# Memo

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**To:** Christopher Jordan and Carrie Whitlock (City of Elk Grove)

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**Subject:** City of Elk Grove Climate Compass: Final Greenhouse Gas Inventory Update Technical Memorandum

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# 1 INTRODUCTION

The City of Elk Grove (City) is updating its Climate Action Plan (CAP) to provide a comprehensive and transformative framework for both mitigating and adapting to climate change while also supporting the City's broader sustainability and resilience goals. The CAP was last comprehensively updated in 2019. This technical memorandum (memo) describes the major greenhouse gas (GHG) emission sources and activities for community and City operations (i.e., municipal operations) in the year 2021 and is the first step in the climate action planning update process. The community and City operations GHG inventories will be used to inform the *Climate Compass: A Plan for Implementing Elk Grove's Climate, Sustainability, and Resilience Goals* (Climate Compass), the update to the City's CAP. The Climate Compass will serve as a roadmap for reducing local GHG emissions across various sectors while building resilience to future impacts posed by climate change.

## 1.1 INVENTORY PURPOSE AND DESCRIPTION

The first step in a city's climate action planning process is to develop a GHG emissions inventory, which is a snapshot of the emissions associated with activities within its jurisdiction in a given year. The purpose of an inventory is to:

- establish a baseline against which future emissions levels and future reduction targets can be measured,
- understand the sectors and sources generating GHG emissions and their relative contribution to total emissions, and
- monitor progress towards achievement of GHG reduction targets.

Preparing a GHG emissions inventory is a critical step in climate action planning. To develop and implement a plan that will effectively reduce GHG emissions, local governments must first have a comprehensive understanding of the emissions that are generated by activities within their jurisdictions. GHG emissions inventories not only serve to provide this knowledge, but they also act as the basis for measuring progress and provide agencies with a framework to track emissions over time and assess the effectiveness of actions taken to reduce emissions. Additionally, local governments often prepare inventories to exhibit accountability and leadership, motivate community action, and demonstrate compliance with regulations.

An inventory estimates GHG emissions generated from activities occurring within a defined geographic boundary during a single year. It identifies the sources, and associated sectors, that are producing these emissions and the relative contribution of each, while also providing a baseline to forecast emissions trends into the future. This information is used to set reduction targets that are consistent with State and/or local objectives and then identify local measures for reducing GHG emissions as part of a jurisdiction's climate action plan.

## 1.2 ORGANIZATION OF THIS MEMO

This memo consists of the following main sections:

- Section 2: Inventory Overview outlines considerations for preparing community and City operations GHG emissions inventories, summarizes industry-leading protocols and methods for inventories, discusses inventory boundaries, and describes the emissions sectors and sources that are included and excluded in the community GHG emissions inventory.
- Section 3: Data, Methods, and Assumptions describes the data, methods, and assumptions used in the community and City operations inventories and presents GHG emissions estimates by sector.
- Section 4: Summary of Results provides a high-level summary of community and City operations GHG emissions estimates for 2021 and compares the 2021 year to the previously surveyed 2013 community inventory and the 2019 City operations inventory.

# 2 INVENTORY OVERVIEW

## 2.1 CONSIDERATIONS FOR DEVELOPING AN INVENTORY

Nations, states, local jurisdictions, public agencies, and corporations estimate GHG emissions for different purposes. Several general approaches exist to quantify GHG emissions, and the method chosen by governments or private entities is driven by the purpose for developing an inventory. State, federal, and international agencies have developed industry protocols and recommendations for local governments preparing GHG emissions inventories at the community level.

### 2.1.1 Production-based Inventories

The GHG emissions inventory approach generally used by local governments in the climate action planning process, known as a "production-based" inventory, estimates GHG emissions generated by activities occurring within a defined boundary during a single year. This has become the standard approach recommended by industry protocols and includes emissions that are generated from community activities that occur within the jurisdictional boundary of the inventory, such as those emitted from natural gas furnaces used for heating buildings throughout a community. It also includes certain "trans-boundary" emissions that are associated with activities occurring within the inventory's boundary but are released into the atmosphere outside of the boundary. For example, electricity emissions in a production-based inventory are attributed to a community based on electricity consumption within the inventory boundary, even if the electricity was generated and produced GHG emissions outside of the inventory boundary.

This memo addresses how inventories of the city's emissions from community activities and City operations were developed using a production-based approach. This is consistent with recommendations and guidance from industry protocols (described further in Section 2.2), and State agencies, including the California Air Resources Board (CARB) and the Governor's Office of Planning and Research (OPR). Production-based inventories provide local governments with the information needed to develop effective climate action policy within their communities; because of this, the production-based inventory method is the most common approach taken by local governments across California and the nation.

## 2.2 PROTOCOLS AND METHODOLOGIES

### 2.2.1 Protocols for Accounting and Reporting of Greenhouse Gas Emissions

Several inventory protocols have been developed to provide guidance for communities and local governments to account for emissions accurately and consistently. ICLEI – Local Governments for Sustainability (ICLEI) develops protocols for local-scale accounting of emissions that have become the industry standard for local governments developing GHG emissions inventories.

The most recent guidance for community-scale emissions inventories is ICLEI's July 2019 publication *US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (Community Protocol), Version 1.2 (ICLEI 2019). State agencies, including CARB and OPR, recommend that jurisdictions prepare community GHG emissions inventories using the guidelines included in the Community Protocol (CARB 2017:100; OPR 2017:226).

The Community Protocol identifies six principles for GHG accounting and reporting. These principles were adapted from internationally recognized sources and were used to guide the development of the Community Protocol. ICLEI recommends that local governments consider the principles when preparing an inventory. The GHG accounting and reporting principles are summarized below.

- **Relevance, Including Policy Relevance, and Utility for Users**: The ultimate objective and intent of an inventory should be considered during the inventory development process. Inventories should be organized in a way that is understandable and useful for policy makers and the public while appropriately reflecting community GHG emissions and enabling the evaluation of emissions trends over time.
- **Accuracy**: The use of GHG emissions accounting methods that are expected to systematically under- or over-estimate emissions should be avoided. Decisionmakers should be able to act with reasonable assurance as to the integrity of emissions estimates.
- **Completeness**: Community GHG emissions inventories should be as comprehensive as possible and include all emissions associated with the community, as well as community GHG emissions "sinks" (i.e., the opposite of an emissions source; any reservoir, natural or otherwise, that accumulates and stores GHG emissions)[1].
- **Measurability**: Methods used to quantify GHG emissions should be readily available, adequately substantiated and of known quality, and updated regularly as established methods evolve.
- **Consistency and Comparability**: Community inventories should consistently use preferred, established methods to enable tracking of emissions over time, evaluation of reduction measures effectiveness, and comparison between communities. Alternative methods should be documented and disclosed.
- **Transparency**: All relevant data sources, methods, and assumptions should be disclosed and described to allow for future review and replication. Similarly, all relevant issues should be documented and addressed coherently.

Consistent with the above principles, as well as industry standards and best practices, the City's inventory of GHG emissions from community activities primarily follows methodologies provided by the Community Protocol. It also follows methodologies from CARB for certain sectors and sources not included in the Community Protocol.

ICLEI has also developed guidance to assist local governments in conducting inventories of emissions from their municipal operations. The City's municipal operations inventory follows methodologies from ICLEI's latest technical guidance in its May 2010 publication *Local Government Operations Protocol (LGOP) for the Quantification and Reporting of Greenhouse Gas Emissions Inventories* (ICLEI 2010).

### 2.2.2 California Air Resources Board Methods

Each year, CARB develops and publishes the California GHG Emission Inventory Data for emissions statewide in California. CARB follows Intergovernmental Panel on Climate Change (IPCC) guidelines for national reporting, and its overarching approach and many of its methods align with the Community Protocol. As climate change science and GHG emissions accounting practices have evolved, CARB has implemented additional methodologies for certain emissions sectors and sources that are not included in the Community Protocol.

The inventory is aligned with the CARB inventory as much as possible. Consistency with the State's methodologies and approaches will be beneficial for upcoming phases of the Climate Compass development process, including estimating projected GHG emissions in the future (i.e., forecasting emissions), setting GHG emissions reduction targets, and measuring progress towards established targets.

The City's inventories use methods provided by CARB and the California GHG Emission Inventory for several emissions sectors and sources. For example, although the Community Protocol recommends using the US Environmental Protection Agency's (EPA) NONROAD model, emissions from off-road vehicles and equipment in the city were obtained from CARB's OFFROAD model, which provides more geographic-specific emissions estimates for California using the best available data.

1 This GHG emissions inventory and the City's Climate Compass focus on emissions sources; they do not incorporate an analysis of emissions sinks.

## 2.3 EMISSIONS SECTORS AND SOURCES

There are several approaches for categorizing and grouping GHG emissions in inventories. Generally, community GHG emissions are organized into emissions sectors, which typically include:

- Building energy
- Transportation
- Solid waste
- Water
- Wastewater

Sometimes, community sectors are broken down further, such as residential building energy and nonresidential building energy, and sectors may also be combined, such as water and wastewater. Local governments may also include additional relevant sectors, such as agriculture.

Municipal GHG emissions are also organized into emissions sectors, which typically include:

- Building and facilities
- Streetlights and traffic signals
- Employee commute
- Vehicle fleet
- Solid waste
- Water supply
- Wastewater treatment

The purpose of categorizing GHG emissions into broad sectors is to provide local governments and the public with a useful organization of community emissions. Importantly, GHG emissions sectors may not align directly with economic sectors (e.g., hospitality), but there may be overlap for some communities.

Within GHG emissions sectors, emissions are generated in a variety of ways. For example, motor vehicles burn fossil fuels and emit GHGs directly into the atmosphere; the electricity used in homes and businesses produces indirect emissions from power plants; and solid waste that ends up in landfills breaks down and releases GHG emissions over time. The Community Protocol organizes different types of community GHG emissions into two general categories:

- GHG emissions **sources** are those that release emissions directly into the atmosphere as a result of any physical process that occurs within the jurisdictional boundary of the inventory. Natural gas combustion for heating in homes and diesel fuel combustion in motor vehicles within the community are examples of GHG emissions sources.
- GHG emissions **activities** are those that release emissions into the atmosphere either directly or indirectly as a result of the use of energy, materials, and/or services within the community. For example, GHG emissions from a community's electricity use are accounted for and considered GHG emissions activities, even if the burning of fossil fuels to generate the electricity occurred and produced emissions outside of the inventory boundary.

For the sake of clarity, this memo uses "GHG emissions sources" to represent both direct in-boundary emissions *sources* as well as indirect emissions that are produced out-of-boundary as a result of *activities* that occur within the community. The GHG emissions sources in the City's community inventory are organized under seven sectors: building energy, on-road transportation, off-road vehicles and equipment, solid waste, water supply, wastewater treatment, and agriculture. The GHG emissions sources in the City's municipal inventory are organized under eight sectors: buildings and facilities, streetlights and traffic signals, employee commute, vehicle fleet, solid waste, water supply, wastewater treatment, and process and fugitive.

