Ukiah Community GHG Inventories

Appendix C - Final Greenhouse Gas Emissions Inventories Report

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1 Introduction

1.1 Report Overview and GHG Inventory Purpose

This Ukiah community greenhouse gas (GHG) inventories report includes the following information by section:

- Section 1: report sections overview and GHG inventories approach;
- Section 2: Ukiah's new 2022 community GHG emissions inventory methodology, activity data, emissions factors, and results by sector;
- Section 3: Ukiah's 2005 and 2010 community GHG inventories including updates to methodology, activity data, emissions factors, and results by sector; and
- Section 4: comparison of updated 2005/2010 inventories and the new 2022 inventory.

The 2005 and 2010 community GHG inventories previously completed for the Ukiah 2014 Climate Action Plan (CAP) were updated to leverage the latest available models and best available data in accordance with the Community Protocol to be consistent with the 2022 GHG inventory. Updating the 2005 and 2010 inventories provides a comparable baseline utilizing a consistent methodology, which is a crucial measure for the City of Ukiah staff to be able to accurately track Ukiah's progress towards achieving its community GHG emissions reduction goals.

1.2 GHG Inventories Approach

GHG Emissions Accounting Protocol

Ukiah's 2005, 2010, and 2022 community GHG inventories were developed in alignment with accounting protocols provided by the Local Governments for Sustainability International Council for Local Environmental Initiatives (ICLEI) as recommended by the Association of Environmental Professionals (AEP) and the California Office of Planning and Research (OPR).[1] 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. Use of Community Protocol methodology for GHG accounting aligns with statewide GHG inventory methods and focuses on analyzing sectors which are within jurisdictional control of cities or counties. The Community Protocol also includes steps to evaluate the relevance, completeness, consistency, transparency, and accuracy of data used in the GHG inventory.

GHG emissions were calculated by multiplying the activity data in each GHG emissions sector (e.g., transportation, energy, waste, water and wastewater) by an associated emission factor. Activity data refer to the relevant measured or estimated level of GHG-generating activity (e.g., energy

[1] Association of Environmental Professionals (AEP). 2013. AEP Climate Change Committee's "The California Supplement to the United States Community-Wide Greenhouse Gas (GHG) Emissions Protocol". Available at: https://califaep.org/docs/California_Supplement_to_the_National_Protocol.pdf

consumption, miles traveled). Emission factors are observation-based conversion factors used to equate activity data to generated GHG emissions. The 2022 community GHG 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.

Emissions Geographic Boundary

Ukiah's community inventories cover the relevant emissions sources within the boundary of the City (i.e., City limits). The inventory, thereby, reflects emissions sectors over which the City of Ukiah has jurisdictional control and influence. Sectors where the jurisdiction has limited influence are generally excluded from the 2005, 2010, and 2022 community GHG inventories, as the City of Ukiah does not have the power to develop measures to impact associated emissions. This method of exclusion for the emissions boundary aligns with Community Protocol standards and is recommended by State guidance for inventory, forecast, and targets accounting.[2]

Emissions Inventory Scope

The Community Protocol recommends reporting GHG emissions from five basic reporting activities in a community inventory that 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. GHG emissions sources can be categorized more generally into the following five activity sectors:

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

All Ukiah community GHG inventories discussed in this report include an assessment of communitywide GHG emissions associated with these five sectors that also serve as the basis for the GHG emissions forecast and target setting.

[2] Governor's Office of Planning and Research (OPR). 2023. Chapter 8, Climate Change. Available at: https://www.opr.ca.gov/docs/OPR_C8_final.pdf

2 2022 Community GHG Inventory

The 2022 GHG emissions assessment (2022 Community GHG Inventory) completed for Ukiah includes GHG emissions from activities within the Ukiah's jurisdictional boundaries during 2022.

A GHG emissions inventory provides a comprehensive understanding of a community's GHG emissions and is developed to serve the following purposes:

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

2.1 2022 Community GHG Emissions Inventory Activity Data and Emissions Factors

2.1.1 Global Warming Potential

The Community Protocol assesses GHG emissions associated with the six internationally recognized GHGs, as outlined in Table 1. The 2022 inventory focuses on the three GHGs most relevant to the City's operations: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). 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 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 2022 inventory used 100-year global warming potentials (GWP) for each gas that are consistent with the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report,[3] 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).

Table 1 2022 Inventory GHGs and GWPs

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

[3] 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/

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/

2.1.2 Energy

Energy: Residential and Nonresidential Electricity

The community of Ukiah relies on electricity sourced exclusively from the City. By establishing its own utility service, the City is able to provide the community of Ukiah with lower cost electricity and better manage energy profiles which affect Ukaih's renewable energy goals. GHG emissions associated with electricity are intricately tied to the energy generation sources from which it is procured such as coal, natural gas, hydroelectric, wind, solar, biomass, and geothermal. Wind and solar are considered carbon-free renewable sources, while biomass and geothermal emit GHGs but are deemed eligible renewables by the State as they produce significantly less emissions compared to fossil-based sources. These eligible renewables typically provide additional benefit by increasing grid resilience as carbon-free sources such as wind and solar are subject to variable conditions for energy generation.

In the context of Ukiah's energy landscape, the City manages the Lake Mendocino Hydroelectric Plant and is an active participant in the Northern California Power Agency (NCPA), a joint powers association (JPA). The hydroelectric plant is a significant contributor to the region's power supply. Hydroelectric power is considered a carbon-free and renewable energy source, as it does not produce direct GHG emissions during the generation process. Furthermore, as a member municipality in the NCPA, the City is actively involved in both selling to, and purchasing power from, the NCPA electric grid mix as well as participating in power generation projects. The NCPA incorporates a diverse array of energy sources, including eligible renewables such as geothermal energy,[4] to increase energy resilience in the region while also reducing GHG emissions. By supplying carbon-free hydroelectric power to the NCPA energy supply, the City is contributing to the overall regional objective to meet and exceed State renewable energy portfolio goals.

Activity data for community electricity consumption was provided by the City through electricity usage reports for the residential sector and nonresidential sector (including commercial and industrial sectors). As industrial electricity use was included as aggregated nonresidential activity data in the Ukiah 2005 and 2010 GHG inventories completed for the Ukiah 2014 CAP (see Section 3), industrial emissions are included in the 2022 Community GHG Inventory to align the scope of the previous inventories.

Emissions from residential and nonresidential electricity were calculated using Community Protocol Equation BE.2.1. To account for electricity only consumed in the built environment, equation **2.1** subtracts electricity consumed by electric vehicles (EVs) from total purchased electricity 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 instead accounted for under the transportation sector of the inventory to provide a more thorough differentiation between building and transportation sector emissions. More information regarding EV energy use can be found in Section 2.1.3. Equation

[4] Northern California Power Agency (NCPA). 2023. NCPA Geothermal. Available at: https://www.ncpa.com/about/generation/geothermal/

2.1 and Table 2 provide the equation and data sources used to quantify GHG emissions associated with community electricity consumption.

EQUATION 2.1

BE.2.1 RESIDENTIAL/NONRESIDENTIAL ELECTRICITY SECTOR EMISSIONS

$$CO_2e_{electricity,j} = \sum_i \left(Elec_{i,j} - EV_{i,j}\right) \times EF_{elec,i,j} \quad 2.1$$

Table 2 Emissions Parameters and Data Sources – Community Electricity Use BE.2.1

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from electricity consumption per building type	$CO_2e_{electricity,j}$	See Table 16	MT CO_2e/year	Calculated
Electricity consumption per building type per energy provider	$Elec_{i,j}$	See Table 16	kWh/year	City of Ukiah Electricity Report[1]
Attributed electric vehicle electricity consumption	$EV_{i,j}$	See Table 16	kWh/year	EMFAC2021[2]
Electricity emission factor based on energy provider[3]	$EF_{elec,i,j}$	See Table 16	MT CO_2e/kWh	2. City of Ukiah 2022 Power Content Label[4] 3. CEC Power Source Disclosure Regulations[5]
Energy Providers	i	City of Ukiah	Categorical	
Building type	j	Residential Nonresidential[6]	Categorical	

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

1. City of Ukiah Electricity Report provided by the City via email on August 31, 2023

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

3. The electricity emissions factor was calculated according to regulatory guidance established by the California Energy Commission (CEC) and based on the Ukiah 2022 power label grid mix. According to CEC guidance, emissions factors for each fuel source are to be sourced from MRR requirements, which in turn stipulates the use of Energy Information Administration (EIA) or Environmental Protection Agency (EPA) emissions factors depending on fuel type. More information regarding MRR regulation requirements are available here: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

4. City of Ukiah. 2023. 2022 Power Content Label, City of Ukiah Electric Utility. Available at: https://cityofukiah.com/wp-content/uploads/2023/09/City-of-Ukiah-2022-PCL.pdf

5. California Energy Commission (CEC). 2020. Modification of Regulations Governing the Power Source Disclosure Program. Available at: https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-source-disclosure-resources

