	0.00531	MT CO_2e/therm	1,631	Scope 1
Gasoline	14,065	Gallons	0.00881	MT CO_2e/gal	124	Scope 1
Total					**1,755**	**Scope 1**

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

4.2.6 Solid Waste Facilities

Scholl Canyon Landfill is owned and operated by the City and provides waste disposal services for the City of Glendale as well as other surrounding jurisdictions. Ownership of the solid waste facility places the entirety of its process related energy consumption and fugitive emissions under the City's control, making it a Scope 1 emissions source. However, as Scholl landfill is located within the City's boundaries, energy consumption for landfill processes are anticipated to be included under the buildings and facilities energy sector of Glendale's 2021 Municipal GHG Inventory. To avoid the risk of double counting, GHG emissions associated with Scholl landfill processes have been excluded from the City's 2021 Municipal GHG Inventory, but are quantified below for informational purposes. The GHG emissions associated with fugitive emissions from municipal generated waste was also quantified for informational purposes but excluded from the 2021 Municipal Inventory.

GHG emissions from waste decomposition were calculated using Community Protocol Method SW.4.1 based on the waste tonnage processed by the landfill and default factors for landfill gas

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

collection efficiency (i.e., 0.75) and oxidation rate (i.e., 0.1). Similarly, process emissions were calculated using Community Protocol Method SW.5 based on the waste tonnage processed by the landfill and the default factor for compressed natural gas (CNG) fuel use. Total waste tonnage activity data for Scholl Canyon Landfill was sourced from CalRecycle tonnage reports for 2021,[32] while municipal solid waste tonnage was provided by the City. A methane emissions factor was developed based on Glendale's Go2Zero Waste Characterization Study[33] and emissions factors per waste material type as provided by the Community Protocol (see Table 19). The GHG emissions calculations for Scholl Canyon process and fugitive emissions as well as municipal solid waste generation are shown in Table 42.

Table 42 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
Landfill Decomposition	422,785	0.3065	129,590	Scope 1
Landfill Process	422,785	0.0110	4,651	Scope 1
Municipal Decomposition	10,790	0.3065	3,307	Scope 1
Total			**129,590**	**Scope 1**

4.2.7 Wastewater Facilities

The LAGWRP produces emissions through every stage of the process and falls under Scope 1 and Scope 2 emissions as it is co-owned and operated by the City. Scope 1 emissions result from LAGWRP's nitrification/denitrification processes and fugitive emissions from discharging treated water into the Los Angeles River. Scope 2 emissions are produced from the wastewater facility's electricity consumption which are not included under the City's building and facilities energy use as LAGWRP is located outside of the City of Glendale. Though Scope 3 emissions would as a result of municipal wastewater downstream processing at the Hyperion WRP, these emissions are anticipated to be negligible and are therefore not included in the City's 2021 Municipal GHG Inventory.

GHG emissions from wastewater treatment were calculated using Community Protocol Methods WW.7 for process emissions and WW.12 for fugitive emissions. Activity data was calculated based on total effluent and nitrogen concentration data provided by LAGWRP[34] (see Table 31). Additionally, activity data was adjusted to reflect the City's 50% co-ownership of LAGWRP. Default emission factors were applied to the activity data based on guidance from the Community Protocol.[35] GHG emissions from electricity use were calculated using activity data provided by

[32] California Department of Resources Recycling and Recovery (CalRecycle). 2019. 2021 Landfill Summary Tonnage Report. Available at: https://www2.calrecycle.ca.gov/LandfillTipFees/

[33] Go2Zero Strategies. 2019. City of Glendale Waste Characterization Study. Provided by the City via SharePoint on March 9, 2023

[34] Los-Angeles-Glendale Water Reclamation Plant (LAGWRP) Summary of Overall Treatment Plant Effluent Quality Report provided by the City via email on March 15, 2023

[35] See Community Protocol Methods WW.7 and WW.12 for all default inputs including emissions factors used to calculate wastewater emissions.