### 2.3.1 Community Protocol-Compliant Sources

When developing a community inventory, it is important for local governments to determine what will be included in the inventory scope. This may be influenced by factors such as the purpose and intended narrative of the inventory, the reporting framework that will be used, and the GHG emissions sources present in the community. While local governments have some flexibility in determining an inventory's scope, the Community Protocol requires the inclusion of a minimum of five emissions sources in community inventories:

1. Use of electricity by the community.
2. Use of fuel in residential and commercial stationary combustion equipment.
3. On-road passenger and freight motor vehicle travel.
4. Use of energy in potable water and wastewater treatment and distribution.
5. Generation of solid waste by the community.

The Community Protocol strongly encourages local governments to include other emissions-generating sources in accounting and reporting as well. Considerations for including additional sources are outlined in the following section.

### 2.3.2 Additional Sources

Many local governments go beyond the minimum requirements of the Community Protocol. Beyond the five emissions sources required by the Community Protocol, the additional GHG emissions sources included in a community inventory are determined by the jurisdiction conducting the inventory. The Community Protocol recommends the Local Government Significant Influence reporting framework, where local governments account for all emissions sources over which they have authority or significant influence. The additional sources included in the community inventory are off-road vehicles, and equipment and agriculture. This approach benefits the overall climate action planning process because it emphasizes the emissions sources that the local government has the greatest ability to address (ICLEI 2019:29).

## 2.4 BOUNDARIES

The scope and boundary chosen for estimating GHG emissions may vary depending on the focus and/or intent of the inventory. For example, while corporate inventories use the concept of ownership to guide GHG emissions accounting—where emissions generated by all sources and activities owned by the entity are accounted for, regardless of where emissions are produced—community-scale inventories serve to convey information about emissions associated with politically defined communities (ICLEI 2019:12).

As described in the previous sections, production-based community inventories include emissions that are produced within a community's geographic boundary as well as those that are produced outside the boundary but result from activities within the community. Regardless of location within or outside of a community's boundary, upstream emissions generated by the consumption of goods and services are excluded from production-based inventories. Inventories following the Community Protocol are required to include several emissions sources; however, certain emissions sources that are located within the inventory boundary may be excluded from a community inventory. The following section outlines considerations and the decision-making framework for determining what GHG emissions sources are included or excluded from an inventory.

### 2.4.1 Inventory Boundaries

The Climate Compass aims to reduce GHG emissions from sources within the city for which the City has operational control, regulatory authority, or significant influence. As a result, the City's inventories include emissions generated from activities that occur within the boundaries of the city and over which the City has operational control, regulatory authority, or significant influence. The inventories do not include emissions generated from activities located within the city's boundary but outside of its jurisdiction, as the City does not have operational control, regulatory authority, or significant influence over these emissions sources. For example, industrial facilities regulated by California's Cap-and-Trade program are overseen by the State and are therefore not included in the inventory. In Elk Grove, this would include the Carson Cogeneration Project.

The GHG emissions sectors and sources included and excluded in the 2021 community and City operations inventories are presented in Table 1. Additionally, Table 1 identifies the protocol that provided the methodology for estimating GHG emissions from each emissions source. Emissions sources that identify multiple protocols used a combination of data and methods from multiple protocols. For example, off-road vehicles and equipment calculations used methods consistent with IPCC and the Community Protocol but substitute California-specific data obtained from CARB for less geographic-specific data provided by the protocols.

**Table 1 2021 Elk Grove Summary of Sectors and Sources in Community and City Operations Inventories**

| Sector/Source | Included | Excluded | Protocol(s) |
|---|---|---|---|
| Community Inventory | | | |
| On-Road Transportation | | | |
| *On-Road Transportation* | Emissions from 100 percent of vehicle trips within the city (internal-internal) and 50 percent of vehicle trips starting or ending outside the city (internal-external and external-internal) | Emissions from 100 percent of pass-through vehicle trips starting and ending outside the city (external-external) | Community Protocol |
| Building Energy | | | |
| *Electricity* | Emissions associated with all electricity consumed within the city | NA | Community Protocol |
| *Natural Gas* | Emissions from natural gas consumed within the city | NA | Community Protocol |
| *Backup Generators* | Emissions from diesel, natural gas, and gasoline consumed in backup generators within the city | NA | Community Protocol |
| Solid Waste | | | |
| *Community-Generated Solid Waste* | Emissions from all waste generated within the city | NA | ClearPath |
| *Composting* | Emissions from compost generated within the city | NA | CARB |
| Off-Road Vehicles and Equipment | | | |
| *Off-Road Vehicles and Equipment* | Emissions from off-road vehicles and equipment within the city | NA | Community Protocol/CARB |
| Wastewater Treatment | | | |
| *Wastewater Treatment* | Emissions associated with wastewater generated within the city | NA | Community Protocol |
| Water Supply | | | |
| *Water Supply* | Emissions associated with water use within the city | NA | Community Protocol |
| Agriculture | | | |
| *Livestock Management* | Emissions associated with manure management practices and enteric fermentation from livestock within the city | NA | Community Protocol |

| Sector/Source | Included | Excluded | Protocol(s) |
|---|---|---|---|
| *Fertilizer Application* | Emissions associated with fertilizer use within the city | NA | CARB/IPCC |
| *Agricultural Equipment – Off-Road Vehicles and Equipment* | Emissions from agricultural off-road vehicles and equipment within the city | NA | Community Protocol/CARB |
| *Agricultural Building Energy* | Emissions associated with all electricity consumed from agricultural operations within the city | NA | Community Protocol |
| City Operations Inventory | | | |
| Buildings and Facilities | | | |
| *Electricity* | Emissions associated with electricity consumed from City operations | NA | LGOP |
| *Natural Gas* | Emissions from natural gas consumed from City operations | NA | LGOP |
| *Backup Generators* | Emissions from diesel consumed in backup generators from City facilities | NA | LGOP |
| Streetlights and Traffic Signals | | | |
| *Electricity* | Electricity used for streetlights and traffic signals within the city | NA | LGOP |
| Employee Commute | | | |
| *VMT* | VMT from City employee commute trips | NA | LGOP |
| Vehicle Fleet | | | |
| *VMT* | VMT from City owned and operated on-road vehicles | NA | LGOP |
| Solid Waste | | | |
| *Solid Waste Disposed* | Emissions from all waste generated by City facilities | NA | ClearPath |
| *Composting* | Emissions from compost generated by City facilities | NA | CARB |
| Wastewater Treatment | | | |
| *Wastewater Treatment* | Emissions associated with wastewater generated by City facilities | NA | LGOP |
| Water Supply | | | |
| *Water Supply* | Emissions associated with water use from City facilities | NA | LGOP |
| Process and Fugitive | | | |
| *Process and Fugitive* | Emissions associated with leakage in the local natural gas distribution system | NA | ClearPath |

Notes: CARB = California Air Resources Board; Community Protocol = US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions; IPCC = Intergovernmental Panel on Climate Change; LGOP = Local Government Operations Protocol; NA = not applicable; VMT = vehicle miles traveled.

Source: Compiled by Ascent in 2023.

# 3 DATA, METHODS, AND ASSUMPTIONS

## 3.1 OVERVIEW OF ACTIVITY DATA AND EMISSIONS FACTORS

The basic calculation for estimating GHG emissions involves two primary inputs: activity data and emissions factors. Activity data refer to the relevant measurement of an activity resulting in emissions, and emissions factors represent the amount of GHGs emitted on a per unit of activity basis. Emissions factors are applied to activity data (i.e., the two values are multiplied together) to estimate GHG emissions. For example, in the community residential energy sector, activity data of annual community electricity consumption in megawatt-hours (MWh) is multiplied by an emissions factor in pounds of GHG per MWh, which results in a pounds of GHG emissions value. This calculation-based methodology is used for estimating emissions from most sources in the City's production-based inventories. An overview of activity data and emissions factors for each emissions source, along with data sources, is shown in Table 2. Detailed methods are described in the following sections.

**Table 2 2021 Elk Grove Summary of Activity Data and Emissions Factors**

| Sector/Source | Input Type | Description and Data Sources |
|---|---|---|
| **Community** | | |
| On-Road Transportation | | |
| *On-Road Transportation* | Activity data | VMT data from Fehr & Peers |
| | Emissions factor | Sacramento County-specific emissions factors from CARB |
| Building Energy | | |
| *Electricity* | Activity data | Electricity consumption data from SMUD |
| | Emissions factor | Utility-specific emissions factor from TCR and EPA |
| *Natural Gas* | Activity data | Natural gas consumption data from PG&E |
| | Emissions factor | Average emissions factors from TCR |
| *Backup Generators* | Activity data | Fuel consumption data from SMAQMD |
| | Emissions factor | Average emissions factors from TCR |
| Solid Waste | | |
| *Community-Generated Solid Waste* | Activity data | Waste disposal data from the City |
| | Emissions factor | California-specific solid waste emissions factors from ClearPath |
| *Composting* | Activity data | Organic waste tonnage data from the City |
| | Emissions factor | Composting emissions factors from CARB |
| Off-Road Vehicles and Equipment | | |
| *Off-Road Vehicles and Equipment* | Activity data<br>Emissions factor | Off-road vehicles and equipment activity and emissions factors data from CARB |
| Wastewater Treatment | | |
| *Wastewater Treatment* | Activity data | Wastewater generation and process-related data from SRWTP and septic system data from SCPH |
| | Emissions factor | Emissions factors based on treatment processes from ICLEI |
| Water Supply | | |
| *Water Supply* | Activity data | Electricity consumption data from EGWD and SCWA |

| Sector/Source | Input Type | Description and Data Sources |
|---|---|---|
| | Emissions factor | Utility-specific emissions factors from TCR and EPA |
| **Agriculture** | | |
| *Livestock Management* | Activity data | Livestock population data from the 2021 Sacramento County Crop Report and US Department of Agriculture's 2017 Census of Agriculture |
| | Emissions factor | Emissions factors by applicable livestock type from CARB |
| *Fertilizer Application* | Activity data | CFDA 2021 Fertilizer Tonnage Report |
| | Emissions factor | Fertilizer emissions factors from CARB |
| *Agricultural Equipment – Off-road Vehicles and Equipment* | Activity data | Off-road vehicles and equipment activity data and emissions factors from CARB |
| | Emissions factor | |
| *Agricultural Equipment – Irrigation Pumps* | Activity data | Diesel-powered irrigation pump data from SMAQMD |
| | Emissions factor | Emission Factors from CARB |
| *Agricultural Building Energy* | Activity data | Electricity consumption data from SMUD |
| | Emissions factor | Utility-specific emissions factor from TCR and EPA |
| **City Operations** | | |
| **Buildings and Facilities** | | |
| *Electricity* | Activity data | Electricity consumption data from SMUD |
| | Emissions factor | Utility-specific emissions factor from TCR and EPA |
| *Natural Gas* | Activity data | Natural gas consumption data from PG&E |
| | Emissions factor | Average emissions factors from TCR |
| *Backup Generators* | Activity data | Fuel consumption data from SMAQMD |
| | Emissions factor | Average emissions factors from TCR |
| **Streetlights and Traffic Signals** | | |
| *Electricity* | Activity data | Electricity use from streetlights and traffic signals from SMUD |
| | Emissions factor | Utility-specific emissions factor from TCR and EPA |
| **Employee Commute** | | |
| *VMT* | Activity data | Employee commute data from the City |
| | Emissions factor | Sacramento County-specific emissions factors from CARB |
| **Vehicle Fleet** | | |
| *VMT* | Activity data | VMT from the City |
| | Emissions factor | Sacramento County-specific emissions factors from CARB |
| **Solid Waste** | | |
| *Solid Waste Disposed* | Activity data | Waste disposal tonnage data from the City |
| | Emissions factor | California-specific solid waste emissions factors from ClearPath |
| *Composting* | Activity data | Organic waste tonnage data from the City |
| | Emissions factor | Composting emissions factors from CARB |
| **Wastewater Treatment** | | |
| *Wastewater Treatment* | Activity data | Wastewater generation and process-related data from SRWTP |

| Sector/Source | Input Type | Description and Data Sources |
|---|---|---|
| | Emissions factor | Emissions factors based on treatment processes from ICLEI |
| **Water Supply** | | |
| *Water Supply* | Activity data | Electricity consumption data from EGWD and SCWA |
| | Emissions factor | Utility-specific emissions factors from TCR and EPA |
| **Process and Fugitive** | | |
| *Process and Fugitive* | Activity data | Natural gas consumption data from PG&E |
| | Emissions factor | Default emissions factor's from ClearPath |