6. Nonresidential includes kWh consumption from commercial and industrial sources.

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 Ukiah. Electricity T&D losses occur in the electricity transmission and distribution system and are therefore upstream of the delivery endpoints located within Ukiah jurisdictional boundaries. This means that this electricity is lost before it is counted. However, T&D losses are estimated and included in the 2022 Community GHG Inventory as they are associated with energy usage in Ukiah and thereby directly impacted by the community's electricity consumption. Additionally, emissions from T&D losses are recommended for inclusion in community

GHG inventories by the Community Protocol. Equation **2.2** and Table 3 provide the calculation method, associated parameters, and data sources used to quantify GHG emissions associated with community T&D losses from electricity consumption. 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 2.2

BE.4 ELECTRICITY T&D LOSS SECTOR EMISSIONS

$$CO_2e_{T\&D,j} = \sum_i Elec_{i,j} \times L_{T\&D} \times EF_{elec,i,j} \quad 2.2$$

Table 3 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 16	MT CO_2e/year	Calculated
Electricity consumption per energy provider and building type	$Elec_{i,j}$	See Table 16	kWh/year	City of Ukiah Electricity Report[1]
Electricity emissions factor per energy provider and building type[2]	$EF_{elec,i,j}$	See Table 16	MT CO_2e/kWh	2. City of Ukiah 2022 Power Content Label[3] 3. CEC Power Source Disclosure Regulations[4]
Electricity loss factor	$L_{T\&D}$	4.12%	Percent	City of Ukiah Electricity Report
Energy Providers	i	City of Ukiah	Categorical	
Building type	j	Residential Nonresidential[5]	Categorical	

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

1. City of Ukiah Electricity Report provided by the City via email on August 31, 2023

2. The electricity emissions factor was calculated according to regulatory guidance established by the California Energy Commission (CEC) and based on the Ukiah 2022 power label grid mix. According to CEC guidance, emissions factors for each fuel source are to be sourced from MRR requirements, which in turn stipulates the use of Energy Information Administration (EIA) or Environmental Protection Agency (EPA) emissions factors depending on fuel type. More information regarding MRR regulation requirements are available here: https://ww2.arb.ca.gov/sites/default/files/classic/cc/reporting/ghg-rep/regulation/mrr-2018-unofficial-2019-4-3.pdf

3. City of Ukiah. 2023. 2022 Power Content Label, City of Ukiah Electric Utility. Available at: https://cityofukiah.com/wp-content/uploads/2023/09/City-of-Ukiah-2022-PCL.pdf

4. California Energy Commission (CEC). 2020. Modification of Regulations Governing the Power Source Disclosure Program. Available at: https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-source-disclosure-resources

5. Nonresidential includes kWh consumption from commercial and industrial sources.

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. Ukiah's natural gas is supplied by Pacific Gas and Electric (PGE) 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). However, data provided by PG&E did not report natural gas use

associated with industrial sector consumption, and therefore there was no natural gas use attributable to industrial operations in the 2022 Community GHG Inventory.

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 purchased 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 **2.3** and Table 4 provide the equation used, associated parameters, and data sources used to quantify GHG emissions associated with community natural gas consumption in residential and nonresidential buildings.

EQUATION 2.3

BE.1.1 RESIDENTIAL/NONRESIDENTIAL NATURAL GAS SECTOR EMISSIONS

$$CO_2e_{NatGas,i} = \left(Fuel_{NG,i} - [1 - L_{enduse}]\right) \times \left[\left(EF_{NG,CO_2} \times GWP_{CO_2}\right) + \left(EF_{NG,CH_4} \times GWP_{CH_4}\right) + \left(EF_{NG,N_2O} \times GWP_{N_2O}\right)\right] \times 10^{-1} \times 10^{-3} \quad (2.3)$$

Table 4 Emissions Parameters and Data Sources – Community Natural Gas Use BE.1.1

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from stationary combustion of natural gas per building type	$CO_2e_{NatGas,i}$	See Table 16	MT CO_2e/year	Calculated
Natural gas consumed per building type	$Fuel_{NG,i}$	See Table 16	therms/year	PGE 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}	0.001	kg CH_4/mmBTU natural gas	EPA Emission Factors Hub
Nitrous oxide emission factor for natural gas combustion	EF_{NG,N_2O}	0.0001	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}	0.001	MT/kg	

Definition	Parameter	Value	Unit	Data Source
Building type (i.e. residential or nonresidential)	i	Residential Nonresidential	Categorical	

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

1. Pacific Gas and Electricity (PGE) Natural Gas Report provided by the City via email on August 31, 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). 2022. GHG Emission Factors Hub (April, 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 consumption from commercial and industrial sources.

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 Ukiah and not reflected in reported total natural gas purchased. While natural gas pipeline distribution leakage is technically outside of the Ukiah jurisdictional boundaries, the leakage is 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 Ukiah 2022 Community GHG Inventory. Methane leaks from end-use discussed previously occur at the point of use in Ukiah and therefore occur within Ukiah's jurisdictional boundaries. Though it is best practice to include emissions from natural gas leakage, the Community Protocol does not provide a specific calculation methodology for determining GHG emissions from natural gas leakage. Therefore, emissions from natural gas leaks were calculated using Equation **2.4** which aligns 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 5 shows the parameters and data sources associated with Equation **2.4** which were used to quantify GHG emissions from natural gas distribution and end-use leakage.

EQUATION 2.4

NATURAL GAS LEAKAGE SECTOR EMISSIONS

$$CO_2e_{leak,i} = Fuel_{NG,i} \times EF_{NG\ leak} \times (L_{enduse} + L_{dist}) \quad 2.4$$

Table 5 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 16	MT CO_2e/year	Calculated
Natural gas consumed per building type	$Fuel_{NG,i}$	See Table 16	therms/year	PGE 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. Pacific Gas and Electricity (PGE) Natural Gas Report provided by the City via email on August 31, 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. Available at: https://www.science.org/doi/abs/10.1126/science.aar7204

4. 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

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

2.1.3 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 emission factors and EV penetration data from CARB's 2021 EMission FACtor (EMFAC2021) model.[5] EMFAC2021 provides data on the county-wide data level and does not differentiate data according to cities. This assessment assumes county-wide data reported by EMFAC2021 is representative of city-level on-road transportation emission factors and EV penetration rates.

The Community Protocol recommends use of regional travel demand models to differentiate passenger, commercial, and bus vehicle miles travelled activity data attributed to the community. This assessment utilizes vehicle miles travelled (VMT) data provided by GHD.[6] The VMT allocation study provided by GHD is based on data pulled from the Mendocino Council of Governments (MCOG) travel demand model[7] which generates attributable daily average VMT for participating communities in Mendocino County. VMT data provided by GHD for the purposes of this inventory were derived from the MCOG travel demand model using the SB 375 Regional Targets Advisory Committee (RTAC) origin-destination methodology.[8] The GHD study provides VMT data from trips occurring within Ukiah city limits (internal-internal), traversing city limits (internal-external), and trips which are entirely outside city limits (external-external). Weekday VMT accounted for 100

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

[6] https://www.ghd.com/en-US

[7] https://www.mendocinocog.org/

[8] California Air and Resources Board (CARB). 2018. Appendix F, Final Environmental Analysis. Available at: https://ww2.arb.ca.gov/sites/default/files/2020-06/SB375_Final_Target_Staff_Report_%202018_AppendixF.pdf

percent of internal-internal trips and 50 percent of internal-external trips and was annualized[9] to determine 2022 VMT activity data for Ukiah. As the MCOG model does not differentiate between passenger, commercial, and bus VMT, activity data was allocated to these sectors based on percent VMT share which was determined using data provided by the EMFAC2021 model. Equation **2.5** and Table 6 define the equations, parameters, and data sources used to convert resulting GHD VMT activity data to GHG emissions from on-road transportation fuel combustion.

EQUATION 2.5

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

$$CO_2e_{onroad,i} = \left(T + \frac{1}{2}T_O + \frac{1}{2}T_D\right) \times \%Share_i \times EF_{auto,i} \quad 2.5$$

Table 6 Emissions Parameters and Data Sources – Community On-road Transportation TR.1.A and TR.2.B

Definition	Parameter	Value	Unit	Data Source
Total annual community on-road GHG emissions per vehicle class	$CO_2e_{Onroad,i}$	See Table 16	MT CO_2e/year	Calculated
VMT occurring within jurisdictional boundaries	T	83,249	miles	MCOG Travel Demand Model (GHD)[1]
VMT originating within and terminating outside of jurisdictional boundaries	T_O	122,583	miles	MCOG Travel Demand Model (GHD)
VMT originating outside of and terminating within jurisdictional boundaries	T_D	526,526	miles	MCOG Travel Demand Model (GHD)
Percent share of total VMT for each vehicle class	$\%Share_i$	See Table 16	%	EMFAC2021 v1.0.1[2]
Emissions factor for on-road vehicles per vehicle class	$EF_{auto,i}$	See Table 16	MT CO_2e/mile	EMFAC2021 v1.0.1
Vehicle class	i	Passenger Commercial Bus	Categorical	

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

1. Mendocino Council of Governments (MCOG) Travel Demand Model activity data provided by GHD via email on October 27, 2023. Further information regarding the regional transportation model is available at: https://www.mendocinocog.org/

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 2022 Community GHG Inventory for more accurate accounting of on-road transportation trends. This was achieved through modifying Equation **2.5** to account for EV modeshare estimates based on total VMT (see

[9] Daily VMT is scaled based on a 347 days per year in alignment with methodology specified in the CARB AB 32 Scoping Plan methodology summary, available at: https://www.arb.ca.gov/cc/scopingplan/document/measure_documentation.pdf. The conversion factor accounts for difference between weekend vs weekday transportation activities.