LAGWRP and the eGRID reported CAMX grid mix emissions factor.[36] The total process and fugitive wastewater emissions generated by the City can be found in Table 43.

Table 43 Municipal Wastewater GHG Emissions

GHG Emission Source	Adjusted Activity Data[1]		Emissions Factor		Emissions [MT CO_2e]	Scope
Nitrification/Denitrification Process N2O	9,036	AF	0.002319	MT CO2e/person	21	Scope 1
Effluent Discharge Fugitive N2O	49,125	kg N/year	0.002080	MT CO_2e/kg N	102	Scope 1
Energy Use	5,009,068	kWh	0.000242	MT CO_2e/kWh	1,213	Scope 2
Total					**123**	**Scope 1**
Total					**1,213**	**Scope 2**

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 50% of the total activity data to account for the City's partial ownership of LAGWRP.

4.2.8 Employee Commute

Emissions from employee commute include Scope 3 GHG emissions sources from the mobile combustion of fossil fuels generated by the City of Glendale's employee vehicles as employees commute to and from work. The City provided employee commute data in the form of number of employees, peak and off-peak average vehicle ridership (AVR) survey responses, and household zip code data. The zip codes of employees were used to determine an average one-way trip distance to work per work day which was then scaled by 260 days per year to reach an annual number of miles per vehicle. A weighted average AVR based survey responses was then applied to convert the activity data from miles per vehicle to annual miles per employee. This was then multiplied by the number of City employees to determine annual milage activity data. As the AVR factor accounts for and removes public transit, active transport, and zero emission vehicles to determine ridership, a mobile combustion emissions factor for passenger vehicles provided by EMFAC2021[37] was applied to the activity data to determine GHG emissions from employee commute. The GHG emissions associated with the employee commute sector are provided in Table 44.

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

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

Table 44 Municipal Employee Commute GHG Emissions

GHG Emission Source	City Employees	Avg AVR [trips/vehicle][1]	Avg One-way Distance [mi/vehicle/day]	Work Days per Year	Emissions Factor [MT CO_2e/mi]	Emissions [MT CO_2e]	Emission Source Scope
Employee Commute	1,785.00	1.21	18.90	260.00	0.000363	2,634	Scope 3

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

1. Average vehicle ridership (AVR) reflects the number of commuting employees divided by the number of vehicles commuting employees use to arrive at the work site and is averaged over the survey week. An AVR of 1 signifies commuting employees are driving individually to work, while an AVR greater than 1 signifies employees are engaging in some degree of commute rideshare and are not riding single-occupancy.

4.2.9 Business Travel

Business travel results in Scope 3 GHG emissions from the mobile combustion of fossil fuels by passenger cars, trains, and airplanes for City employee's work-related travel. Activity data in the form of VMT by mode type was provided by the City and emissions factors were sourced from EMFAC2021[38] for passenger vehicles, the EPA Emission Factors for Greenhouse Gas Inventories[39] report for train, and the BlueSkyModel for airplane.[40] The GHG emission calculation details associated with business travel sector sources are provided below in Table 45.

Table 45 Municipal Business Travel GHG Emissions Calculations

GHG Emission Source	Activity Data [miles]	Emissions Factor [MT CO_2e/mile]	Emissions [MT CO_2e]	Scope
Passenger Car	1,721	0.000354	1	Scope 3
Train	0.00	0.0001513	0	Scope 3
Airplane	0.00	0.0241767	0	Scope 3

Notes: MT CO_2e = Metric tons of carbon dioxide equivalent

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

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

40 The BlueSkyModel was used to determine the emissions factor of airplane business travel. Available at: https://blueskymodel.org/air-mile#:~:text=On%20average%2C%20a%20plane%20produces,(CO2)%20per%20mile.