Notes: CARB = California Air Resources Board; CEC = California Energy Commission; CFDA = California Department of Food and Agriculture; CPUC = California Public Utilities Commission; EGWD = Elk Grove Water District; EPA = US Environmental Protection Agency; ICLEI = ICLEI – Local Governments for Sustainability; PG&E = Pacific Gas & Electric; SCPH = Sacramento County Public Health; SCWA = Sacramento County Water Agency; SMAQMD = Sacramento Municipal Air Quality Management District; SMUD = Sacramento Municipal Utility District; SRWTP = Sacramento Regional Wastewater Treatment Plant; TCR = The Climate Registry; VMT = vehicle miles traveled.

Source: Compiled by Ascent in 2023.

## 3.2 GLOBAL WARMING POTENTIALS AND EMISSIONS UNITS

GHG emissions other than carbon dioxide ($CO_2$) are stronger insulators and, thus, have a greater ability to warm the Earth's atmosphere through the greenhouse effect. This effect is measured in terms of a pollutant's Global Warming Potential (GWP). $CO_2$ has a GWP factor of one while all other GHGs have GWP factors measured in multiples of one relative to the GWP of $CO_2$. This conversion of non-$CO_2$ gases to one unit enables the reporting of all emissions in terms of carbon dioxide equivalent ($CO_2e$), which allows consideration of all gases in comparable terms and makes it easier to communicate how various sources and types of GHG emissions contribute to climate change. The standard unit for reporting emissions is metric tons of carbon dioxide equivalent ($MTCO_2e$). Consistent with the best available science, these inventories use GWP factors published in the Sixth Assessment Report from IPCC, as shown in Table 3.

**Table 3 GHG Global Warming Potential Factors**

| GHG | GHG Source Description | $GWP_{100}$ |
|---|---|---|
| $CO_2$ | All sources of $CO_2$ | 1 |
| $CH_4$ (biogenic) | $CH_4$ from landfills and wastewater treatment | 27.0 |
| $CH_4$ (fossil - combustion) | $CH_4$ from combustion (vehicles, residential, commercial and industrial usage) | 27.0 |
| $CH_4$ (fossil – fugitive and process) | $CH_4$ from natural gas distribution leakage and natural gas production | 29.8 |
| $N_2O$ | All sources of $N_2O$ | 273 |

Notes: GHG = greenhouse gas; GWP = Global Warming Potential; $CO_2$ = carbon dioxide; $CH_4$ = methane; $N_2O$ = nitrous oxide.

Source: IPCC 2023.

These values represent the GWP of a GHG on a 100-year time horizon. This means that methane ($CH_4$) is 27 and 29.8 times stronger than $CO_2$, depending on the source of methane, and $N_2O$ is 273 times stronger than $CO_2$ in their potential to warm Earth's atmosphere over the course of 100 years. The use of 100-year GWP values is consistent with CARB methods and reflects the long-term planning horizon of the Climate Compass.

The GWP factor for methane depends on the source of methane. Methane emissions in the city mostly come from biogenic and fossil-combustion sources. Therefore, a GWP value of 27 is used for methane in the City's community and City operations inventories. The only exception to this is in the process and fugitive emissions sector of the City's municipal inventory where a methane value of 29.8 is used instead. This sector is not typically assessed in a community inventory but was included in the municipal inventory to compare to a previous municipal inventory.

## 3.3 DATA QUALITY AND ACCURACY

When preparing a GHG emissions inventory, the goal is to use the best available data and methodologies to develop the most accurate picture of a community's emissions. However, some degree of inaccuracy is inherent to all inventories. As described by the Community Protocol, "While no community inventory is fully comprehensive (some emissions cannot be estimated due to a lack of valid methods, a lack of emissions data, or for other reasons), community inventories often aim to provide as complete a picture of GHG emissions associated with a community as is feasible" (ICLEI 2019:12). The accuracy of a GHG emissions inventory is primarily dependent on activity data (e.g., tons of solid waste generated by a community), emissions factors (e.g., grams of $CO_2$ per vehicle mile traveled [VMT] in a county), and scaling factors (e.g., percentage of county-level off-road vehicles and equipment emissions attributed to a local jurisdiction). The year 2021 was chosen for the inventories because it is the most recent calendar year for which representative data are available.

Development of the City's GHG emissions inventories was a robust and comprehensive process rooted in industry standards and best practices, and it included extensive research and consultation with City staff and departments and regional and State agencies and organizations to obtain data that are as accurate as feasible. The City recognizes that even though its inventory is consistent with all protocols previously discussed and the data used are as accurate as feasible, perfect precision in emissions estimates is not possible at this time.

## 3.4 COMMUNITY INVENTORY DATA AND ASSUMPTIONS

### 3.4.1 Sector-Specific Assumptions and Methods

The following sections describe in detail the methods, data, and assumptions that were used in estimating the City's community GHG emissions in 2021. Population and employment data were used to scale activity levels for certain emissions sources and sectors. Population and employment data for 2021 were obtained from Fehr & Peers from the EGSIM20 model. The list below summarizes this information at a high level for each sector.

- **Building Energy:** Annual electricity and natural gas usage data for the city were provided by the Sacramento Municipal Utility District (SMUD) and Pacific Gas & Electric (PG&E). Utility emissions factors were provided by The Climate Registry (TCR) and EPA (see Tables 4 and 5). Annual nonresidential backup generator usage was provided by the Sacramento Metropolitan Air Quality Management District (SMAQMD). Emissions factors for nonresidential backup generator fuels were obtained from TCR.
- **On-Road Transportation:** For the on-road transportation sector, annual VMT data were obtained from Fehr & Peers using the EGSIM20 travel model. Vehicle emissions factors were derived from the 2021 EMissions FACtor (EMFAC2021) model, CARB's statewide mobile source emissions inventory model.
- **Off-Road Vehicles and Equipment**: Off-road vehicles and equipment emissions were estimated from CARB's OFFROAD2021 models and scaled by population, employment, or service population (i.e., the sum of population and employment) depending on the equipment type.
- **Solid Waste:** Emissions associated with waste and compost generated by residents and businesses in the city were estimated using disposal data available from the City. Landfill gas (LFG) collection information was available from EPA. Solid waste calculations were computed in ClearPath using California-specific solid waste emissions factors.
- **Water Supply:** Water supply emissions were estimated using electricity consumption data for electricity associated with water consumption. Data were provided by Elk Grove Water District (EGWD) and the Sacramento County Water Agency (SCWA). Water well data were also provided by the Sacramento County Public Health Department (SCPH).
- **Wastewater Treatment:** Emissions from wastewater treatment depend on the types of treatment processes and equipment that centralized wastewater treatment plants (WWTPs) use, as well as emissions from wastewater from

septic systems. Data regarding treatment processes for the WWTP were provided by the Sacramento Regional Wastewater Treatment Plant (SRWTP) and septic system data were provided by SCPH.

- **Agriculture:** Emissions associated with the agriculture sector result from livestock management (i.e., enteric fermentation and manure management), fertilizer application, the operation of agricultural equipment (i.e., diesel-powered irrigation pumps and agricultural off-road vehicles and equipment), and building energy consumption from agricultural operations. Agriculture emissions were estimated using data available from CARB, SMAQMD, SMUD, Sacramento County, the California Department of Food and Agriculture (CDFA), and the US Department of Agriculture (USDA).

## 3.4.2 Utility Emissions Factors

Emissions of $CO_2$, methane, and $N_2O$ per MWh of electricity or therm of natural gas can vary by location and from year to year depending on several factors. Utility-specific emissions factors were obtained and used throughout the 2021 inventories to estimate GHG emissions from electricity and natural gas consumption. Sources for electricity and natural gas emissions factors are shown below.

- **Electricity:** A SMUD-specific $CO_2$ emissions factor for 2021 was provided by TCR. California-specific emissions factors for methane and $N_2O$ were obtained from EPA's Emissions & Generation Resource Integrated Database (eGRID) 2021 model for (EPA 2023).
- **Natural Gas:** Utility natural gas emissions factors for $CO_2$, methane, and $N_2O$ were obtained from TCR's 2023 Default Emission Factors (TCR 2023).

Specific utility emissions factors used in the inventory calculations are shown in Tables 4 and 5. Emissions factors are shown in standards units for electricity (pounds of GHG per MWh) and natural gas (pounds per therm). Emissions factors are also presented in pounds of GHG per kilo British thermal unit (kBTU) to enable a comparison between energy types in similar terms.

**Table 4 2021 Elk Grove Electricity Emissions Factors**

| Provider | Pollutant | Emissions Factor (lb/MWh) | Emissions Factor (lb/kBTU) |
|---|---|---|---|
| SMUD | $CO_2$ | 534.47 | 0.1566075 |
| SMUD | $CH_4$ | 0.031 | 0.0000091 |
| SMUD | $N_2O$ | 0.004 | 0.0000012 |

Notes: $CH_4$ = methane; $CO_2e$ = carbon dioxide equivalent; kBTU = kilo British thermal unit; lb = pounds; MWh = megawatt-hours; $N_2O$ = nitrous oxide; SMUD = Sacramento Municipal Utility District.
Source: Utility emissions factors provided by TCR 2023 and EPA 2023.

**Table 5 2021 Elk Grove Natural Gas Emissions Factors**

| Provider | Pollutant | Emissions Factor (lb/therm) | Emissions Factor (lb/kBTU) |
|---|---|---|---|
| PG&E | $CO_2$ | 11.6977276 | 0.11700521 |
| | $CH_4$ | 0.0010362 | 0.0000104 |
| | $N_2O$ | 0.0000220 | 0.0000002 |

Notes: $CH_4$ = methane; $CO_2$ = carbon dioxide; kBTU = kilo British thermal unit; lb = pounds; MWh = megawatt-hours; $N_2O$ = nitrous oxide; PG&E = Pacific Gas & Electric.
Source: Utility emissions factors provided by TCR 2023.