Equation **2.6**). Note that Equation **2.5** was not adjusted above to account for EV share of VMT data due to use of the EMFAC2021 weighted emissions factors which attribute GHG emissions to be zero for EV activity. Due to this zero emissions attribution, application of the EMFAC2021 emissions factor to total VMT data in Equation **2.5** in effect excludes EV GHG emissions. As such, GHG emissions associated with EV VMT quantified according to Equation **2.6** below does not result in double counting of emissions resulting from Equation **2.5** methodology. The equation, parameters, and data sources used to estimate GHG emissions attributable to on-road EV activity is provided in Equation **2.6** and Table 7 below.

EQUATION 2.6

ON-ROAD TRANSPORTATION ELECTRIC VEHICLE EMISSIONS

$$CO_2e_{onroad,EV,i} = \left(T + \frac{1}{2}T_O + \frac{1}{2}T_D\right) \times \%Share_i \times EV_{share,i} \times EPM_i \times EF_{elec,j} \quad 2.6$$

Table 7 Emissions Parameters and Data Sources – Community On-road Transportation EV

Definition	Parameter	Value	Unit	Data Source
Total annual community on-road EV GHG emissions per vehicle class	$CO_2e_{Onroad,EV,i}$	See Table 16	MT CO_2e/year	Calculated
VMT occurring within jurisdictional boundaries	T	83,249	miles	MCOG Travel Demand Model (GHD)[1]
VMT originating within and terminating outside of jurisdictional boundaries	T_O	122,583	miles	MCOG Travel Demand Model (GHD)
Vehicle miles travelled originating outside of and terminating within jurisdictional boundaries	T_D	526,526	miles	MCOG Travel Demand Model (GHD)
Percent share of total VMT for each vehicle class	$\%Share_i$	See Table 16	%	EMFAC2021 v1.0.1[2]
Percent share of VMT attributable to EVs	$EV_{share,i}$	See Table 16	%	EMFAC2021 v1.0.1
Average rate of electricity consumption per EV-mile per vehicle class	EPM_i	Various[3]	kWh/mile	EMFAC2021 v1.0.1
Weighted average electricity emissions factor per building type	$EF_{elec,j}$	See Table 16	MT CO_2e/kWh	See Table 2
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

Definition	Parameter	Value	Unit	Data Source

1. Mendocino Council of Governments (MCOG) Travel Demand Model activity data provided by GHD via email on October 27, 2023. Further information regarding the regional transportation model is available at: https://www.mendocinocog.org/
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. The electricity consumption per EV-mile (EPM) in 2022 is as follows: Passenger = 0.3647, Commercial = 0.0000, and Bus = 1.7498

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 **2.7** below. Table 8 lists the parameters, values, and data sources used to quantify emissions in according with the Community Protocol.

EQUATION 2.7

TR.8 OFF-ROAD EQUIPMENT SECTOR EMISSIONS

$$CO_2e_{offroad,j} = EF_j \times \sum_i Fuel_{offroad,i,j} \times AF_i \quad (2.7)$$

Table 8 Emissions Parameters and Data Sources – Community Off-Road Equipment TR.8

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from offroad equipment	$CO_2e_{offroad,j}$	See Table 16	MT CO_2e/year	Calculated
Annual fuel consumption in the County per sector per fuel type	$Fuel_{offroad,i,j}$	See Table 16	Gallons/year	OFFROAD2021[1]
Fuel attribution factor per equipment type	AF_i	See Table 9	Percent	California Department of Finance[2]
Emission factor per fuel type	EF_j	See Table 16	MT CO_2e/gallon	EPA Emission Factors Hub[3]
Equipment Type	i	See Table 9	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). Mobile Source Emissions Inventory Off-road (OFFROAD2021) v.1.0.5. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-road-documentation-0
2. California Department of Finance. 2023. E-5 Population and Housing Estimates for Cities, Counties, and the State, 2020-2023. Available at: https://dof.ca.gov/forecasting/demographics/estimates/e-5-population-and-housing-estimates-for-cities-counties-and-the-state-2020-2023/
3. Environmental Protection Agency (EPA). 2022. GHG Emission Factors Hub. Available at: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

The OFFROAD2021 model is in alignment with Community Protocol standards, though the model only reports off-road equipment fuel consumption on a county-wide basis. Attribution factors per equipment type used to allocate Ukiah 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 9.

Table 9 Community Off-road Equipment Sector Attributions

Equipment Type	Attribution Metric	Attribution	Data Source
Agricultural	Excluded – Other[1]	0.00%	Not Applicable
Airport Ground Support	Employment[2]	19.07%	California Department of Finance[3]
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	19.07%	California Department of Finance
Industrial	Employment	19.07%	California Department of Finance
Lawn and Garden	Population	17.86%	California Department of Finance
Light Commercial	Employment	19.07%	California Department of Finance
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	17.86%	California Department of Finance
Portable Equipment	Employment	19.07%	California Department of Finance
Transport Refrigeration Unit	Employment	19.07%	California Department of Finance
Recreational	Population	17.86%	California Department of Finance
Military Tactical Support	Excluded - Not Under Jurisdictional Control	0.00%	Not Applicable
Forestry	Excluded - Other	0.00%	Not Applicable

Notes:

1. Agricultural excluded as acres of farmland within Ukiah boundaries are anticipated to be negligible based on incorporated Ukiah land use identified in the General Plan 2040, available here: https://cityofukiah.com/wp-content/uploads/2023/01/General-Plan-2040-122922_Signed.pdf

2. The City owns and operates the Ukiah Airport and therefore has jurisdictional control over its operations: https://cityofukiah.com/departments/ukiah-airport/#:~:text=Ukiah%20Municipal%20Airport&text=The%20airport%20is%20comprised%20of,87%20aircraft%20based%20on%20site.

3. California Department of Finance. 2023. E-5 Population and Housing Estimates for Cities, Counties, and the State, 2020-2023. Available at: https://dof.ca.gov/forecasting/demographics/estimates/e-5-population-and-housing-estimates-for-cities-counties-and-the-state-2020-2023/

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

2.1.4 Solid Waste

GHG emissions associated with the waste sector result from the decomposition of waste at a landfill as well as landfill operation processes. C&S Waste Solutions[10] provides solid waste, recycling, and mixed organic waste collection services for Ukiah. Once collected, solid waste is ultimately processed at the following landfills: Eastlake Sanitary Landfill, Forward Landfill Inc, Potrero Hills Landfill, Recology Hay Road, Redwood Landfill.[11] GHG emissions from waste decomposition were calculated using Community Protocol Method SW.4.1. Equation **2.8** and Table 10 provide the calculation method, associated parameters, and data sources used to quantify GHG emissions in accordance with Community Protocol SW.4.1.

EQUATION 2.8

SW.4.1 SOLID WASTE FUGITIVE EMISSIONS

$$CO_2e_{Waste,fugitive} = GWP_{CH_4} \times (1 - CE) \times (1 - OX) \times M \times \sum_i P_i \times EF_i \quad 2.8$$

Table 10 Emissions Parameters and Data Sources – Community Solid Waste SW.4.1

Definition	Parameter	Value	Unit	Data Source
Annual community generated waste GHG emissions	$CO_2e_{Waste,fugitive}$	3,764	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	9,957	Wet short tons	C&S Waste Solutions[2]
Proportion of total waste material per material type	P_i	1	Fraction	
Emission factor per material type[3]	EF_i	0.060	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. C&S Waste Solutions 2022 Solid Waste tonnage report provided by the City via email on August 31, 2023

3. For mixed municipal waste streams where the proportion of material type is unknown, ICLEI specifies a default value of 0.060 MT CH_4 per wet short ton may be used.

Landfill process emissions were quantified according to Equation SW.5 of the Community Protocol. Equation **2.9** and Table 11 provide the calculation method, associated parameters, and data sources used to quantify GHG emissions from landfill operations.