5 GHG Forecast

The City's 2021 Community GHG Inventory establishes a baseline reference point; however, annual GHG emissions change over time. GHG emissions forecasts provide a way to estimate future emission levels based on population and job growth. Forecasts also account for State legislative actions that are anticipated to reduce GHG emissions. Calculating the difference between the forecasted GHG emissions and the reduction target determines the gap to be closed through local policies. This section includes an estimate of the future emissions for the City in the years 2030, 2035, 2040, and 2045 in a *business-as-usual scenario* (BAU) forecast and an *adjusted scenario* (adjusted) forecast, which are defined as follows:

- B*usiness-as-usual scenario*- Provides a forecast of how future GHG emissions would change as population, housing, and job growth occurs and if current activities continued as they did in 2019 absent of any policies or legislation that would reduce local emissions. The BAU forecast is based on growth trends projected in population, housing, employment, and transportation activity over time, consistent with regional projections.
- *Adjusted scenario*- Provides a forecast of how currently adopted legislation would reduce GHG emissions from the *business-as-usual scenario*. The *adjusted scenario* represents the State's contribution to reducing local GHG emissions to meet State goals without any additional contribution from local policies or actions.

5.1 Business-as-usual Forecast

Future GHG emissions for the BAU forecast were calculated using projected demographic data provided by Southern California Association of Government's (SCAG) 2016-2040 RTP/SCS Final Growth Forecast by Jurisdiction model.[41] The demographic metrics used to project activity data and associated growth factors for each forecasted GHG emission source are provided in Table 46 for each of the GHG emission sources in the 2021 Community GHG Inventory.

[41] Southern California Association of Governments (SCAG). 2023. 2016-2040 RTP/SCS Final Growth Forecast by Jurisdiction. Available at: https://scag.ca.gov/sites/main/files/file-attachments/2016_2040rtpscs_finalgrowthforecastbyjurisdiction.pdf?1605576071

Table 46 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) per Household	5,502
Non-residential Electricity	Employment	Electricity Consumption (kWh) per Job	2,148
Residential Natural Gas	Households	Natural Gas Consumption (therms) per Household	347
Non-residential Natural Gas	Employment	Natural Gas Consumption (therms) per Job	82
Electricity Transmission and Distribution Losses (T&D Losses)	N/A	T&D Losses Factor (4.40%) applied to total Electricity Consumption	N/A
Natural Gas Leakage	N/A	Leakage Factor (2.30% distribution, 0.50% end-use) applied to total Natural Gas Consumption	N/A
Transportation			
On-Road Passenger	Households	Vehicle miles travelled (miles) per household	16,306
On-Road Commercial	Employment	Vehicle miles travelled (miles) per job	396
On-Road Bus	Population Serviced	Vehicle miles travelled (miles) per population served	39
Off-Road Equipment[1]	N/A	N/A	N/A
Wastewater			
Wastewater Process and Fugitive Emissions	Population Serviced	Wastewater Process and Fugitive Emissions (MT CO_2e) per population served	0.0058
Water			
Water Consumption	Population Serviced	Electricity Consumption (kWh) per population served	85
Solid Waste			
Solid Waste Disposal	Population Serviced	Solid Waste Emissions (MT CO_2e) per population served	0.2340

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

1. Off-road GHG emissions forecasted based on forecasted fuel consumption reported under the CARB OFFROAD2021 Model, available at: https://arb.ca.gov/emfac/emissions-inventory/5e0cb7d6006cc10661f4b3ffb9c120a486d46ea6

The BAU forecast was calculated using the growth factors in Table 46, the demographic and projection metrics in Table 47, and the 2021 Community GHG Inventory emission factors. In the BAU forecast, GHG emissions are expected to increase through 2045.

Table 47 BAU Forecast Demographic and Projection Metrics by Forecast Year

Demographics/ Sector	Data Source	2030	2035	2040	2045
Population	SCAG 2016-2040 RTP/SCS Final Growth Forecast	206,033	209,000	214,000	216,906
Employment	SCAG 2016-2040 RTP/SCS Final Growth Forecast	77,733	79,000	81,100	82,307
Households	SCAG 2016-2040 RTP/SCS Final Growth Forecast	122,733	124,200	127,000	129,946
Population Serviced[1]	Calculated	328,767	333,200	341,000	346,853

1. Population Serviced[1] is calculated as the combined total number of employees and residents in the City.

A summary of the BAU forecast results by GHG emission sector is provided in Table 48.