## 3.4.3 Building Energy

Building energy use in the city resulted in approximately 398,365 $MTCO_2e$ in 2021. This sector generated approximately 38 percent of the City's community emissions in 2021 and represents the second-largest emissions sector in the inventory. Emissions were a result of natural gas combustion for heating and cooking in homes and businesses and electricity use, primarily for lighting and heating, ventilation, and air conditioning (HVAC) and to power appliances. Emissions from electricity come from the portion of SMUD's electricity portfolio that is not yet carbon free. In 2021, 48 percent of SMUD's electricity mix came from carbon-free sources (CEC 2023). A marginal amount of nonresidential building energy emissions was associated with the consumption of diesel, natural gas, and gasoline in nonresidential backup generators. Annual electricity, natural gas, and backup generator usage and GHG emissions are shown in Table 6, and additional information regarding each emissions source and calculations are discussed below.

**Table 6 2021 Elk Grove Community Building Energy Use and GHG Emissions**

| Energy Type | Quantity | GHG Emissions |
|---|---|---|
| Electricity | kWh | $MTCO_{2e}$ |
| Residential | 617,573,503 | 150,260 |
| Nonresidential | 416,331,544 | 101,296 |
| *Electricity Total* | *1,033,905,047* | *251,556* |
| Natural Gas | Therms | $MTCO_2e$ |
| Residential | 22,858,657 | 121,641 |
| Nonresidential[1] | 4,716,002 | 25,096 |
| *Natural Gas Total* | *27,574,659* | *146,736* |
| Backup Generators | gal / therms | $MTCO_2e$ |
| Nonresidential - Diesel | 6,959 (gal) | 71 |
| Nonresidential – Natural Gas | 139 (therms) | 1 |
| Nonresidential - LPG | 114 (gal) | 1 |
| *Nonresidential Backup Generator Total[2]* | *NA* | *73* |
| Energy Combined[2] | NA | $MTCO_2e$ |
| Residential | NA | 271,900 |
| Nonresidential | NA | 126,465 |
| **Total[2]** | **NA** | **398,365** |

Notes: Totals in columns may not sum exactly due to independent rounding. Gal = gallons; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; kWh = kilowatt-hour; NA = not applicable

[1] Nonresidential natural gas represents commercial nonresidential only, as industrial usage was not available due to the CPUC's 15/15 Rule.

[2] Summary data for quantity not applicable due to a difference in energy units.

Source: Data compiled and modeled by Ascent in 2023.

## RESIDENTIAL ENERGY

Residential energy emissions in the city result indirectly from electricity consumption and directly from onsite combustion of natural gas. SMUD is the provider of residential electricity in the city. To calculate the $MTCO_2e$ of residential electricity consumption, emissions factors (shown in Table 4) for $CO_2$, methane, and $N_2O$ were applied to electricity consumption data. Annual residential natural gas consumption in therms was obtained from PG&E. $CO_2$, methane, and $N_2O$ emissions factors for natural gas were applied to consumption data to estimate $MTCO_2e$ from residential natural gas usage.

Residential electricity use accounted for 150,260 $MTCO_2e$, which represents 38 percent of emissions within the sector. Residential natural gas use accounted for 121,641 $MTCO_2e$, which represents 31 percent of the community's 2021 building energy emissions.

## NONRESIDENTIAL ENERGY

Nonresidential energy emissions, which are generated by commercial and industrial uses, result indirectly from electricity consumption and directly from onsite combustion of natural gas. SMUD provides nonresidential electricity in the city and PG&E provides nonresidential natural gas. Natural gas consumption data for industrial uses were not available due to the California Public Utility Commission's (CPUC) 15/15 Rule, so only natural gas for commercial uses is accounted for in this inventory.[2] Emissions associated with nonresidential energy consumption were quantified using the same methods as described above for residential energy calculations.

Data for annual nonresidential backup generators were obtained from SMAQMD. Generator horsepower and total annual hours used were provided for each permitted generator in the city. Data were then converted to gallons for diesel fuel and liquid propane gas (LPG) and therms for natural gas. Emissions factors obtained from TCR were applied to fuel consumption data to estimate GHG emissions associated with nonresidential backup generator usage.

Nonresidential electricity use accounted for 101,296 $MTCO_2e$, which represents 25 percent of emissions within the sector. Nonresidential natural gas use accounted for 25,096 $MTCO_2e$, which represents 6 percent of the City's 2021 building energy emissions. Nonresidential backup generators also accounted for 73 $MTCO_2e$, representing less than 1 percent of emissions from the building sector in 2021.

## 3.4.4 On-Road Transportation

Based on modeling conducted, on-road transportation in the city resulted in approximately 586,220 $MTCO_2e$ in 2021, or 56 percent of the City's total community emissions. The on-road transportation sector represents the largest emissions sector in the city. Annual vehicle miles traveled (VMT) and GHG emissions from on-road transportation are shown in Table 7. Additional details and calculation methodologies and assumptions are described below.

**Table 7 2021 Elk Grove Community On-Road Transportation VMT and GHG Emissions**

| Source | Annual VMT | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| On-Road Passenger Transportation | 944,367,693 | 339,716 |
| On-Road Commercial Transportation | 192,332,970 | 246,504 |
| **Total** | **1,136,700,664** | **586,220** |

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled.

Source: Data compiled and modeled by Ascent in 2023, based on modeling from Fehr & Peers.

On-road transportation emissions are primarily the result of the combustion of gasoline and diesel fuels in passenger vehicles (i.e., cars, light-duty trucks, and motorcycles) and commercial vehicles (i.e., medium- and heavy-duty trucks) permitted to operate "on road." To a smaller degree, emissions from on-road electric vehicles also result from upstream electricity generation; these emissions are represented in annual electricity emissions in the city (captured in the building energy sector). Due to lack of available data, emissions from the combustion of natural gas and other non-electric alternative fuels in on-road vehicles were not included in the community inventory and are assumed to have minimal contribution to total emissions.

Fehr & Peers conducted a VMT analysis for the City using the EGSIM20 travel model. It considered daily VMT in the city for 2021 and annualized the daily VMT using an annualization factor of 334.[3] Passenger vehicles accounted for 944,367,693 VMT in 2021 and resulted in 339,716 $MTCO_2e$, which represents 58 percent of total on-road emissions for the City. Commercial vehicles accounted for 192,332,970 VMT and resulted in 246,504 $MTCO_2e$, which represents 42 percent of total on-road emissions. These VMT estimates are associated with trips that begin or end in the city. VMT

[2] The 15/15 Rule states that a utility cannot provide an anonymized data set if the set does not consist of at least 15 accounts and no one account accounts for more than 15 percent of the total consumption of the data set (CPUC 2014).

[3] This annualization factor comes from an analysis done using Caltrans Performance Measurement System (PeMS) that determined the relationship between daily and annual volume for interstates in the Sacramento region.

estimates included 100 percent of vehicle trips that both originate from and end in the city (i.e., fully internal trips), 50 percent of trips that either end in or depart from the city (i.e., internal-external, or external-internal trips), and zero percent of vehicle trips that are simply passing through the city boundaries (i.e., external-external, or "pass-through," trips). This vehicle trip accounting method is consistent with the Regional Targets Advisory Committee (RTAC) origin-destination method established through Senate Bill 375 and CARB recommendations.

Two countywide VMT emissions rates, one for passenger vehicles and one for commercial vehicles, were derived from EMFAC2021. EMFAC2021 was used to generate emission rates for Sacramento County for the calendar year 2021 with all vehicle classes, model years, speeds, and fuel types (e.g., gasoline, electricity). The countywide $MTCO_2e$ per mile emissions factors were calculated based on the distribution of VMT for each vehicle class and its emissions factor.

### 3.4.5 Off-Road Vehicles and Equipment

Based on modeling conducted, off-road vehicles and equipment operating in the city emitted 18,341 $MTCO_2e$ in 2021, or 2 percent of the 2021 community inventory. The largest emissions-generating off-road category is construction and mining equipment, which produced 9,033 $MTCO_2e$ in 2021 and accounted for 49 percent of emissions within the sector. The estimated annual emissions and scaling factors used are presented in Table 8 by vehicles and equipment type. Additional details regarding calculation methods and assumptions are discussed below.

**Table 8 2021 Elk Grove Community Off-Road Vehicles and Equipment GHG Emissions and Scaling Method**

| Off-Road Vehicles and Equipment Type | GHG Emissions ($MTCO_2e$) | Scaling Method |
|---|---|---|
| Construction and Mining Equipment | 9,033 | Service Population |
| Industrial Equipment | 1,219 | Employment |
| Lawn and Garden Equipment | 2,817 | Population |
| Light Commercial Equipment | 2,071 | Employment |
| Portable Equipment | 1,905 | Employment |
| Recreational Equipment | 229 | Population |
| Transportation Refrigeration Units | 1,066 | Service Population |
| **Total** | **18,341** | NA |

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

Source: Data compiled and modeled by Ascent in 2023, based on CARB's OFFROAD2021 model.

Emissions from the off-road vehicles and equipment sector result from fuel combusted in off-road vehicles and equipment. Data associated with this sector were available from CARB's OFFROAD2021 model. This model provides emissions details at the state, air basin, or county level. Sacramento County emissions data from OFFROAD2021, which include emissions from the entire county, were apportioned to the city using custom scaling factors depending on the off-road vehicle and equipment type. For example, due to the likely correlation between commercial activity and employment, the city's portion of emissions from light commercial equipment in the entire county is assumed to be proportional to the number of jobs in the city as compared to the county as a whole.

### 3.4.6 Solid Waste

Based on modeling conducted, the solid waste sector was responsible for 20,222 $MTCO_2e$ in 2021, or 2 percent of community GHG emissions. Community-generated solid waste emissions are associated primarily with the decomposition of solid waste generated by city residents and businesses in landfills. A smaller proportion of emissions are produced by compost generated by the city. Table 9 summarizes emissions from the solid waste sector. Additional details regarding calculation methods and assumptions are discussed below.

**Table 9 2021 Elk Grove Community Solid Waste Quantity and GHG Emissions**

| Source | Quantity (tons) | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| Community-Generated Solid Waste | 64,689 | 18,508 |
| Compost | 24,480 | 1,714 |
| **Total** | **89,169** | **20,222** |

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

## COMMUNITY-GENERATED SOLID WASTE

Methane emissions associated with community-generated solid waste occur from the decay of landfill disposed waste generated annually by residences and businesses in the city. A total of 64,689 tons of landfilled waste was reported for the city in 2021 and resulted in 18,508 $MTCO_2e$, which represents 92 percent of total solid waste emissions for the 2021 inventory. Data for landfilled waste were provided by the City.

The amount of methane released from community-generated waste depends on the LFG management systems of the landfills at which the waste is disposed. Information regarding the use of an LFG capture system was available from EPA's Landfill Methane Outreach Program. All facilities where the city sends its solid waste include an LFG capture system; therefore, the default LFG collection efficiency of 0.75 was applied to adjust emissions estimates, as recommended by the Community Protocol. Solid waste calculations were computed in ClearPath using California-specific default waste characterization emissions factors.