[10] https://candswaste.com/locations/california/mendocino-county/ukiah-waste-solutions/

[11] California Department of Resources Recycling and Recovery (CalRecycle). 2019. Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility. Available at: https://www2.calrecycle.ca.gov/LGCentral/DisposalReporting/Destination/DisposalByFacility

EQUATION 2.9

SW.5 SOLID WASTE PROCESS EMISSIONS

$$CO_2e_{Waste,process} = M \times EF_p \quad 2.9$$

Table 11 Emissions Parameters and Data Sources – Community Solid Waste SW.5

Definition	Parameter	Value	Unit	Data Source
Annual landfill process GHG emissions	$CO_2e_{Waste,process}$	110	MT CO_2e/year	Calculated
Total mass of solid waste that enters the landfill in the inventory year	M	9,957	Wet short tons/year	C&S Waste Solutions[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. C&S Waste Solutions 2022 Solid Waste tonnage report provided by the City via email on August 31, 2023

2.1.5 Water

Water consumption generates GHG emissions from the electricity used to extract, convey, treat, and deliver water to the community. The City provides the entirety of the community's water needs. The City's potable water supply consists of groundwater pumped from the Ukiah Valley Groundwater Basin and surface water sourced from the Russian River. Well pumps used to extract groundwater are located within Ukiah boundaries, while surface wells are located along the Russian River which lies outside of Ukiah's boundaries. Additionally, the City owns and operates a water treatment plant located within Ukiah city limits which treats extracted surface water.[12]

As the City supplies all of the community's water needs and the majority of processes occur within Ukiah city limits, electricity consumption associated with local groundwater and surface water management is anticipated to be included under nonresidential electricity use. Therefore, to avoid double counting water management GHG emissions are excluded from the 2022 Community GHG Inventory. However, GHG emissions associated with City groundwater and surface water management is quantified and presented below for information purposes. Table 12 shows the parameters and data sources associated with Equation **2**.**10** which were used to quantify GHG emissions from local and imported water sources.

[12] City of Ukiah. 2021. 2020 Urban Water Management Plan (UWMP). Provided by the City via email on August 31, 2023

EQUATION 2.10

WW.14 WATER SECTOR EMISSIONS

$$CO_2e_{Water,i} = Vol_i \times \sum_j EI_{i,j} \times EF_{elec,i,j} \quad 2.10$$

Table 12 Emissions Parameters and Data Sources – Community Water WW.14

Definition	Parameter	Value	Unit	Data Source
Annual GHG emissions from water consumption per water district	$CO_2e_{Water,i}$	See Table 16	MT CO_2e/year	Calculated
Volume of water supplied to the community per water district	Vol_i	See Table 16	AF	City of Ukiah 2022 Water Production Report[1]
Energy intensity of water distribution per water district	$EI_{i,j}$	See Table 16	kWh/AF	1. City of Ukiah 2020 UWMP[2] 2. ICLEI Community Protocol
Electricity emissions factor per water process stage per source type	$EF_{elec,i,j}$	0.000278	MT CO_2e/kWh	See Table 2
Water district	i	City of Ukiah	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. City of Ukiah 2022 Water Production Report provided by the City via email on August 31, 2023

2. City of Ukiah. 2021. 2020 Urban Water Management Plan (UWMP). Provided by the City via email on August 31, 2023.

2.1.6 Wastewater

Management of wastewater produces emissions through every stage of the process from collection to final use or discharge. The City owns and operates the City of Ukiah wastewater treatment plant (WWTP) which provides treatment services for Ukiah as well as the Ukiah Valley Sanitation District (UVSD) which lies just outside of the incorporated Ukiah boundaries. The WWTP has a dry-weather capacity of 3.01 million gallons per day (MGD) and a wet weather capacity of 24.5 MGD. The WWTP was upgraded to produce recycled water in 2019 using primary, secondary, and tertiary treatment. This upgrade allows the City to avoid wastewater effluent discharge by either utilizing recycled water for irrigation and agriculture or by storing excess treated wastewater in percolation ponds.[13]

GHG emissions from the City's WWTP operations are a result of stationary combustion of digester gas, process emissions which occur with nitrification/denitrification, and electricity use.[14] As the WWTP is located within Ukiah boundaries, the facility's electricity use is anticipated to be included under nonresidential electricity consumption. To avoid double counting, WWTP electricity use is

[13] City of Ukiah. 2021. 2020 Urban Water Management Plan (UWMP). Provided by the City via email on August 31, 2023

[14] Ibid

excluded and only process related emissions are quantified. The set of methods used to quantify stationary combustion emissions is outlined in Equation **2.11** and Table 13 as well as Equation **2.12** and Table 14 below.

EQUATION 2.11

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

$$CO_2e_{WW,Stat,CH4,i} = (Digester\ Gas \times f_{CH4} \times BTU_{CH4} \times 10^{-6} \times EF_{CH4} \times 365.25 \times 10^{-3}) \times GWP_{CH4} \quad 2.11$$

Table 13 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 16	MT CO_2e/year	Calculated
Rate of digester gas volume production	$Digester\ Gas$	21,319	std ft^3 /day	City of Ukiah 2022 Wastewater Production Report[1]
Fraction of methane in digester gas	f_{CH4}	0.60	Fraction	City of Ukiah 2022 Wastewater Production Report
Default higher heating value of methane	BTU_{CH4}	1,028	BTU/ft^3	ICLEI Community Protocol
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}	28		IPCC Fifth Assessment Report
Wastewater treatment plant (WWTP)	i	Ukiah	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. City of Ukiah. 2023. City of Ukiah 2022 Wastewater Production Report. Provided by the City via email on August 31, 2023.

EQUATION 2.12

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

$$CO_2e_{WW,Stat,N2O,i} = (Digester\ Gas \times f_{CH4} \times BTU_{CH4} \times 10^{-6} \times EF_{N2O} \times 365.25 \times 10^{-3}) \times GWP_{N2O} \quad 2.12$$

Table 14 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 16	MT CO_2e/year	Calculated
Rate of digester gas volume production	$Digester\ Gas$	21,319	std ft^{3}day	City of Ukiah 2022 Wastewater Production Report[1]
Fraction of methane in digester gas	f_{CH4}	0.60	Fraction	City of Ukiah 2022 Wastewater Production Report
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}	0.00063	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	Ukiah	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. City of Ukiah. 2023. City of Ukiah 2022 Wastewater Production Report. Provided by the City via email on August 31, 2023

Equation **2.13** shows the calculation method use to quantify process emissions with nitrification/denitrification in accordance with Community Protocol WW.7. Table 15 show the parameter definitions, default factors, and data sources used.

EQUATION 2.13

WW.7 CENTRALIZED WWTP W/ NITRIFICATION/DENITRIFICATION

$$CO_2e_{WW,nit/denit,i} = P_i \times F_{ind-com} \times EF_{nit/denit} \times 10^{-6} \times GWP_{N2O} \quad 2.13$$

Table 15 Emissions Parameters and Data Sources – Community Wastewater WW.7

Definition	Parameter	Value	Unit	Data Source
Total annual GHG emitted by WWTP processes	$CO_2e_{WW,nit/denit,i}$	29.55	MT CO_2e/year	Calculated

Definition	Parameter	Value	Unit	Data Source
Population	P_i	15,929	People	California Department of Finance[1]
Factor for insignificant industrial or commercial discharge	$F_{ind-com}$	1.00		ICLEI Community Protocol
Emissions factor for a WWTP without nitrification or denitrification	$EF_{w/o\ nit/denit}$	7.00	g N_2O/person/year	ICLEI Community Protocol
Conversion factor	10^{-6}	0.000001	mmBTU/BTU	
Global warming potential of nitrous oxide	GWP_{N2O}	265		IPCC Fifth Assessment Report[2]
Wastewater treatment plant (WWTP)	i	Ukiah WWTP	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. California Department of Finance. 2023. E-5 Population and Housing Estimates for Cities, Counties, and the State, 2020-2023. Available at: https://dof.ca.gov/forecasting/demographics/estimates/e-5-population-and-housing-estimates-for-cities-counties-and-the-state-2020-2023/

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

2.2 2022 Community GHG Emissions Inventory Results

The 2022 community inventory provides Ukiah with current communitywide GHG emissions estimates that follow the Community Protocol and current best practices for GHG accounting. The results of the 2022 community GHG inventory are shown in Figure 1 and Figure 2 summarized in detail in Table 16.