Table 48 BAU Forecast Results Summary by Emission Sector (MT CO_2e)

GHG Emissions Sector	2030	2035	2040	2045
Energy	408,073	414,165	424,651	432,074
Transportation	593,032	604,348	621,510	633,037
Waste	76,934	77,972	79,797	81,166
Water	6,752	6,843	7,003	7,124
Wastewater	1,894	1,920	1,965	1,999
Total	**1,086,686**	**1,105,248**	**1,134,926**	**1,155,400**
Change since 2021	**3.19%**	**4.95%**	**7.77%**	**9.71%**

Notes: all values are presented in MT CO_2e = Metric tons of carbon dioxide equivalent

5.2 Adjusted Forecast

5.2.1 Legislative Reduction Programs

Additional legislative programs are expected to reduce GHG emissions in specific sectors throughout California, as identified in the 2017 Scoping Plan Update. Many of these programs were incorporated into the adjusted 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 coordinates the goals of the Low Emissions Vehicles, Zero Emissions Vehicles, and Clean Fuels Outlet programs, and is more stringent than the federal Corporate Average Fuel Economy (CAFE) standards. The new

standards will reduce California's GHG emissions by 34% in 2025 which is modeled using the CARB EMission FACtor (EMFAC) Model and included in the GHG forecast.[42]

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, and emissions reductions attributable to the Advanced Clean Cars II program were therefore, excluded from the GHG forecast.

Advanced Clean Trucks was approved by CARB in June 2020 sets a zero emission vehicle (ZEV) percent-of-sales requirement on medium- and heavy- duty vehicle manufacturers to promote increased truck ZEV sale 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.[43] EMFAC models the effect of the Advanced Clean Trucks regulation on ZEV truck penetration and associated GHG emissions and in included in the forecast.

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. CARB anticipates that the Pavley I standard will reduce GHG emissions from new California passenger vehicles by about 30% in 2016, while simultaneously improving fuel efficiency and reducing motorists' costs.[44] The impacts of the Pavley Standards on zero emission vehicle market penetration was incorporated into the EMFAC model starting in 2014 and is 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 adopt Zero-Emission Bus Rollout Plans to establish a roadmap towards zero emission public transit buses.[45] The effects of the ICT regulation on GHG emissions are modeled in EMFAC2021 and is therefore included in the forecast.

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[42] 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

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

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

[45] 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

Energy Legislation

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 Nonresidential Buildings, was adopted in 1978 in response to a legislative mandate to reduce California's energy consumption, which in turn reduces 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) estimates that the 2019 standards will reduce electricity consumption by 53% for residential buildings and 30% for non-residential buildings, relative to the 2016 standards. The CEC further estimates residential natural gas efficiency increases of 7% for residential end uses.[46] 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.[47] Due to the complexity of the new code there is currently no available model establishing projected efficiency increase as a result of the standard. Therefore, the updated 2022 code was not included to provide a conservative estimate of forecasted GHG emissions reductions resulting from efficiency increases. Furthermore, the new building electrification ordinance passed by the City of Glendale will be accounted for in the measures and actions in the City's CAAP.

Renewables Portfolio Standard, Senate Bill 100, & Senate Bill 1020

Established in 2002 under SB 1078, enhanced in 2015 by SB 350, and accelerated for the first time 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% of total procurement by 2026 and 60% of total procurement by 2030. The RPS program further that by 2045 that 100% 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% of total procurement by 2035 and 95% of total procurement by 2040. The requirements of SB 1020 do not affect those previously set forth and 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. GWP currently provides electricity in the City and is subject to RPS requirements. GWP's emissions factor was projected through 2045 assuming compliance with

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[46] 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

[47] 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

the RPS requirements established by SB 100 and SB 1020.[48] As GWP currently provides all of Glendale's electricity at a single supply standard, current and forecasted emissions factors remain the same across residential and nonresidential sectors. As shown in Table 49, the RPS, SB 100, and SB 1020 requirements to reduce overall carbon intensity would reduce the community's emissions compared to the BAU scenario.