## COMPOSTING

In addition to solid waste pickup and disposal, the City also collects and composts organic waste (i.e., food waste and green waste). While composting does produce GHG emissions, GHG emissions from composting are significantly lower than those associated with the decomposition of organic waste that is sent to landfills. A total of 24,480 tons of organic waste was reported in 2021 and resulted in 1,714 $MTCO_2e$, which represents 8 percent of total emissions from the solid waste sector in 2021. Organic waste tonnage data were provided by the City.

Emissions from composting were calculated using CARB's *Method for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities* (CARB 2016). CARB's method remains the best guidance on estimating GHG emissions for compost, but it is important to note that emissions factors provided in the guidance are calculated using different GWP values for methane and $N_2O$ than the ones used in this inventory. The emissions factors were derived using the IPCC's Fourth Assessment, rather than the IPCC's most recent Sixth Assessment, using a GWP value of 25 for methane and 293 for $N_2O$.

## 3.4.7 Water Supply

Based on modeling conducted, water supply in the city resulted in GHG emissions of 2,802 $MTCO_2e$, which represents less than 1 percent of total community emissions. Water is supplied by the Elk Grove Water District (EGWD) and the Sacramento County Water Agency (SCWA). GHG emissions associated with water consumption occur from the indirect use of energy associated with water extraction, conveyance, treatment, and distribution to the point of use (e.g., residences and businesses).

Private wells also account for less than 1 percent of annual water consumption. Data on the number of estimated wells in the city were provided by Sacramento County Public Health. The average water consumption per well was assumed to be 0.5 acre-feet per year.[4] Water from private wells is supplied from local sources within the city; therefore, it was assumed that all electricity usage associated with extracting and conveying well water is captured in the emissions estimates of the building energy sector because these activities occur within the city.

The methods used are explained in more detail below. Table 10 presents water supply, electricity consumption, and associated GHG emissions for the city.

**Table 10 2021 Elk Grove Community Water Supply Quantity and GHG Emissions**

| Source | Quantity (AF) | Electricity Consumption (kWh) | GHG Emissions ($MTCO_2e$) |
|---|---|---|---|
| Elk Grove Water District | 6,862 | 2,722,412 | 662 |
| Sacramento County Water Agency | 19,951 | 8,797,498 | 2,140 |
| Wells | 46 | 8,786 | NA |
| **Total** | **26,859** | **11,528,696** | **2,802** |

Notes: AF = acre-feet; GHG = greenhouse gas; kWh = kilowatt-hour; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

## WATER AND ELECTRICITY CONSUMPTION

EGWD and SCWA provided annual water consumption data and annual electricity consumption data for 2021 for the customers they serve in the city. To calculate GHG emissions from the water sector, electricity emissions factors (shown in Table 4) were applied to the total electricity consumption data for each water provider. Water supplied by EGWD resulted in 662 $MTCO_2e$, which represents 24 percent of emissions from the water sector. Water supplied by SCWA resulted in 2,140 $MTCO_2e$, which represents the other 76 percent of emissions from the water sector.

# 3.4.8 Wastewater Treatment

Based on modeling conducted, wastewater treatment associated with the city resulted in GHG emissions of 2,957 $MTCO_2e$, which represents less than 1 percent of total emissions for 2021. A centralized WWTP accounts for 94 percent of emissions from wastewater treatment, while septic systems make up the remaining 6 percent of emissions from this sector. Wastewater treatment emissions are summarized in Table 11, and additional details for this sector are included below.

**Table 11 2022[1] Elk Grove Community Wastewater Treatment GHG Emissions**

| Wastewater Treatment Type | GHG Emissions ($MTCO_2e$) |
|---|---|
| Centralized WWTP | 2,791 |
| Septic Systems | 167 |
| **Total** | **2,957** |

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; WWTP = wastewater treatment plant.

[1] Data for 2022 were used instead because SRWTP went through process changes in 2021. Data from 2022 were a better representation of SRWTP's current emissions.

Source: Data compiled and modeled by Ascent in 2023.

## CENTRALIZED WASTEWATER TREATMENT PLANTS

Emissions associated with the treatment of sewage are highly dependent on the processes and components used by specific WWTPs such as lagoons, nitrification or denitrification, and digester gas or combustion devices. SRWTP is the

[4] An average water consumption value of 0.05 acre-feet per year was recommended by Zone 7 Water Agency, a water provider in Livermore, California.

centralized wastewater treatment provider in the city. It collects wastewater from customers' homes and businesses. Collected wastewater enters the regional sewer system, which is operated by the Sacramento Regional County Sanitation District and is then conveyed and pumped to the facility where it is treated before being safely reintroduced to the environment. Data specific to SRWTP's wastewater processes were provided by SRWTP, including average daily digester gas, BTU content of the digester gas, and average daily nitrogen discharge. It was assumed that individuals in the city who do not have a septic system are served by SRWTP.

Stationary methane and $N_2O$ emissions from the combustion of digester gas were calculated based on average daily digester gas and the average BTU content of the digester gas, using Community Protocol equations WW.1b and WW.2b, respectively. Process $N_2O$ emissions for WWTPs with nitrification or denitrification were calculated based on population and an industrial-commercial equivalent factor of 1.25 since both industrial and commercial land uses are served by the SRWTP, using Community Protocol equation WW.7. Fugitive $N_2O$ emissions from effluent discharge were calculated based on average daily nitrogen load and an effluent factor of 0.005—because discharge is released to the Sacramento River—using Community Protocol equation WW.12.

Energy-related emissions result from the energy required for wastewater treatment operations, including the energy used in wastewater conveyance as well as energy used throughout wastewater treatment processes and to provide power to the SRWTP facility. Energy-related emissions were estimated using the energy emissions factors for SMUD and PG&E, as shown in Table 4 and Table 5 in section 3.4.2, using Community Protocol equation WW.15.

#### SEPTIC SYSTEMS

Onsite septic systems are used to collect wastewater in rural areas of the city. These systems collect wastewater onsite in underground tanks, which create anaerobic conditions. Microorganisms biodegrade the soluble organic material found in waste, which results in fugitive methane emissions. Consistent with the Community Protocol, wastewater discharge and treatment energy intensities associated with septic tanks and other onsite systems are assumed to be negligible.

Data provided by Sacramento County Public Health determined that there are an estimated 441 septic systems in the city. Methane emissions from the septic systems were calculated based on the population served by these systems, using equation WW.11(alt) of the Community Protocol. It was assumed each septic system serves one household and average household size was used to calculate total population served by septic systems. This method resulted in an estimate of 1,424 individuals in the city to be served by septic systems.

### 3.4.9 Agriculture

Based on modeling conducted, emissions from the agriculture sector accounted for approximately 10,275 $MTCO_2e$ in 2021, or approximately 1 percent of the City's community emissions. Emissions in this sector are generated from fertilizer application, livestock management, the operation of agricultural equipment, and from building energy use associated with agricultural operations. Emissions from livestock, which include enteric fermentation and manure management, accounted for 27 percent of emissions from the agriculture sector, emissions from fertilizer application accounted for 15 percent, emissions from agricultural equipment accounted for 9 percent, and emissions from building energy associated with agricultural operations accounted for 50 percent. The City's agriculture emissions in 2021 are summarized in Table 12, and additional details and information about this sector are included below.

**Table 12 2021 Elk Grove Community Agriculture GHG Emissions**

| Agricultural Activity | GHG Emissions ($MTCO_2e$) |
|---|---|
| Livestock Management | 2,779 |
| Fertilizer Application | 1,518 |
| Agricultural Equipment | 875 |
| Agricultural Building Energy | 5,104 |

| Agricultural Activity | GHG Emissions ($MTCO_2e$) |
|---|---|
| Total | 10,275 |

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

# LIVESTOCK MANAGEMENT

Livestock produce methane and $N_2O$ emissions through enteric fermentation (a type of digestion process) and decomposition of manure produced by these animals. The 2021 Sacramento County Crop Report and USDA's 2017 Census of Agriculture provided total heads of beef cattle and calves, sheep and lambs, goats, poultry, swine, and horses in Sacramento County (County of Sacramento 2021; USDA 2017). These data were scaled to the city level using the proportion of agriculture acres in the city compared to the county. Emissions factors for livestock were obtained from CARB's California GHG Emission Inventory (CARB 2022).

Livestock heads data are shown in Table 13 below, along with associated data sources.

**Table 13 2021 Elk Grove Livestock Heads Data and Sources**

| Livestock Type | Livestock Heads | Source | GHG Emissions ($MTCO_2e$) |
|---|---|---|---|
| Cattle and Calves | 572 | 2021 Sacramento County Crop Report | 2,622 |
| Sheep and Lambs | 133 | USDA 2017 Census of Agriculture | 46 |
| Goats | 148 | USDA 2017 Census of Agriculture | 38 |
| Poultry | 181 | USDA 2017 Census of Agriculture | 0.8 |
| Swine | 10 | USDA 2017 Census of Agriculture | 5 |
| Horses | 72 | USDA 2017 Census of Agriculture | 67 |

Notes: USDA = US Department of Agriculture; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

Livestock emissions factors for enteric fermentation and manure management are displayed in Table 14. Emissions factors were derived from CARB's California GHG Emission Inventory, which provides statewide heads and emissions for a variety of subcategories of each livestock type. For example, enteric fermentation emissions for cattle are provided for dairy calves, dairy cows, dairy replacements, beef calves, beef replacements, beef cows, bulls, stocker and feedlot heifer, and stocker and feedlot steer. Using data for all subcategories, a weighted average enteric fermentation emissions factor for cattle was calculated and used to estimate emissions from enteric fermentation from the cattle and calves livestock type in the city.

**Table 14 2021 Elk Grove Enteric Fermentation and Manure Management Emissions Factors**

| Livestock Type | Enteric Fermentation Emissions Factor (kg $CH_4$/head) | Manure Management Emissions Factor (kg $CH_4$/head) | Manure Management Emissions Factor (kg $N_2O$/head) |
|---|---|---|---|
| Cattle and Calves | 80 | 73 | 1.6 |
| Sheep and Lambs | 8 | 0.7 | 0.4 |
| Goats | 5 | 0.4 | 0.4 |
| Poultry | 0 | 0.1 | 0.004 |
| Swine | 2 | 16 | 0.1 |
| Horses | 18 | 3.3 | 1.3 |

Notes: $CH_4$ = methane; kg = kilogram; $N_2O$ = nitrous oxide.

Source: Data compiled by Ascent in 2023.

# FERTILIZER APPLICATION

The application of fertilizers and other soil amendments produces GHG emissions. Nitrogen fertilizers produce $N_2O$ emissions, and application of lime produces emissions of $CO_2$. Data for nitrogen (including urea) and lime application were obtained from the California Department of Food and Agriculture's (CDFA's) *2021 Fertilizer Tonnage Report* (CDFA 2021). Emissions factors and quantification methods for GHG emissions associated with application of nitrogen and lime were obtained from IPCC. Data for fertilizer and lime application and associated emissions are presented in Table 15 below.