Figure 1 2022 Inventory GHG Emissions by Sector

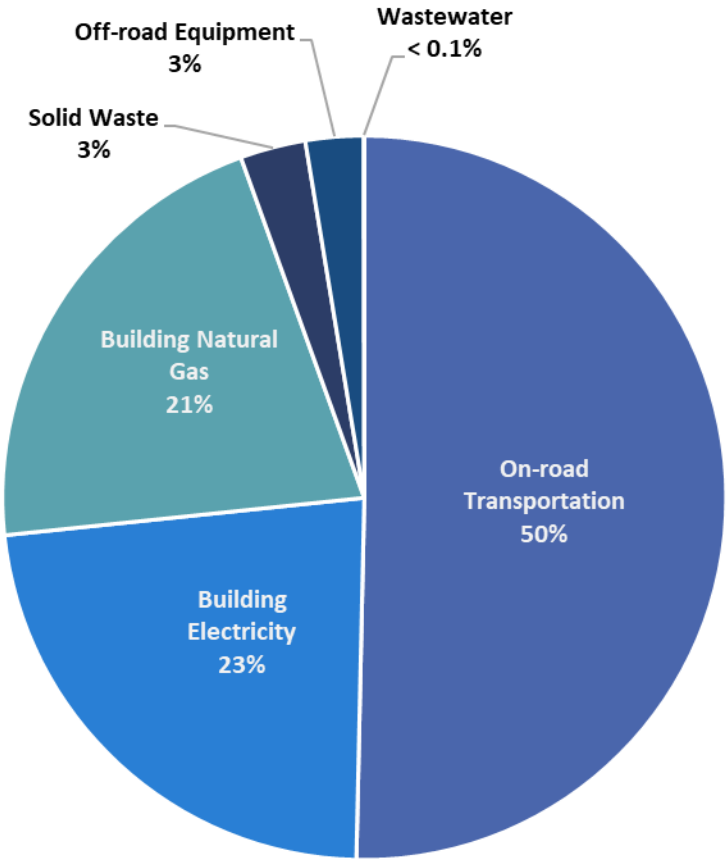

Figure 2 2022 Inventory GHG Emissions by Sub-Sector

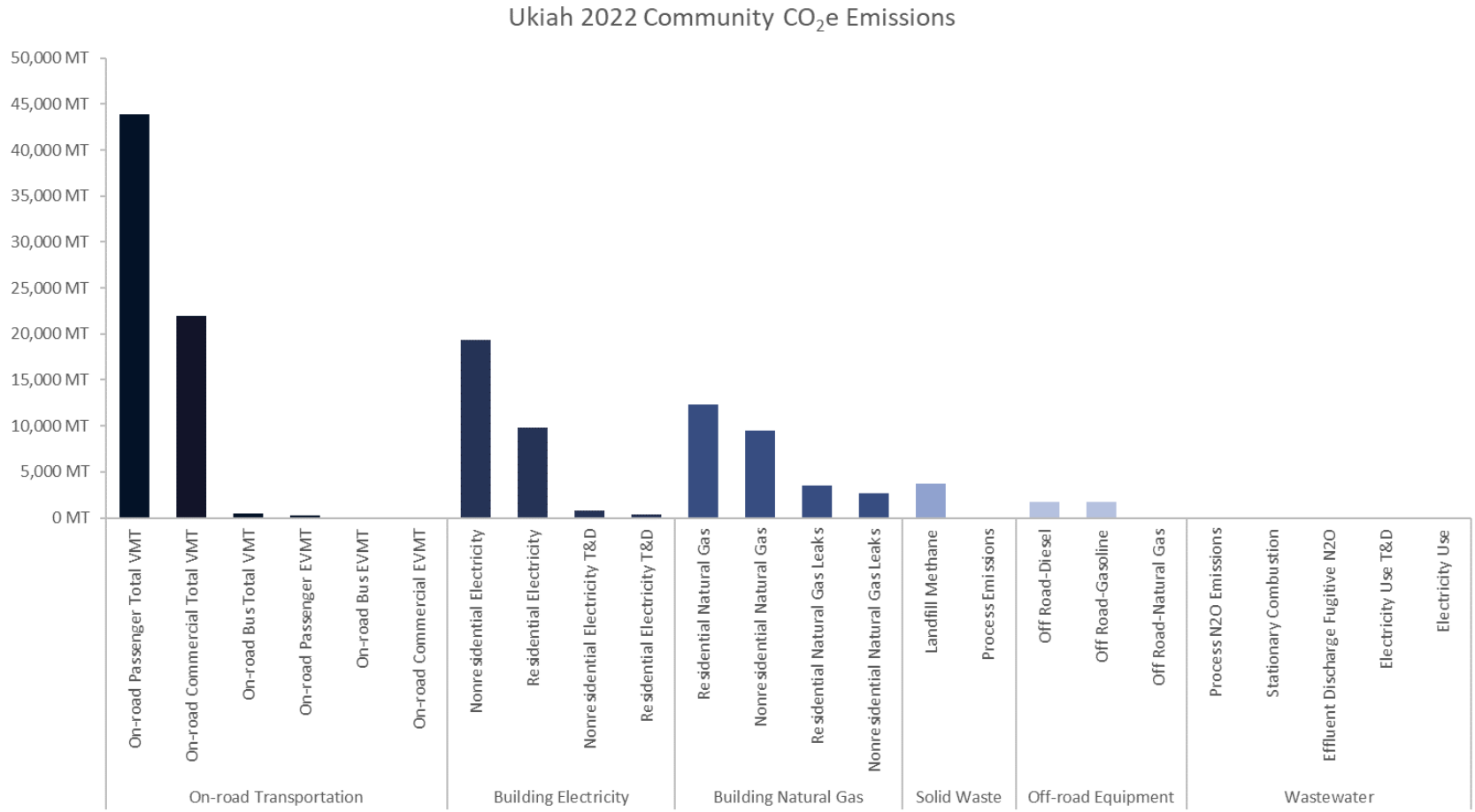

Table 16 2022 Community GHG Emissions Inventory

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
Energy	Residential Electricity	35,413,493	kWh	0.000278	MT CO_2e/kWh	9,847
	Residential Electricity T&D	1,504,429	kWh	0.000278	MT CO_2e/kWh	418
	Nonresidential Electricity	69,671,948	kWh	0.000278	MT CO_2e/kWh	19,372
	Nonresidential Electricity T&D	2,872,337	kWh	0.000278	MT CO_2e/kWh	799
	Residential Natural Gas	2,324,152	therms	0.005311	MT CO_2e/therm	12,345
	Residential Natural Gas Leaks	65,403	therms	0.053067	MT CO_2e/therm	3,471
	Nonresidential Natural Gas	1,780,588	therms	0.005311	MT CO_2e/therm	9,458
	Nonresidential Natural Gas Leaks	50,107	therms	0.053067	MT CO_2e/therm	2,659
Transportation	Passenger VMT	123,285,957	VMT	0.000356	MT CO_2e/mile	43,890
	Commercial VMT	17,898,549	VMT	0.001228	MT CO_2e/mile	21,979
	Bus VMT	323,308	VMT	0.001406	MT CO_2e/mile	455
	Passenger EVMT	1,079,053	kWh	0.000278	MT CO_2e/kWh	300
	Commercial EVMT	0	kWh	0.000278	MT CO_2e/kWh	0
	Bus EVMT	1,584	kWh	0.000278	MT CO_2e/kWh	0
	Off-road Diesel	166,350	Gallons	0.010471	MT CO_2e/gal	1,742
	Off-road Gasoline	183,909	Gallons	0.009158	MT CO_2e/gal	1,684
	Off-road Natural Gas	0	Gallons	0.000000	MT CO_2e/gal	0
Solid Waste	Landfill Methane	9,957	Wet short tons	0.378000	MT CO_2e/ton	3,764
	Process Emissions	9,957	Wet short tons	0.011000	MT CO_2e/ton	110
Water[1]	Groundwater	860,648	kWh	0.000278	MT CO_2e/kWh	332
	Surface Water	796,852	kWh	0.000278	MT CO_2e/kWh	680
Wastewater	Stationary Combustion	7,786,765	scf	0.0000002	MT CO2e/scf	1
	Process N2O Emissions	15,929	people	0.001855	MT CO_2e/person	30
Total						**132,323**

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

1. Water sector activity data is included for informational purposes but is not included in total inventory GHG emissions to avoid double counting

3 2005/2010 Community GHG Inventory Update

The Ukiah community GHG Inventory for 2005 and 2010 (2005/2010 Inventory) was completed in support of the Ukiah CAP, a draft of which was prepared on March 12, 2014 but not adopted. Though the 2005/2010 Inventory was completed in accordance with the ICLEI Local Governments for Sustainability Community Protocol, some of the data sources used in Ukiah's 2005/2010 Inventory have recently been updated based on best available information and regulatory updates. These model changes may introduce artificial trends in Ukiah's GHG emissions progress when comparing the 2005/2010 Inventory to the 2022 Community GHG Inventory quantified in the above sections of this report. To allow cross-comparison of Ukiah's GHG inventories, the 2005/2010 Inventory was updated to use the latest data sources and align accounting methods with those used in the Ukiah 2022 Community GHG Inventory. Additionally, fugitive emissions from the closed City landfill were excluded in the process of updating the 2005/2010 Inventory based on best practice GHG accounting and standards set by the Community Protocol. Updating the 2005 and 2010 inventories to align with 2022 Community GHG Inventory methodology provides a more accurate baseline of comparison which is critical for City of Ukiah staff to accurately track Ukiah's progress towards achieving its community GHG emissions reduction goals. The sections below outline the data sources and accounting methods used to update the Ukiah 2005/2010 GHG Inventory.

3.1 2005/2010 Community GHG Inventory Updates

3.1.1 Global Warming Potential

The 2005/2010 Inventory was completed using GWPs from the IPCC Second Assessment Report.[15] The GWPs used in the inventory are outdated and inconsistent with the AR5 GWPs used in the CARB 2022 Scoping Plan and the 2022 Community GHG Inventory (see Section 2.1.1). Therefore, the 2005/2010 Inventory was updated across all GHG emission sectors to use AR5 GWPs to improve consistency and traceability of emissions with State GHG reduction goals.