Table 49 Glendale Forecasted RPS and Electricity Emission Factors

Metric	2030	2035	2040	2045
GWP Renewables Mix	60%	90%	95%	100%
GWP Emission Factor (MT CO_2e/kWh)	0.0001345	0.0000336	0.0000168	0.0000000

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

Waste Legislation

Assembly Bill 939 & Assembly Bill 341

In 2011, AB 341 set the target of 75% 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% 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 places requiring California businesses to recycle all of 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. As the City has already implemented an organics collection program, implementation of AB 1826 compliance is reflected in the City's community inventory solid waste activity data 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% reduction in the level of the statewide disposal of organic waste from the 2014 level by 2020 and a 75% reduction by 2025.[49] Additionally, SB 1383 requires a 20% reduction in "current"[50] edible food disposal by 2025. Although SB 1383 has been signed into law, compliance with this Senate Bill

[48] CPA provides three electricity services to the community: 100% Green Power, Clean Power, and Lean Power. Since an average emission factor for CPA was not available, emission factors for each service and the proportion of electricity provided through each service were used to calculate CPA-specific emission factors for the residential and nonresidential sectors.

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

[50] SB 1383 does not specify a baseline year for the 20% 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.

must occur at the jurisdiction-level rather than the state-level. Due to current limitations in local jurisdiction's ability to comply with organic waste targets set by SB 1383, anticipated emissions reductions attributable to the bill are conservatively excluded from the forecast. However, estimated impacts associated with SB 1383 As such, SB 1383 is not included as part of the GHG forecast analysis and will be included in the GHG reduction measures in the CAAP.

5.2.2 Legislative GHG Emission Reduction Contribution

Based on the above-described legislation and emission reduction potential for each, the City can expect significant help from these State regulations in meeting State GHG emission reduction goals. These GHG emissions reductions are primarily expected in the energy sector and transportation sectors. In the energy sector, Title 24 reductions were accounted for first, followed by California RPS reductions associated with GWP developments towards renewable electricity. The legislative emissions reductions for Title 24 and California RPS are known to be additive and were calculated separately to avoid double counting. A summary of the reductions from the BAU forecast that can be expected under the adjusted forecast are provided in Table 50.

Table 50 Summary of Legislative GHG Emissions Reductions (MT CO_2e)

Legislation	2030	2035	2040	2045
California RPS	65,330	148,667	167,261	185,024
Title 24	2,143	3,563	5,745	7,229
Transportation Legislation (Pavley, Innovative Clean Transit, etc.)	86,295	117,697	139,097	149,759
Total	**153,768**	**269,927**	**312,103**	**342,012**

Notes: all values are presented in MT CO_2e = Metric tons of carbon dioxide equivalent

5.2.3 Adjusted Forecast Results

In the adjusted forecast, the electricity sector experiences a strong downward trend, approaching zero in 2045 due to stringent RPS requirements from SB 100 and SB 1020. Natural gas emissions are expected to continue on an upward trajectory until 2045 due to housing and employment growth projections. This trend is partially offset due to the increasingly stringent efficiency requirements for new residential construction from Title 24. On-road transportation emissions are expected to decrease through 2045 due to existing fuel efficiency requirements, fleet turnover rates, and increasing vehicle electrification driven by the electric vehicle market. As most current regulations expire in 2025 or 2030, emissions standards will experience diminishing returns while VMT continues to increase, leading to lower rates of emissions reduction in the on-road transportation sector. Wastewater and solid waste emissions are projected to increase through 2045 while water emissions experience a downward trend to zero due to the sector's direct ties to emissions from electricity consumption. A detailed summary of the projected GHG emissions under the adjusted forecast by sector and year through 2045 can be found in Table 51.

