CITY OF ELK GROVE
CITY COUNCIL STAFF REPORT

AGENDA TITLE:	**Receive Information on the 2024 Climate Compass and provide direction as needed**
MEETING DATE:	**July 24, 2024**
PREPARED BY:	**Carrie Whitlock, AICP, Strategic Planning and Innovation Program Manager**
DEPARTMENT HEAD:	**Christopher Jordan, AICP, Director of Strategic Planning and Innovation**

RECOMMENDED ACTION:

Staff recommends that the City Council receive information regarding the Climate Compass, the 2024 update to the City's Climate Action Plan, and provide direction on potential programs as needed.

BACKGROUND INFORMATION:

In February 2019, the City Council approved an update to the Elk Grove *Climate Action Plan* (CAP). The 2019 CAP is a plan for reducing greenhouse gas (GHG) emissions consistent with state-adopted targets and a programmatic tiering document under the California Environmental Quality Act (CEQA) for discretionary development. A programmatic tiering document can help reduce time and cost for future development projects that are subject to CEQA.

Since the 2019 CAP was adopted, significant changes have occurred at the federal and state levels to address climate change. This includes moves at the federal level to increase carbon-free electricity generation and accelerate the shift to zero-emission vehicles. In addition, the State of California has moved aggressively to address climate change in recent years. SB 32, passed in 2016, set the state's GHG emissions reduction target to 40% below 1990 levels by 2030. The Climate Crisis Act (AB 1279) was passed in 2022, requiring the state to achieve net zero GHG emissions by 2045. The California Air Resources Board's 2022 Scoping Plan seeks to achieve this carbon neutrality goal through a combination of an 85% reduction in anthropogenic emissions (human-related emissions of greenhouse gases), as well as a 15% reduction achieved via carbon capture and carbon sequestration (the process of capturing and storing atmospheric carbon dioxide). To meet these ambitious targets by 2045, the 2022 Scoping Plan assumes a steeper reduction for interim years than is required under SB 32. The 2022 Scoping Plan shows that statewide emissions must be reduced by 48% below 1990 levels by 2030 to remain on a trajectory towards an 85% reduction by 2045. The CAP adopted in 2019 included measures sufficient to achieve the City's fair share of the SB 32 target for 2030 but would require additional reduction measures to achieve the new 2045 targets included in AB 1279 and the 2030 trajectory included in the 2022 Scoping Plan.

In March 2023, staff initiated an update to the 2019 CAP. The update, titled the Climate Compass, is intended to ensure the City remains consistent with new state policies and regulations and identify new programs, technologies, and emissions reduction strategies that can be leveraged to meet the City's GHG reduction goals. This update process is currently underway and expected to continue through spring 2025.

This report is the first in a series of three where staff will introduce the Climate Compass project and seek Council feedback on potential policy and program considerations, which will inform the ultimate plan. Future Council meetings will focus on those sectors which account for the largest GHG emissions, including building and energy, and transportation. This Council meeting will focus on sectors which may have a smaller GHG emission reduction impact but demonstrate City leadership in addressing climate adaptation, resilience, and sustainability. Following the Council sessions, additional work will be done on analyzing the actions, including quantification of GHG reductions, costing, and effort, to develop a final list for inclusion in the proposed Climate Compass.

This series of presentations is part of a larger community engagement effort, described later in this report, that has included residents and the business community, development stakeholders, and related agencies (e.g., SMUD, Air District).

<u>ANALYSIS/DISCUSSION</u>:

CEQA Requirements

CEQA allows for the tiering, or streamlining, of GHG analyses for individual discretionary development projects under a programmatic GHG reduction plan, such as a CAP. This creates efficiencies for new development applications and reduces the time and expense of preparing project-specific analysis. The majority of development applications since the original CAP in

2014 have taken advantage of this approach and included the CAP measures as part of their project descriptions.