3.1.2 Energy

Electricity

The 2005/2010 Community Inventory included electricity consumption from residential and nonresidential buildings as well as electricity transmission and distribution losses, however, emissions factors were calculated using ICLEI default factors and excluding emissions from non-carbon free eligible renewable sources (i.e. geothermal and biomass), which resulted in under-reporting emissions associated with electricity consumption by approximately 50 percent. The CEC includes fossil-based GHG emissions as well as emissions from non-carbon-free renewable energy when determining the emissions factor for an electric grid portfolio.[16] To align with CEC

[15] Intergovernmental Panel on Climate Change (IPCC). 1995. AR5 Synthesis Report: Climate Change 2014. Available at: https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_sar_wg_I_full_report.pdf

[16] California Energy Commission (CEC). 2020. Modification of Regulations Governing the Power Source Disclosure Program. Available at: https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/power-source-disclosure-resources

methodology and current best practices used to quantify the 2022 Community GHG Inventory, electricity emissions factors were updated following fuel and feedstock type emissions factor determination methods outlined in Table 2 and using 2005 and 2010 grid mix data as provided the City. The results of the 2005/2010 Community Inventory update for electricity sector emissions is provided in Table 17.

Table 17 2005/2010 Electricity GHG Emissions Update

	GHG Emissions [MT CO_2e]	
Sector	**Original**	**Update**
2005 Inventory		
Residential Electricity	1,918	3,733
Residential Electricity T&D[1]	–	131
Nonresidential Electricity	4,323	8,418
Nonresidential Electricity T&D[1]	–	295
2010 Inventory		
Residential Electricity	1,679	3,720
Residential Electricity T&D[1]	–	130
Nonresidential Electricity	3,212	7,119
Nonresidential Electricity T&D[1]	–	249

Notes:
1. T&D in the original 2005/2010 Community GHG Inventory is included but aggregated into total GHG emissions.

Natural Gas

The 2005/2010 Community Inventory included emissions attributable to the combustion of natural gas, but excluded losses associated with natural gas distribution and end use. Though ICLEI does not provide a recommended methodology for estimating natural gas distribution losses, it is a recommended source of emissions under the Community Protocol to be included in community inventories as it may be directly impacted by community activities. Thus, the 2005/2010 Community Inventory was updated to include natural gas losses associated with distribution and end use in accordance with Equation **2.3** and Equation **2.4** above using natural gas residential and commercial activity data from the Ukiah 2014 Climate Action Plan. A comparison of original inventory natural gas GHG emissions and the results of the 2005/2010 Community Inventory update are summarized in Table 18 below.

Table 18 2005/2010 Natural Gas GHG Emissions Update

	GHG Emissions [MT CO_2e]	
Sector	**Original**	**Update**
2005 Inventory		
Residential Natural Gas	14,370	14,265
Residential Natural Gas Leaks	–	4,011
Nonresidential Natural Gas	9,658	9,587
Nonresidential Natural Gas Leaks	–	2,696
2010 Inventory		

Sector	GHG Emissions [MT CO_2e]	
	Original	Update
Residential Natural Gas	14,490	14,384
Residential Natural Gas Leaks	–	4,044
Nonresidential Natural Gas	9,231	9,164
Nonresidential Natural Gas Leaks	–	2,576
Notes:		

3.1.3 Transportation

On-road

On-road vehicle transportation emissions in the original 2005/2010 Community Inventory were quantified based on vehicle miles travelled (VMT) data pulled from the 2010 baseline year MCOG Travel Demand model and allocated into speed bins. The inventory used weighted average CO_2 emissions factors from the CARB EMFAC2011 model, while CH_4 and N_2O emissions factors were sourced from the Community Protocol default factors and weighted according to Community Protocol default vehicle class mix values.

The 2005/2010 Community Inventory was updated to quantify on-road transportation GHG emissions in alignment with methods used in the Ukiah 2022 Community GHG Inventory (see Equation **2.5**). Though the model has not been updated since the 2010 version, updated activity data for 2005 and 2010 based on MCOG Travel Demand model was provided by GHD based on current best practices in VMT accounting and allocated to passenger, commercial, and bus vehicle categories according EMFAC2021[17] percent vehicle share of total VMT. Activity data for 2010 was adjusted by GHD to reflect fewer daily trips due to reduced employment during the recession that followed the 2008 financial collapse. Emissions factors pulled from EMFAC2021 per vehicle class type were used to align on-road transportation GHG emissions with the latest vehicle emissions accounting methods. Table 19 summarizes the results of the 2005/2010 inventory updates for on-road transportation emissions.

Table 19 2005/2010 On-road Transportation GHG Emissions Update

Sector	GHG Emissions [MT CO_2e]	
	Original	Update
2005 Inventory		
Passenger Total VMT	74,477	53,592
Commercial Total VMT		24,880
Bus Total VMT		352
Passenger EVMT	–	2
Commercial EVMT	–	0
Bus EVMT	–	0
2010 Inventory		

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

Sector	GHG Emissions [MT CO_2e]	
	Original	Update
Passenger Total VMT	73,896	50,580
Commercial Total VMT		22,389
Bus Total VMT		598
Passenger EVMT	–	3
Commercial EVMT	–	0
Bus EVMT	–	0
Notes:		

Off-road

The 2005/2010 Inventory was developed using the CARB OFFROAD2007 model to estimate GHG emissions in the off-road sector. Emissions from lawn and garden equipment activity data were apportioned to Ukiah based on the proportion of households in Ukiah compared to the county, while construction, industrial, and light commercial equipment were apportioned based on population. The 2005/2010 Inventory was updated to use activity data from the latest OFFROAD2021[18] model and apportion fuel use across all off-road equipment classes according to Table 9 in alignment with the 2022 Community GHG Inventory. GHG emissions were quantified using emissions factors provided by the EPA Emission Factors Hub[19] for each equipment category. Table 20 summarizes the results of the 2005/2010 inventory updates for off-road transportation emissions.

Table 20 2005/2010 Off-road Transportation GHG Emissions Update

Sector	GHG Emissions [MT CO_2e]	
	Original[1]	Update
2005 Inventory		
Diesel	8,530	422
Gasoline		1,519
Natural Gas		0
2010 Inventory		
Diesel	8,436	508
Gasoline		1,474
Natural Gas		0

Notes:

1. GHG emissions includes off-road agricultural equipment which was quantified as a separate sector in the original inventory

[18] California Air Resource Board (CARB). Mobile Source Emissions Inventory Off-road (OFFROAD2021) v.1.0.5. Available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-road-documentation-0

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

3.1.4 Solid Waste

The 2005/2010 Community Inventory included fugitive emissions from solid waste generated by the community as well as fugitive emissions from a closed landfill that exists within the boundaries of Ukiah. To avoid double counting emissions, the Community Protocol recommends only including fugitive emissions associated with community waste generation. Therefore, the 2005/2010 Community Inventory was updated to exclude emissions from the closed landfill. Additionally, in the 2005/2010 Community Inventory the EPA LandGEM model was used to quantify fugitive emissions from generated solid waste. Though the EPA's LandGEM model uses the first order decay method as recommended by the Community Protocol, it is inconsistent with the 2022 Community Inventory which utilizes Community Protocol quantification methods and default factors. To establish consistency in Ukiah's waste sector emissions, adhere to Community Protocol recommendations, and align with State emissions reporting methods, the 2005/2010 Community Inventory was updated to quantify fugitive GHG emissions in accordance with Equation **2.8**.

The 2005/2010 Community Inventory did not take into consideration landfill process emissions which is a recommended GHG emissions source under the Community Protocol. To align with Community Protocol recommendations and maintain consistency with the 2022 Community Inventory, landfill process emissions were included in the inventory update and quantified according to Equation **2.9**. A comparison of the original solid waste GHG emissions estimates and the results of the 2005/2010 Community Inventory update are summarized in Table 21 below.

Table 21 2005/2010 Solid Waste GHG Emissions Update

	GHG Emissions [MT CO_2e]	
Sector	**Original**	**Update**
2005 Inventory		
Landfill Methane	4,722	6,332
Process Emissions	–	184
Landfill Methane (closed)	36,934	–
2010 Inventory		
Landfill Methane	2,641	3,541
Process Emissions	–	103
Landfill Methane (closed)	30,543	–

Notes:

3.1.5 Water

As described in Section 2.1.5, the City provides the entirety of the community's water needs and therefore GHG emissions from water processes was excluded from the 2022 Community GHG Inventory to avoid double counting with emissions from nonresidential electricity consumption. It is similarly anticipated that nonresidential electricity use reported in the original 2005/2010 Community GHG Inventory includes electricity consumption attributable to City water supply operations. Therefore, water sector GHG emission were removed from the 2005/2010 Community GHG Inventory update to avoid double counting.

3.1.6 Wastewater

Prior to completion of its 2019 treatment operation upgrades, the City's wastewater treatment plant processed wastewater using digesters with stationary combustion and treatment processes without nitrification/denitrification. Treated wastewater produced by the plant was discharged as effluent into the Russian river.[20] Wastewater sector GHG emissions in the original 2005/2010 Community GHG Inventory were calculated appropriately according to the Community Protocol and were not updated. However, the population demographic activity data used to quantify GHG emissions from wastewater process N_2O and effluent discharge was updated to be consistent with demographic data sources used in the 2022 Community GHG Inventory. Table 22 below summarizes the results of the 2005/2010 inventory updates for wastewater emissions.