Table 51 Adjusted Forecast Results (MT CO_2e)

GHG Emissions Source	2021	2030	2035	2040	2045
Residential Electricity	94,400	59,320	14,955	7,576	0
Non-residential Electricity	58,600	36,830	9,300	4,731	0
Residential Natural Gas	177,328	182,311	185,079	189,669	192,307
Non-residential Natural Gas	66,778	68,246	69,061	70,618	72,256
Energy Sector Total	**397,105**	**346,706**	**278,396**	**272,595**	**264,564**
On-road Passenger Vehicles	438,021	378,405	360,764	359,133	359,691
On-road Commercial Vehicles	56,989	47,255	41,066	37,340	36,082
On-road Buses	26,791	21,608	15,208	9,506	5,288
Off-road Equipment	50,732	56,077	58,974	61,964	64,598
Transportation Sector Total	**572,532**	**503,346**	**476,012**	**467,944**	**465,659**
Waste	**75,067**	**76,934**	**77,972**	**79,797**	**81,166**
Water	**6,588**	**4,037**	**1,023**	**523**	**0**
Wastewater	**1,848**	**1,894**	**1,920**	**1,965**	**1,999**
Total GHG Emissions	**1,053,141**	**932,917**	**835,322**	**822,824**	**813,388**

Notes: all values are presented in MT CO_2e = Metric tons of carbon dioxide equivalent

6 Provisional GHG Emissions Targets

GHG reduction targets are used in climate action planning to establish metrics that guide the community's commitment to achieve GHG emissions reductions and help gauge progress reducing emissions over time. California has established statewide GHG reduction goals for 2030 and 2045, relative to a baseline emissions level. CARB's 2022 Scoping Plan encourages local agencies to take ambitious, coordinated climate action that is consistent with and supportive of the state's climate goals[51]. Thus, local agencies are recommended to establish equivalent reduction targets at the local level by establishing community wide GHG reduction goals for climate action that will help California achieve its 2030 and 2045 goals. CARB has issued several guidance documents concerning the establishment of GHG emission reduction targets for CAAPs to comply with legislated GHG emissions reductions targets and 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 CAAP.

In the most recent 2022 Scoping Plan, typical target years listed include 2030 (for Senate Bill 32 consistency) and 2045 (for Assembly Bill 1279 consistency).[52] Senate Bill (SB) 32 mandates a reduction of GHG emissions by 40% below 1990 levels by 2030 and Assembly Bill (AB) 1279 mandates a State goal of carbon neutrality by 2045 through a reduction of anthropogenic GHG emissions by 85% below 1990 levels. AB 1279 sets a 15% target for GHG emissions reductions to be achieved through carbon capture and sequestration (CCS) methods, though does not provide a clear pathway as to how CCS technology is to be implemented to achieve said reductions. Therefore, provisional targets established herein align with the carbon neutrality goal set by AB 1279 until a clear mechanism for CCS reductions is established by the State.

Pursuant to the Scoping Plan's recommendations, the community GHG reduction targets will be developed based on local levels of GHG emissions that would be proportional to the statewide goals, relative to 1990 level emissions.

6.1 1990 Level GHG Emissions Back-cast

The City does not have a 1990 GHG emissions inventory from which to develop GHG reduction targets consistent with SB 32, however, 1990 GHG emissions can be estimated for the community relative to the City's 2021 Community GHG Inventory using a state-level emissions change metric.

The City's 1990 GHG emissions have been calculated using the State's 2020 GHG emissions inventory as compared to the State's GHG emissions inventory in 1990 to calculate specific percent reduction in the City between 2021 and 1990. This approach assumes that the City's community GHG emissions have generally tracked with the State's GHG emissions. The calculation is developed using the published State-wide emissions results from CARB[53], after removing emissions from

[51] 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

[52] California Air Resources Board. 2022. California's Climate Change Scoping Plan, Appendix D – Local Actions, p. 14. https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

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

sectors not included in the City's inventory (e.g., agriculture, aviation, non-specified, industrial) and excluding GHGs other than CO_2, CH_4, and N_2O consistent with the City's 2021 inventory scope. The 1990 back-cast for the City is shown in Table 52.