**Table 15 2021 Elk Grove Fertilizer and Lime Application Data and Emissions**

| Application Type | Application Amount (tons) | Source | GHG Emissions ($MTCO_2e$) |
|---|---|---|---|
| Nitrogen | 310 | CDFA | 1,506 |
| Lime | 30 | CDFA | 12 |

Notes: CDFA = California Department of Food and Agriculture; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

Emissions factors and data sources for fertilizer and lime application are shown in Table 16.

**Table 16 2021 Elk Grove Fertilizer and Lime Application Emissions Factors and Sources**

| Application Type | Emissions Factor | Source |
|---|---|---|
| Nitrogen (g $N_2O$/ton N) | 17,820 | IPCC |
| Lime (g $CO_2$/ton lime) | 398,886 | IPCC |

Notes: $CO_2$ = carbon dioxide; g = grams; IPCC = Intergovernmental Panel on Climate Change; N = nitrogen; $N_2O$ = nitrous oxide.

Source: Data compiled by Ascent in 2023.

# AGRICULTURAL EQUIPMENT

GHG emissions associated with agricultural equipment were obtained from CARB's OFFROAD2021 model, as discussed in Section 3.4.5. "Off-Road Vehicles and Equipment." Agricultural equipment emissions were obtained from CARB at the Sacramento County level and were scaled to the city level using the percent of Sacramento County's agricultural acres that are within the city's boundaries.

Agricultural equipment emissions also include GHG emissions from diesel-powered irrigation pumps. SMAQMD provided the number of diesel irrigation pumps in the city. Annual diesel fuel consumption was not available so the air district-specific average daily emissions factor (daily tons of $CO_2$ per pump) provided by CARB was used instead to estimate emissions (CARB 2006). This daily value was then annualized by a factor of 365, per CARB's guidance, to calculate total annual emissions for 2021.

Activity data and associated GHG emissions from agricultural equipment are included in Table 17.

**Table 17 2021 Elk Grove Agricultural Equipment Data and Sources**

| Equipment Type | Activity Data | Source | GHG Emissions ($MTCO_2e$) |
|---|---|---|---|
| Off-Road Agricultural Equipment | —[1] | CARB | 764 |
| Diesel-Powered Irrigation Pumps | 2 pumps | SMAQMD | 111 |
| **Total** | **NA** | **NA** | **875** |

Notes: CARB = California Air Resources Board; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable; SMAQMD = Sacramento Metropolitan Air Quality Management District.

1 Emissions from off-road agricultural equipment were obtained directly from CARB's OFFROAD2021 model; no activity data were used to calculate emissions estimates.

Source: Data compiled and modeled by Ascent in 2023.

## AGRICULTURAL BUILDING ENERGY

Building energy emissions associated with agricultural operations in the city result indirectly from electricity consumption. Building electricity data specific to agricultural operations was provided by SMUD. This subsector is included in the agriculture sector, rather than the building energy sector, because it will allow for more accurate forecasting of future emissions from building energy associated with agricultural operations. Agricultural operations have different growth projections than residential and nonresidential building development projections in the city. To calculate the $MTCO_2e$ of agricultural electricity consumption, emissions factors for $CO_2$, methane, and $N_2O$ were applied to electricity consumption data. Activity data and associated GHG emissions from agricultural building energy are included in Table 18.

**Table 18 2021 Elk Grove Agricultural Building Energy Data**

| Energy Type | Quantity (kWh) | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| Agricultural Building Energy | 20,976,011 | 5,104 |

Notes: GHG = greenhouse gas; kWh = kilowatt-hour; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

# 3.5 CITY OPERATIONS INVENTORY DATA AND ASSUMPTIONS

## 3.5.1 Sector-Specific Assumptions and Methods

The following sections describe in detail the methods, data, and assumptions that were used in estimating the City's municipal operations GHG emissions in 2021. Employment data obtained from the City were used to scale activity levels for certain emissions sources and sectors.

The following summarizes data sources and methods used in estimating the City's municipal operations GHG emissions in 2021:

- **Buildings and Facilities:** Annual municipal electricity and natural gas usage data for the City were provided by SMUD and PG&E. Emissions factors were obtained from TCR and EPA. Annual municipal backup generator usage was provided by the City, and emissions factors for backup generators were available from TCR.
- **Streetlights and Traffic Signals:** Annual municipal electricity use for all streetlights and traffic signals was provided by SMUD. Electricity emissions factors were obtained from TCR and EPA.
- **Employee Commute:** Emissions associated with City employee commutes were calculated using employee commute data provided by the City, including average commute distance, percentage of year each employee was employed with the City, and average number of days per week each employee commutes. Vehicle emissions factors were derived using EMFAC2021.
- **Vehicle Fleet:** Municipal vehicle fleet VMT data were provided by the City. Vehicle emissions factors were derived using EMFAC2021.
- **Solid Waste:** Emissions associated with waste and compost generated by municipal operations were estimated using municipal disposal data available from the City. LFG collection information was available from EPA. Solid waste calculations were computed in ClearPath using California-specific solid waste emissions factors.
- **Water Supply:** Water consumption data for municipal facilities were provided by the City's water purveyors, EGWD and SCWA. An average supplier-specific energy intensity (AF/kWh) was applied to water consumption data provided by EGWD and SCWA to estimate total electricity consumption based on water use. Electricity emissions factors from TCR and EPA were applied to total electricity consumption.

- **Wastewater Treatment:** Data regarding treatment processes, digester gas production and combustion, and nitrogen load were obtained from SRWTP. Data were scaled down to the municipal level by population provided by the City.
- **Process and Fugitive:** Data regarding natural gas consumption was provided by PG&E. Calculations were computed in ClearPath using default emissions factors.

It should be noted that the GHG emissions associated with City operations are not additive emissions to the City's community inventory GHG emissions, except for process and fugitive emissions since they are not included in the City's community inventory.

### 3.5.2 Buildings and Facilities

Municipal buildings and facilities accounted for approximately 1,741 $MTCO_2e$, or 41 percent of total emissions resulting from City operations in 2021. This sector includes emissions from energy (i.e., electricity, natural gas, diesel) used for all City buildings and facilities, primarily for lighting, HVAC, pumps, generators, and other equipment. Electricity accounted for approximately 47 percent of emissions from this sector in 2021, natural gas accounted for approximately 53 percent, and diesel backup generators accounted for less than 1 percent. Building energy use and emissions by source are presented in Table 19 below.

**Table 19 2021 Elk Grove City Operations Buildings and Facilities Energy Use and GHG Emissions**

| Source | Quantity | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| Electricity (MWh) | 3,352 | 816 |
| Natural Gas (therms) | 173,627 | 924 |
| Backup Generators (gallons) | 181 | 2 |
| **Total** | **NA** | **1,741** |

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; MWh = megawatt-hours; NA = not applicable.

Source: Data compiled and modeled by Ascent in 2023.

Buildings and facilities energy use data for 2021 were provided by SMUD and PG&E, and generator fuel usage was provided by SMAQMD. Municipal electricity GHG emissions were estimated using 2021 electricity emissions factors provided by TCR and EPA. Municipal natural gas and backup generator GHG emissions were estimated using emissions factors from TCR. GHG emissions were estimated using the same methods as described in the community building energy sector.

### 3.5.3 Streetlights and Traffic Signals

City streetlights and traffic signals accounted for approximately 893 $MTCO_2e$ in 2021, or 21 percent of total City operations emissions in 2021. This sector includes emissions associated with electricity consumption to power City-owned streetlights and traffic signals. Electricity consumption and GHG emissions associated with streetlights and traffic signals are shown in Table 20.

**Table 20 2021 Elk Grove City Operations Streetlights and Traffic Signals GHG Emissions**

| Source | Quantity (MWh) | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| Streetlights | 3,094 | 753 |
| Traffic Signals | 577 | 140 |
| **Total** | **3,670** | **893** |

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; MWh = megawatt-hours.

Source: Data compiled and modeled by Ascent in 2023.

Electricity consumption from streetlights and traffic signals were provided by SMUD. GHG emissions were estimated using the methods and emissions factors as described in the community building energy sector.

### 3.5.4 Employee Commute

Employee commute accounted for approximately 835 $MTCO_2e$ in 2021, approximately 20 percent of total City operations emissions in 2021. This sector estimates GHG emissions associated with VMT for City employees commuting to and from work. Table 21 shows employee commute VMT and GHG emissions. Additional details regarding calculation methods and assumptions are discussed below.

**Table 21 2021 Elk Grove City Operations Employee Commute GHG Emissions**

| Source | VMT | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| Employee Commute | 2,319,909 | 835 |

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled.

Source: Data compiled and modeled by Ascent in 2023.

Total VMT was estimated based on employee commute data provided by the City. Daily VMT commute distance for each employee was estimated by calculating the distance between the zip code associated with the employee's home and the zip code associated with the City's office buildings.[5] The calculation also took into account the percentage of the year each employee was employed with the City and the average number of days per week each employee commutes to the office. The daily VMT was annualized by 234, which is the average number of work days in a year when holidays and vacation are taken into account. Annual VMT data for each employee was then summed to calculate total annual VMT for all employees. Based on a 2019 employee commute survey that showed 97 percent of employees drive alone to work, total annual VMT for all employees was then reduced by 3 percent. Emissions were estimated using emissions factors derived from EMFAC2021, as discussed in the on-road transportation sector of the community inventory.

### 3.5.5 Vehicle Fleet

City-owned vehicle fleet emissions accounted for 620 $MTCO_2e$ in 2021, approximately 15 percent of total municipal operations emissions in 2021. This sector includes emissions estimated from on-road vehicles owned and operated by the City. Table 21 displays vehicle fleet VMT by vehicle class and type, as well as associated emissions factors and GHG emissions. Additional details regarding calculation methods and assumptions are discussed below.

**Table 22 2021 Elk Grove City Operations Vehicle Fleet GHG Emissions**

| Vehicle Class and Type | VMT | Emissions Factor ($MTCO_2e$/mile) | GHG Emissions ($MTCO_2e$) |
|---|---|---|---|
| LDA Combustion | 336,165 | 0.0003 | 107 |
| LDT1 Combustion | 37,230 | 0.0004 | 14 |
| LDT1 Electric | 1,460 | 0.0000 | 0 |
| MDV Combustion | 944,837 | 0.0005 | 458 |
| LHD1 Combustion | 31,691 | 0.0008 | 27 |
| MCY Combustion | 59,436 | 0.0002 | 14 |
| **Total** | **1,410,819** | **NA** | **620** |

[5] For employees living in the same zip code as the City's offices, an average one-way commute distance of 3 miles was assumed.

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled; LDA = passenger cars, LDT1 = light-duty trucks, MDV = medium-duty trucks, LHD1 = light-heavy-duty trucks, MCY = motorcycle.

Source: Data compiled and modeled by Ascent in 2023.