Table 22 2005/2010 Wastewater GHG Emissions Update

	GHG Emissions [MT CO_2e]	
Sector	**Original**	**Update**
2005 Inventory[1]		
Stationary Combustion	377.3	0.7
Process N2O Emissions		13.5
Effluent Discharge Fugitive N2O		309.8
2010 Inventory		
Stationary Combustion	0.7	0.7
Process N2O Emissions	15.6	13.5
Effluent Discharge Fugitive N2O	356.1	308.3

Notes:

1. Solid Waste emissions for the 2005 inventory were back-casted from total wastewater sector 2010 GHG emissions based on population and housing demographic data and therefore does not report GHG emissions per sector.

[20] City of Ukiah. 2021. 2020 Urban Water Management Plan (UWMP). Provided by the City via email on August 31, 2023.

3.2 2005/2010 Community GHG Inventory Results

Figure 3 2005 Updated Inventory GHG Emissions by Sector

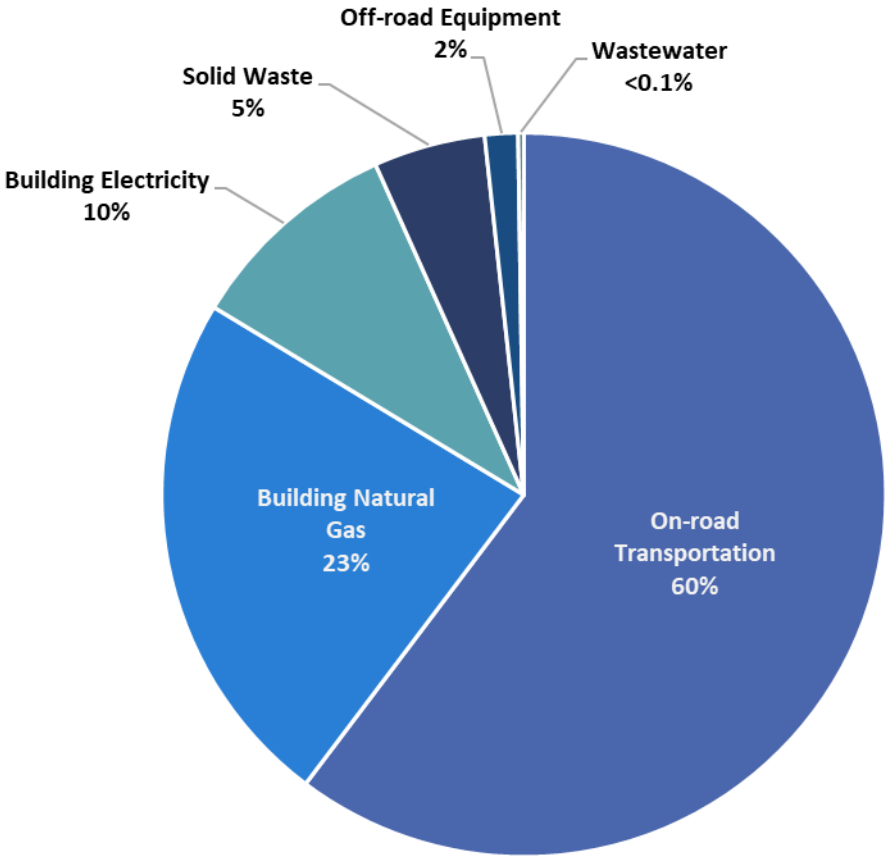

Table 23 2005 Community GHG Emissions Inventory

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
Energy	Residential Electricity	32,643,291	kWh	0.000114	MT CO_2e/kWh	3,733
	Residential Electricity T&D	1,143,166	kWh	0.000114	MT CO_2e/kWh	131
	Nonresidential Electricity	73,612,798	kWh	0.000114	MT CO_2e/kWh	8,418
	Nonresidential Electricity T&D	2,576,448	kWh	0.000114	MT CO_2e/kWh	295
	Residential Natural Gas	2,685,714	therms	0.005311	MT CO_2e/therm	14,265
	Residential Natural Gas Leaks	75,578	therms	0.053067	MT CO_2e/therm	4,011

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
	Nonresidential Natural Gas	1,805,047	therms	0.005311	MT CO_2e/therm	9,587
	Nonresidential Natural Gas Leaks	50,795	therms	0.053067	MT CO_2e/therm	2,696
Transportation	Passenger VMT	120,431,986	VMT	0.000445	MT CO_2e/mile	53,592
	Commercial VMT	19,590,355	VMT	0.001270	MT CO_2e/mile	24,880
	Bus VMT	226,557	VMT	0.001555	MT CO_2e/mile	352
	Passenger EVMT	18,599	kWh	0.000057	MT CO_2e/kWh	2
	Commercial EVMT	0	kWh	0.000057	MT CO_2e/kWh	0
	Bus EVMT	0	kWh	0.000057	MT CO_2e/kWh	0
	Off-road Diesel	40,261	Gallons	0.010472	MT CO_2e/gal	422
	Off-road Gasoline	166,107	Gallons	0.009146	MT CO_2e/gal	1,519
	Off-road Natural Gas	0	Gallons	0.000000	MT CO2e/gal	0
Solid Waste	Landfill Methane	16,750	Wet short tons	0.378000	MT CO_2e/ton	6,332
	Process Emissions	16,750	Wet short tons	0.011000	MT CO_2e/ton	184
Wastewater	Stationary Combustion	4,140,432	scf	0.0000002	MT CO_2e/scf	1
	Process N2O Emissions	15,960	persons	0.000848	MT CO_2e/person	14
	Effluent Discharge Fugitive N2O	15,960	persons	0.019413	MT CO_2e/person	310
Water[1]	Groundwater	-	kWh	-	MT CO_2e/kWh	-
	Surface Water	-	kWh	-	MT CO_2e/kWh	-
Total						**130,743**

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

1. Water sector activity data is included for informational purposes but is not included in total inventory GHG emissions to avoid double counting

Figure 4 2010 Updated Inventory GHG Emissions by Sector

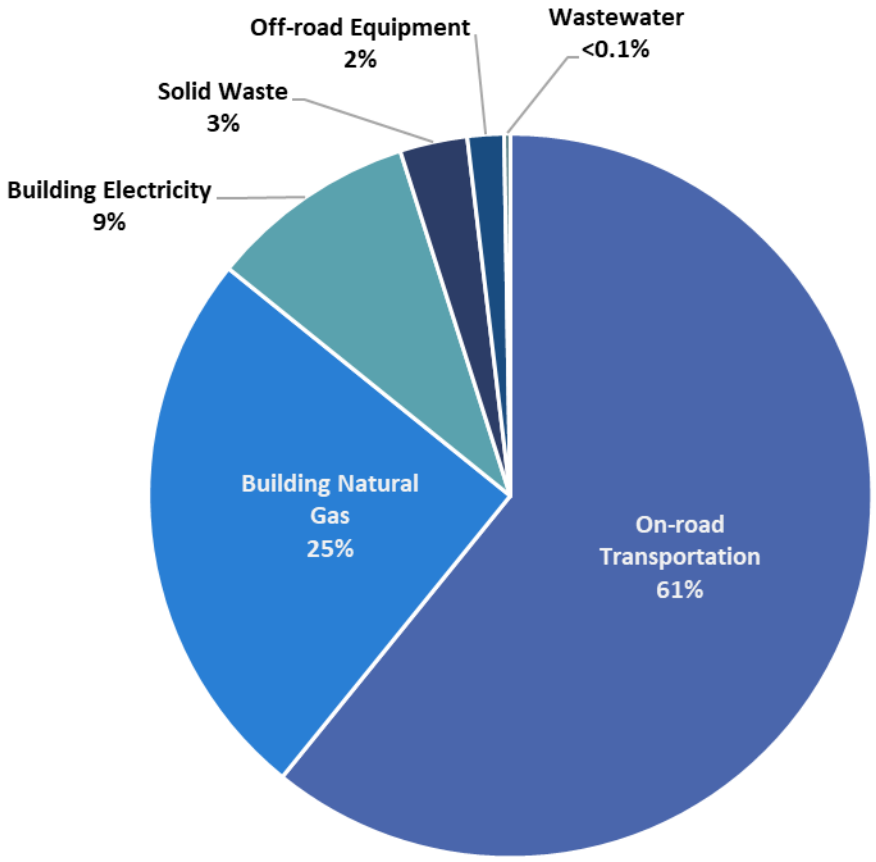

Table 24 2010 Community GHG Emissions Inventory

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
Energy	Residential Electricity	36,583,840	kWh	0.000102	MT CO_2e/kWh	3,720
	Residential Electricity T&D	1,281,379	kWh	0.000102	MT CO_2e/kWh	130
	Nonresidential Electricity	70,017,335	kWh	0.000102	MT CO_2e/kWh	7,119
	Nonresidential Electricity T&D	2,450,609	kWh	0.000102	MT CO_2e/kWh	249
	Residential Natural Gas	2,708,159	therms	0.005311	MT CO_2e/therm	14,384
	Residential Natural Gas Leaks	76,210	therms	0.053067	MT CO_2e/therm	4,044
	Nonresidential Natural Gas	1,725,280	therms	0.005311	MT CO_2e/therm	9,164