Table 52 990 Back-cast Calculations

1990 Back-cast Calculations	
2020 Statewide GHG Emissions (MT CO_2e)	219,786,184
1990 Statewide GHG Emissions (MT CO_2e)	281,648,899
2020 to 1990 Statewide GHG Emissions Change (%)	22%
2021 City GHG Emissions (MT CO_2e)	1,053,141
1990 City GHG Emissions Back-cast (MT CO_2e)	1,349,567
1990 City Population	180,038
1990 City Per Capita GHG Emissions Back-cast (MT CO_2e/person)	7.50

6.2 GHG Emissions Reduction Target Setting

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 GHG reduction measures has been completed. The purpose of target setting is to develop the trajectory toward achieving the State's 2030 goal (SB 32) and prepare for the deep decarbonization needed by 2045 in a cost-effective manner by setting an incremental path toward achieving AB 1279 targets. CARB guidance is for jurisdictions to first strive to exceed the SB 32 targets of reducing GHG emissions 40% below 1990 levels, while establishing a policy framework to achieve the long-term target of neutrality 1990 by 2045.

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. The CEQA Guidelines section 15183.5(b) requires qualified GHG reduction plans (which allow for CEQA streamlining) to "Establish a level, based on substantial evidence, below which the contribution to greenhouse gas emissions from activities covered by the plan would not be cumulatively considerable".[54] A defensible way (shown through litigation) to identify such levels is to demonstrate consistency with State targets. To maintain consistency with State targets, Glendale's provisional GHG emissions reduction targets are:

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

With GHG emission reduction targets in place, the reduction gap that the City will be responsible for through local action can be calculated. The City's GHG emissions reduction gap is based on the difference between the adjusted forecast, discussed previously, and the established GHG emission reduction targets. Table 53 provides a summary of the GHG emission reduction targets and gap in mass emissions. Although per capita, plan-level GHG emissions targets were recommended in the

[54] https://casetext.com/regulation/california-code-of-regulations/title-14-natural-resources/division-6-resources-agency/chapter-3-guidelines-for-implementation-of-the-california-environmental-quality-act/article-12-special-situations/section-151835-tiering-and-streamlining-the-analysis-of-greenhouse-gas-emissions

2017 Scoping Plan to incentivize growth in a coordinated manner and not penalize cities which are growing at significant rates[55], CARB now recommends, in the 2022 Scoping Plan, that jurisdictions focus on developing locally appropriate, plan-level targets (community-wide mass emissions targets) that align with the trajectory to carbon neutrality instead of focusing on a per capita targets[56]. Therefore, only mass emissions targets are considered in this analysis as a metric for the City to track progress toward target achievement.

Table 53 GHG Emissions Reduction Targets and Gap Analysis

Emissions Forecast or Pathway	2021	2030	2035	2040	2045
Mass Emissions Target Pathway Scenario [MT CO2e]					
Adjusted Forecast	1,053,141	932,917	835,322	822,824	813,387
SB 32 Mass Emissions Target Pathway[1]	1,053,141	809,740	539,827	269,913	0
Remaining Emissions Gap	0	123,177	295,495	552,910	813,387

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.

2. The target pathway is calculated by reducing 1990 per capita 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.

Figure 3 provides a visual representation of future GHG emissions, with the impacts of State legislation and the remaining gap the City will be responsible for to meet the GHG emission reduction targets set by the State. The figure also includes a linear reduction pathway to neutrality as the City is anticipated to be able to achieve reductions on a mass emissions to meet SB 32 targets.

55 California Air Resources Board. 2017. California's Climate Change Scoping Plan, p. 99-102. https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf

56 California Air Resources Board. 2022. California's Climate Change Scoping Plan, Appendix D – Local Actions, p.13. https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

Figure 3 GHG Emissions Forecast and Provisional Target Pathways (Mass Emissions)