Daily VMT data for each vehicle in the City's fleet were provided by the City. The daily VMT for each non-police vehicle was annualized by a factor 234, which is the average number of work days in a year when holidays and average vacation hours are taken into account. The daily VMT for each police vehicle was annualized by a factor of 365 because these vehicles are typically used daily. Each vehicle in the City's fleet was assigned to an EMFAC vehicle class (e.g., LDA or MDV) and an emissions factor ($MTCO_2e$ per mile) for each vehicle class and fuel type (i.e., combustion or electric) was calculated using emissions factors derived from EMFAC 2021.

### 3.5.6 Solid Waste

Municipal solid waste disposal accounted for approximately 139 $MTCO_2e$ in 2021, or 3 percent of total City operations emissions in 2021. Solid waste emissions are generated from the decomposition of organic material in landfills and from composting. Table 23 presents estimated tons of solid waste disposal and associated GHG emissions from municipal operations.

**Table 23 2021 Elk Grove City Operations Solid Waste GHG Emissions**

| Source | Quantity (tons) | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| Landfill Disposed Waste | 375 | 107 |
| Compost | 458 | 32 |
| **Total** | **833** | **139** |

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

Tonnage data for landfilled-disposed waste and composted organic waste were provided by the City. A total of 375 tons of landfilled waste was reported for City operations in 2021 and resulted in 107 $MTCO_2e$, which represents 77 percent of total solid waste emissions for the City operations in 2021. A total of 458 tons of organic waste was reported for City operations in 2021 and resulted in 32 $MTCO_2e$, which represents 23 percent of total emissions from the solid waste sector. Methods for estimating emissions from these sources are based on the methodology described in the community solid waste sector.

### 3.5.7 Water Supply

Water supplied for the City's municipal operations resulted in approximately 9 $MTCO_2e$ in 2021, or less than 1 percent of total City operations GHG emissions in 2021. Water usage and associated electricity consumption are provided in Table 24.

**Table 24 2021 Elk Grove City Operations Water Supply GHG Emissions**

| Source | Annual Water Consumption (AF) | Average Annual Electricity Consumption (kWh/AF) | Total Annual Electricity Consumption (kWh) | GHG Emissions ($MTCO_2e$) |
|---|---|---|---|---|
| EGWD | 2.82 | 397 | 1,118 | 0.2 |
| SCWA | 82.02 | 441 | 36,167 | 8.8 |
| **Total** | **84.84** | **NA** | **37,284** | **9** |

Notes: : Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; MWh = megawatt-hours; $MTCO_2e$ = metric tons of carbon dioxide equivalent; EGWD = Elk Grove Water District; SCWA = Sacramento County Water Agency.

Source: Data compiled and modeled by Ascent in 2023.

EGWD and SCWA provide water for City operations and provide annual water consumption data for the municipal facilities they serve within the City. Using an average annual electricity consumption value (kWh/AF) derived from the community data for each water provider, total electricity consumption associated with water consumption was calculated for EGWD and SCWA. To calculate GHG emissions, the electricity emissions factors provided by TCR and EPA were applied to total electricity consumption for each water provider.

### 3.5.8 Wastewater Treatment

Wastewater emissions associated with the City's municipal operations accounted for approximately 7 $MTCO_2e$ in 2021, or less than 1 percent of total City operations emissions in 2021. Municipal wastewater GHG emissions associated with this sector included emissions generated by the energy used to treat municipal wastewater as well as emissions that are produced as a result of wastewater treatment processes. GHG emissions from wastewater associated with City operations are shown in Table 25.

**Table 25 2021 Elk Grove City Operations Wastewater GHG Emissions**

| Source | GHG Emissions ($MTCO_2e$) |
|---|---|
| Wastewater Treatment | 7 |

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

Wastewater-related data was provided by SRWTP, which provides wastewater treatment for the City's municipal operations. Methods for estimating emissions from these sources are based on the methodology described in the community wastewater sector and were scaled based on the number of City employees in 2021.

### 3.5.9 Process and Fugitive Emissions

Process and fugitive emissions result from leakage in the local natural gas distribution system. Emissions in this sector accounted for approximately 32 $MTCO_2e$ in 2021, or less than one percent of the City's municipal operations. This sector was included in the City operations inventory to allow for comparison with the City's 2019 inventory, where it was also assessed. This sector was excluded, however, from the community inventory because it is not typically a sector included in the Community Protocol.

Emissions from this sector were calculated using ICLEI's ClearPath. To calculate emissions, the City's total annual natural gas consumption, provided by PG&E, was applied to the default leakage rate and emissions factors in ClearPath. Natural gas consumption and resulting GHG emissions from process and fugitive emissions are shown in Table 26.

**Table 26 2021 Elk Grove City Operations Process and Fugitive GHG Emissions**

| Source | Annual Natural Gas Consumption (therms) | GHG Emissions ($MTCO_2e$) |
|---|---|---|
| Process and Fugitive Emissions | 173,627 | 32 |

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

# 4 SUMMARY OF RESULTS

## 4.1 COMMUNITY INVENTORY

### 4.1.1 Summary of GHG Emissions from Community Activities and Sources

Community activities generated 1,039,181 $MTCO_2e$ in 2021. The largest emissions-generating sectors include on-road transportation (56 percent) and building energy (38 percent). Collectively, on-road transportation and building energy accounted for approximately 94 percent of all community emissions in 2021. The remaining 6 percent of emissions are attributable to solid waste (2 percent), off-road vehicles and equipment (2 percent), wastewater treatment (less than 1 percent), water supply (less than 1 percent), and agriculture (less than 1 percent).

The 2021 inventory will be the City's GHG emissions baseline for the Climate Compass and will be used to forecast emissions and set emissions reductions targets. Table 27 and Figure 1 present the results of the City's 2021 community GHG emissions inventory by sector.

**Table 27 2021 Elk Grove Community GHG Emissions Inventory**

| Sector | GHG Emissions ($MTCO_2e$) | Percent of Total |
|---|---|---|
| On-Road Transportation | 586,220 | 56% |
| Building Energy (Includes Residential and Nonresidential) | 398,365 | 38% |
| Solid Waste | 20,222 | 2% |
| Off-Road Vehicles and Equipment | 18,341 | 2% |
| Wastewater Treatment | 2,957 | <1% |
| Water Supply | 2,802 | <1% |
| Agriculture | 10,275 | <1% |
| **Total** | **1,039,181** | **100%** |

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

Source: Data modeled by Ascent in 2023.

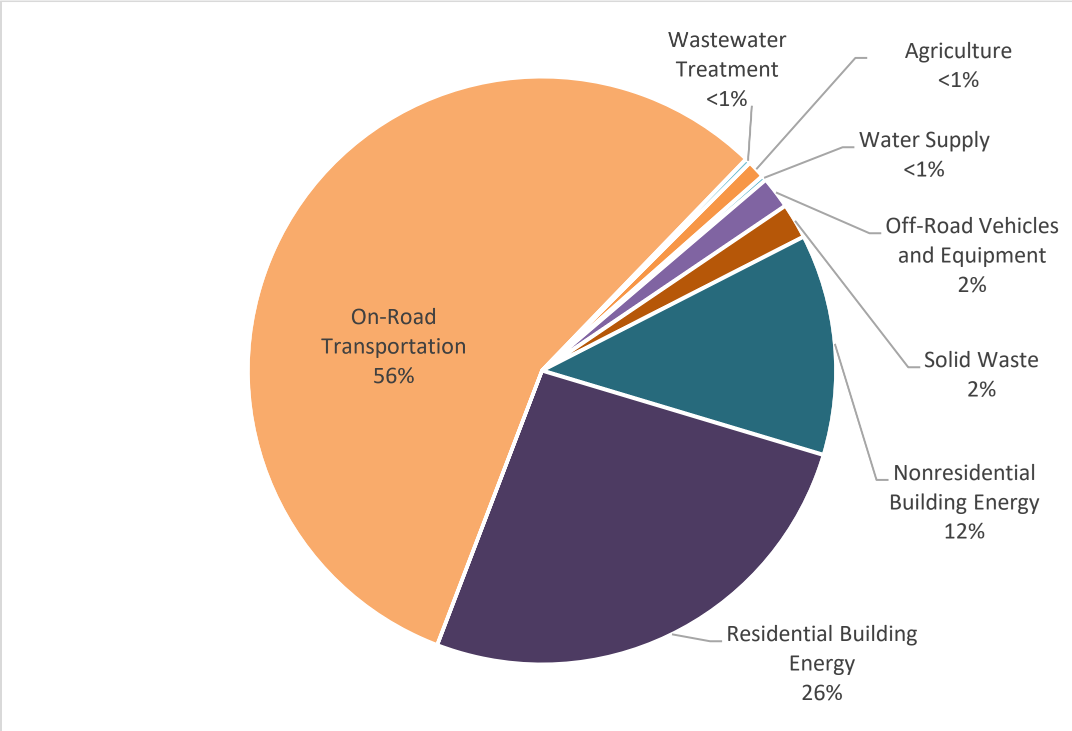


Figure 1 2021 City of Elk Grove Community GHG Emissions Inventory

### 4.1.2 2013 to 2021 Community GHG Inventory Comparison

This section compares the City's 2021 community inventory to the City's 2013 community inventory, which is the previous community inventory. Table 28 presents the total emissions for both inventory years by sector, as well as the percent change in emissions from 2013 to 2021.

**Table 28 2013 and 2021 Elk Grove Community GHG Emissions Inventory Comparison**

| Sector | 2013 GHG Emissions ($MTCO_2e$) | 2021 GHG Emissions ($MTCO_2e$) | Percent Change 2013 to 2021 |
|---|---|---|---|
| On-Road Transportation[1] | 430,340 | 586,220 | +36% |
| Building Energy | 361,260 | 398,365 | +10% |
| Solid Waste | 26,260 | 20,222 | -23% |
| Off-Road Vehicles and Equipment | 93,340 | 18,341 | -80% |
| Wastewater Treatment | 3,854 | 2,957 | -23% |
| Water Supply | 2,708 | 2,802 | +3% |
| Agriculture[2] | 1,030 | 10,275 | +898% |
| **Total** | **918,790** | **1,039,181** | **+13%** |

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data compiled and modeled by Ascent in 2023.

[1] The increase in on-road transportation emissions is due to a change in the travel model used for each inventory, along with the methods to quantify emissions. The City saw an overall increase in vehicle miles traveled which exceeded the benefits of cleaner vehicles over the 9-year period.

[2] This significant increase is due to building energy from agricultural operations being included in the agriculture sector in the 2021 community inventory. The 2013 community inventory only included emissions from livestock management, fertilizer application, and agricultural equipment.

A per capita comparison for the 2013 and 2021 community inventories is also shown in Table 29. This comparison accounts for the population growth the City has experienced since 2013. Since 2013, the City's population grew from 163,093 to 179,287.

**Table 29 2013 and 2021 Elk Grove Community GHG Emissions Inventory Per Capita Comparison**

| Sector | 2013 GHG Emissions Per Capita ($MTCO_2e$) | 2021 GHG Emissions Per Capita ($MTCO_2e$) | Percent Change 2013 to 2021 |
|---|---|---|---|
| On-Road Transportation[1] | 2.64 | 3.27 | +24% |
| Building Energy | 2.22 | 2.22 | 0% |
| Solid Waste | 0.16 | 0.11 | -30% |
| Off-Road Vehicles and Equipment | 0.57 | 0.10 | -82% |
| Wastewater Treatment | 0.02 | 0.02 | -30% |
| Water Supply | 0.02 | 0.02 | -6% |
| Agriculture[2] | 0.01 | 0.06 | +807% |
| **Total** | **5.63** | **5.80** | **+2.9%** |

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent.