GHG Emissions Sector	GHG Emissions Subsector	Activity Data		Emission Factor		GHG Emissions (MT CO_2e)
	Nonresidential Natural Gas Leaks	48,551	therms	0.053067	MT CO_2e/therm	2,576
Transportation	Passenger VMT	116,543,060	VMT	0.000434	MT CO_2e/mile	50,580
	Commercial VMT	18,321,286	VMT	0.001222	MT CO_2e/mile	22,389
	Bus VMT	382,721	VMT	0.001562	MT CO_2e/mile	598
	Passenger EVMT	26,994	kWh	0.000044	MT CO_2e/kWh	3
	Commercial EVMT	0	kWh	0.000044	MT CO_2e/kWh	0
	Bus EVMT	67	kWh	0.000044	MT CO_2e/kWh	0
	Off-road Diesel	48,514	Gallons	0.010473	MT CO_2e/gal	508
	Off-road Gasoline	161,156	Gallons	0.009146	MT CO_2e/gal	1,474
	Off-road Natural Gas	0	Gallons	0.000000	MT CO2e/gal	0
Solid Waste	Landfill Methane	9,369	Wet short tons	0.378000	MT CO_2e/ton	3,541
	Process Emissions	9,369	Wet short tons	0.011000	MT CO_2e/ton	103
Wastewater	Stationary Combustion	4,119,418	scf	0.0000002	MT CO_2e/scf	1
	Process N2O Emissions	15,879	persons	0.000848	MT CO_2e/person	13
	Effluent Discharge Fugitive N2O	15,879	persons	0.019413	MT CO_2e/person	308
Water[1]	Groundwater	-	kWh	-	MT CO_2e/kWh	-
	Surface Water	-	kWh	-	MT CO_2e/kWh	-
Total						**120,905**

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

1. Water sector activity data is included for informational purposes but is not included in total inventory GHG emissions to avoid double counting

4 Community GHG Inventories Comparison

The table below presents the comparative summary of GHG emissions results for the Ukiah 2005, 2010, and 2022 Community GHG inventories. Emissions dropped significantly between the years of 2005 and 2010 primarily due to a large decrease in the tons of waste sent to landfill as well as decreased VMT in 2010 that occurred as a result of increased unemployment related to the 2008 economic recession. Notably, community GHG emissions rose to above 2005 levels in 2022 largely as a result of increased electricity sector emissions. This increase is attributable to significant changes in Ukiah's electric utility grid mix in which 46.20 percent of energy was sourced from unspecified power supplies in the 2022 inventory year. The notable rise may be attributable to the passing of Assembly Bill 1110, which changes CEC methodology for classifying unspecified power beginning in the 2019 power disclosure reporting year. According to these changes, unspecified power encompasses electricity that lacks traceability to specific generation sources through an auditable contract trail or equivalent. This includes energy initially obtained as a bundled eligible renewable product, where the associated Renewable Energy Credits (RECs) are subsequently resold separately as unbundled RECs. It also includes electricity from traceable open market transactions which have no upfront contractual intention to procure electricity from a specified resource. Despite diverse electricity sources falling under unspecified power, unspecified power is attributed to an emissions factor akin to that of a natural gas generator by the CEC.[21] Therefore, as Ukiah brings more traceable renewable energy sources online to meet regional renewable portfolio goals, a decrease in Ukiah's future electric grid emissions factor and, thus, a decrease in overall GHG emissions is anticipated.

[21] California Energy Commission (CEC). 2023. PSD Frequently Asked Questions. Available at: https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure-program/psd-frequently-asked-questions

Figure 5 Ukiah Community Inventory GHG Emissions Comparison by Sector

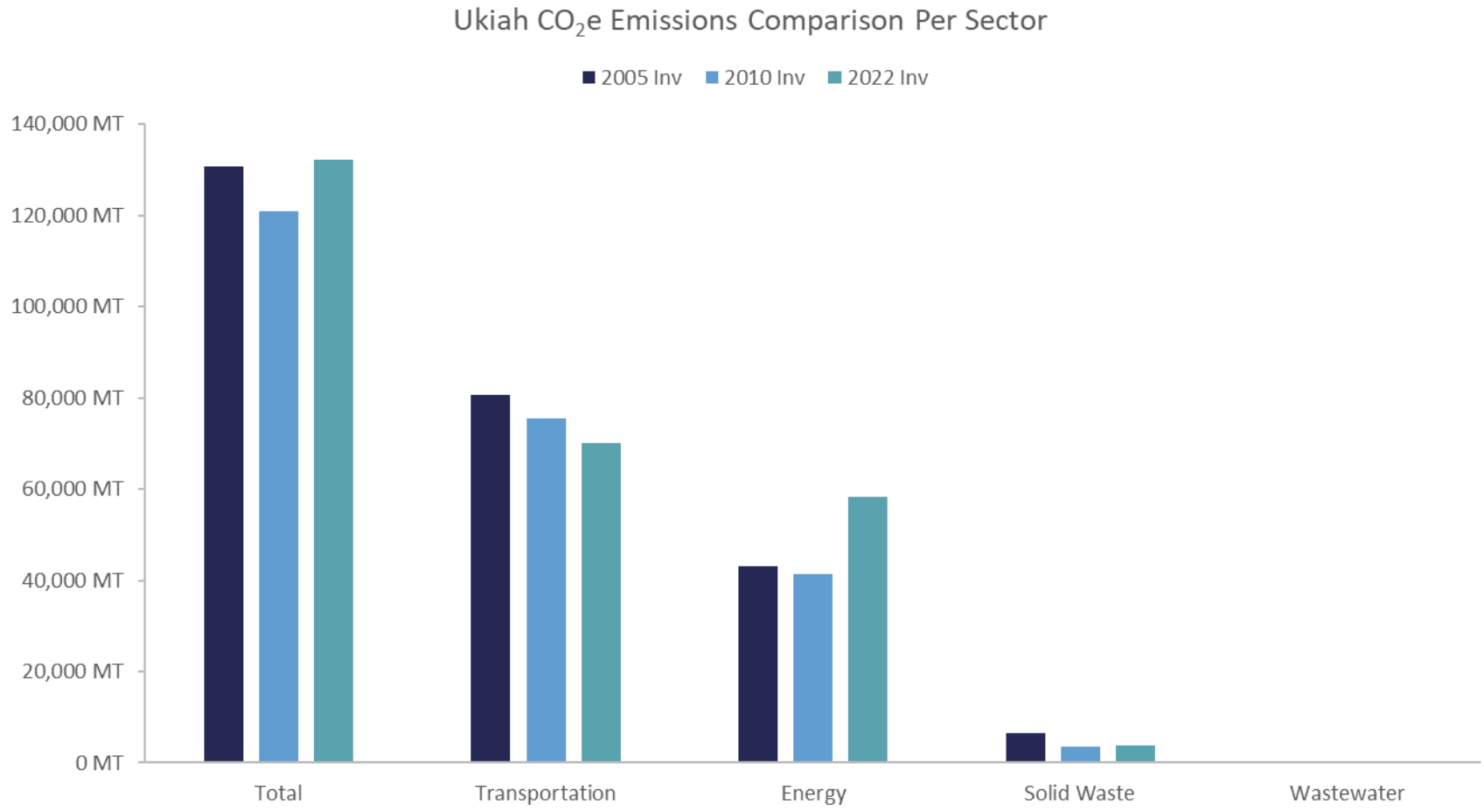

Table 25 Comparative Community GHG Emissions Inventories Summary

GHG Emissions Sector	GHG Emissions Subsector	GHG Emissions ($MT CO_2e$)		
		2005	2010	2022
Energy	Residential Electricity	3,733	3,720	9,841
	Residential Electricity T&D	131	130	418
	Nonresidential Electricity	8,418	7,119	19,372
	Nonresidential Electricity T&D	295	249	799
	Residential Natural Gas	14,265	14,384	12,345
	Residential Natural Gas Leaks	4,011	4,044	3,471
	Nonresidential Natural Gas	9,587	9,164	9,458
	Nonresidential Natural Gas Leaks	2,696	2,576	2,659
Transportation	Passenger VMT	53,592	50,580	43,890
	Commercial VMT	24,880	22,389	21,979
	Bus VMT	352	598	455
	Passenger EVMT	2	3	300
	Commercial EVMT	0	0	0
	Bus EVMT	0	0	0
	Off-road Diesel	422	508	1,742
	Off-road Gasoline	1,519	1,474	1,684
	Off-road Natural Gas	0	0	0
Solid Waste	Landfill Methane	6,332	3,541	3,764
	Process Emissions	184	103	110
Wastewater	Stationary Combustion	1	1	1
	Process N2O Emissions	14	13	30
	Effluent Discharge Fugitive N2O	310	308	-
Water	Groundwater	-	-	-
	Surface Water	-	-	-
Total		**130,743**	**120,905**	**132,323**

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