[1] The increase in emissions is due to a 29 percent increase in VMT from 2013 to 2021, as emissions factors for on-road transportation decreased between the two inventory years.

[2] This significant increase is due to building energy from agricultural operations being included in the agriculture sector in the 2021 community inventory.

Source: Data compiled and modeled by Ascent in 2023.

Based on the modeling conducted, total community GHG emissions increased by approximately 13 percent and per capita emissions increased by approximately 3 percent from 2013 to 2021. In general, differences in GHG emissions estimates between the inventories can be explained by:

- differences in data sources between inventories,
- the use of different GWP values between inventories,
- adjustments in calculation methodologies (e.g., equations and emissions factors), and
- differences in data included in each sector.

# 4.2 CITY OPERATIONS INVENTORY

## 4.2.1 Summary of GHG Emissions from City Operations

The City's municipal operations generated approximately 4,275 $MTCO_2e$ in 2021, which makes up less than one percent of the community emissions. Buildings and facilities (41 percent), streetlights and traffic signals (21 percent), and employee commute (20 percent) together account for approximately 82 percent of emissions from City operations in 2021. The remaining 18 percent of emissions are attributable to vehicle fleet (15 percent), solid waste (3 percent), water supply (less than 1 percent), wastewater treatment (less than 1 percent), and process and fugitive emissions (less than 1 percent). Table 30 presents the City's 2021 municipal operations GHG emissions inventories by sector, and Figure 2 illustrates the municipal operations inventory.

**Table 30 2021 Elk Grove City Operations GHG Emissions Inventory**

| Sector | $MTCO_2e$ | Percent of Total |
|---|---|---|
| Buildings and Facilities | 1,741 | 41% |
| Streetlights and Traffic Signals | 893 | 21% |
| Employee Commute | 835 | 20% |
| Vehicle Fleet | 620 | 15% |
| Solid Waste | 139 | 3% |
| Water Supply | 9 | <1% |
| Wastewater Treatment | 7 | <1% |
| Process and Fugitive Emissions | 32 | <1% |
| **Total** | **4,275** | **100%** |

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

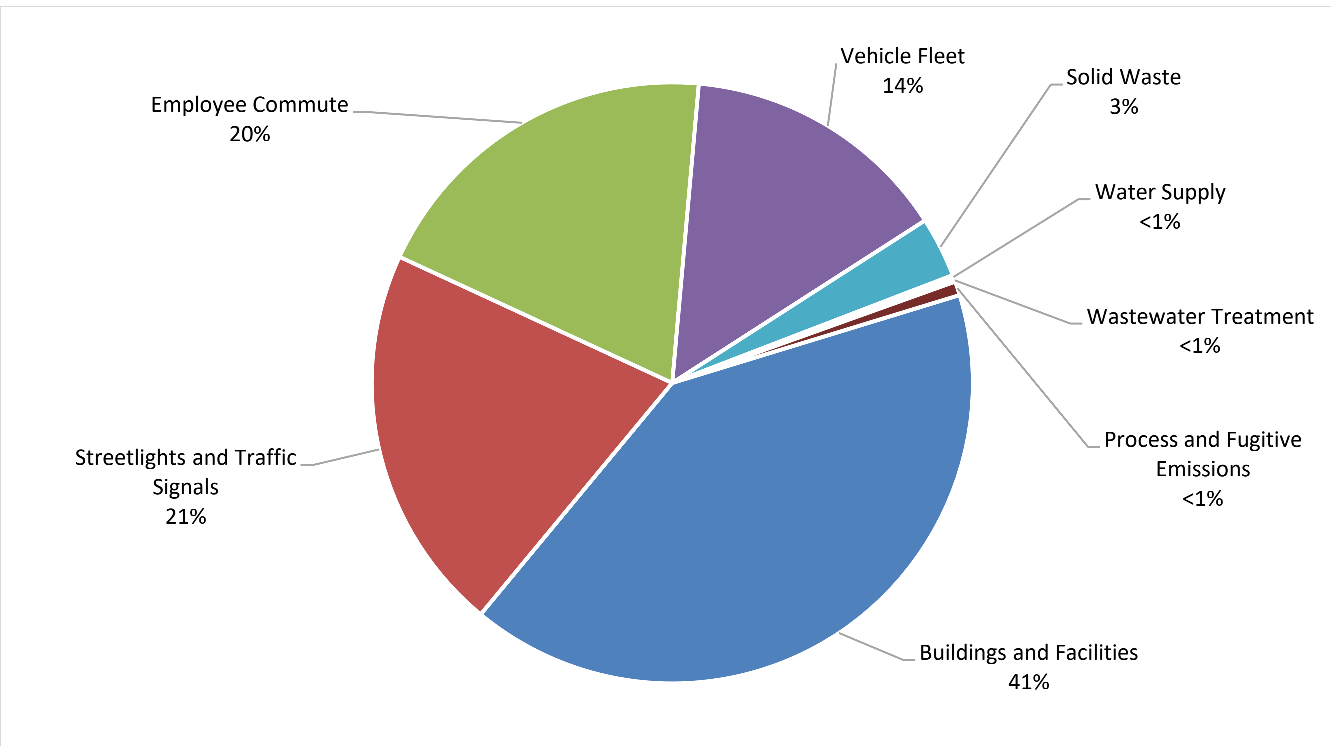


Figure 2 2021 City of Elk Grove City Operations GHG Emissions Inventory

### 4.2.2 2019 to 2021 City Operations Inventory Comparison

This section compares the City's 2021 municipal inventory to the City's 2019 municipal inventory, which is the last municipal inventory completed. Table 31 presents the total emissions for each inventory year by sector, as well as the percent change in emissions from 2019 to 2021.

**Table 31 2019 and 2021 Elk Grove City Operations GHG Emissions Inventory**

| Sector | 2019 GHG Emissions ($MTCO_2e$) | 2021 GHG Emissions ($MTCO_2e$) | Percent Change 2019 to 2021 |
|---|---|---|---|
| Buildings and Facilities[1] | 643 | 1,741 | +171% |
| Streetlights and Traffic Signals | 617 | 893 | +45% |
| Employee Commute | 1,143 | 835 | -27% |
| Vehicle Fleet | 909 | 620 | -32% |
| Solid Waste | 83 | 139 | +68% |
| Water Supply[2] | N/A | 9 | N/A |
| Wastewater Treatment | 34 | 7 | -80% |
| Process and Fugitive Emissions[3] | 5 | 32 | +540% |
| **Total** | **3,434** | **4,725** | **+25%** |

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent; N/A = not available.

[1] This increase is due to a higher electricity emissions factor and higher natural gas use in 2021.

[2] This sector was not assessed in the 2019 City operations inventory.

[3] This increase is due to higher natural gas use in 2021 associated with new City facilities

Source: Data compiled and modeled by Ascent in 2023.

Based on the modeling conducted, GHG emissions from City operations increased by approximately 25 percent from 2019 to 2021. In general, differences in GHG emissions estimates between the inventories can be explained by:

- differences in data sources between inventories,
- the use of different GWP values between inventories,
- adjustments in calculation methodologies (e.g., equations and emissions factors), and
- differences in data included in each sector.

# 5 REFERENCES

California Air Resources Board (CARB). 2006. Rulemaking to Consider Proposed Amendments to the Stationary Diesel Engine Control Measure - Appendix D: Emission Inventory Methodology Agricultural Irrigation Pumps - Diesel. Available: https://ww2.arb.ca.gov/sites/default/files/barcu/regact/agen06/append.pdf. Accessed August 3, 2023.

———. 2016. Method for Estimating Greenhouse Gas Emission Reductions from Diversion of Organic Waste from Landfills to Compost Facilities. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/waste/cerffinal.pdf. Accessed August 3, 2023.

———. 2017. *California's 2017 Climate Change Scoping Plan*. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf. Accessed August 3, 2023.

———. 2022. California GHG Emission Inventory Data: Query Tool for years 2000-2020. Available: https://ww2.arb.ca.gov/applications/greenhouse-gas-emission-inventory-0. Accessed August 3, 2023.

California Department of Food and Agriculture. 2021. *Fertilizing Materials Tonnage Report*. Available: https://www.cdfa.ca.gov/is/ffldrs/pdfs/2021_Tonnage.pdf. Accessed August 3, 2023.

California Energy Commission. 2023. 2021 Power Content Label. Sacramento Municipal Utility District. Available: https://www.energy.ca.gov/filebrowser/download/4674. Accessed October 23, 2023.

California Governor's Office of Planning and Research. 2017. *General Plan Guidelines, Chapter 8: Climate Change*. Available: https://opr.ca.gov/planning/general-plan/guidelines.html. Accessed August 3, 2023.

CARB. *See* California Air Resources Board.

CDFA. *See* California Department of Food and Agriculture.

CEC. *See* California Energy Commission.

County of Sacramento. 2021. Sacramento County Crop Report. Available: https://agcomm.saccounty.gov/Documents/CropandLivestockReports/2021.pdf. Accessed August 3, 2023.

CPUC. *See* California Public Utilities Commission.

California Public Utilities Commission. 2014 (May). Decision Adopting Rules to Provide Access to Energy Usage and Usage-Related Data While Protecting Privacy of Personal Data. Available: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M090/K845/90845985.PDF. Accessed August 3, 2023.

EPA. *See* US Environmental Protection Agency.

ICLEI. *See* ICLEI – Local Governments for Sustainability.

IPCC. *See* Intergovernmental Panel on Climate Change.

ICLEI – Local Governments for Sustainability. 2019. US Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. Version 1.2. Available: https://icleiusa.org/us-community-protocol/. Accessed August 3, 2023.

———. 2010. Local Government Operations Protocol (LGOP) for the Quantification and Reporting of Greenhouse Gas Emissions Inventories. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/protocols/lgo_protocol_v1_1_2010-05-03.pdf. Accessed August 3, 2023.

Intergovernmental Panel on Climate Change. 2023 (March). AR6 Synthesis Report: Climate Change 2023 – Annex II. Available: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Annex-II.pdf. Accessed August 8, 2023.

OPR. *See* California Governor's Office of Planning and Research.

TCR. *See* The Climate Registry.

The Climate Registry. 2023. *2023 Default Emission Factor Document*. Available: 2023-Default-Emission-Factors-Final-1.pdf (theclimateregistry.org). Accessed August 3, 2023.

US Department of Agriculture. 2017. Census of Agriculture County Profile: Sacramento County. Available: https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/California/cp06067.pdf. Accessed August 3, 2023.

US Environmental Protection Agency. 2023. Download Data: eGRID with 2021 Data. Available: https://www.epa.gov/egrid/download-data. Accessed August 3, 2023.

USDA. *See* US Department of Agriculture.