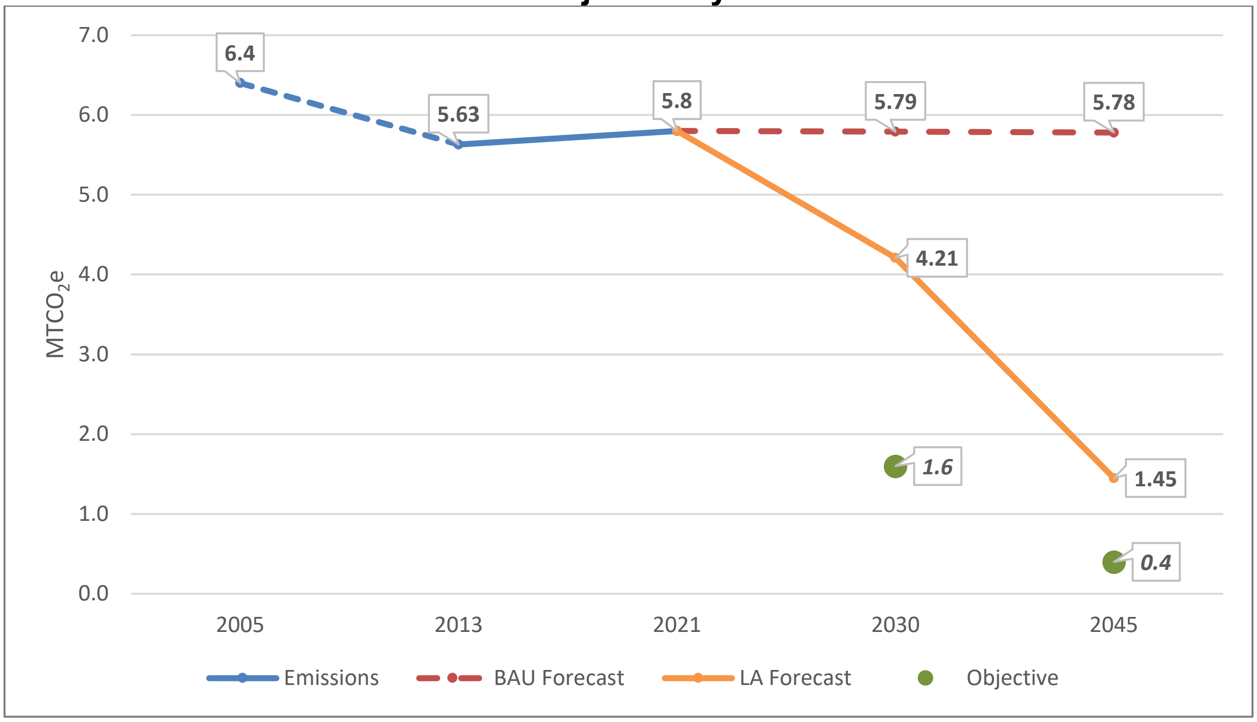
To qualify for CEQA streamlining, a CAP must meet certain technical requirements, including quantifying existing and forecasted GHG emissions, establishing thresholds for GHG emissions, specifying measures and standards that would collectively achieve the target emissions levels, and include a monitoring plan. The Climate Compass is being developed to meet these requirements.

While the precise environmental document for the Climate Compass has not yet been finally determined, staff anticipates the environmental document will be a Subsequent or Supplemental Environmental Impact Report in order to continue providing CEQA streamlining for appropriate future development projects within the city.

Greenhouse Gas Emissions Inventory and Forecast
As noted, CEQA Guidelines 15183.5(b)(1)(A) require the quantification of GHG emissions and projections for a specific timeframe. Therefore, the Climate Compass work started with a GHG inventory and forecasting for both community-wide emissions and local government operations (LGO) emissions. For a full description and methodology of the GHG emission inventory see Attachment 2. For a full description and methodology of the GHG emission forecast see Attachment 3. For a summary of what is included in the GHG emissions inventory and forecast see Attachment 1.

Communitywide Emissions and Forecast
The results of the communitywide GHG emissions inventory and forecasting (Chart 1) show that the City would not meet the updated state objectives for 2030 and 2045 utilizing only the state-mandated climate reductions. Chart 1 shows this through existing emissions (in blue) and projected (future) emissions. The future emissions are shown in an unmitigated “business-as-usual” (BAU) forecast and a forecast that includes current state and federal legislation/regulations (the legislative-adjusted (LA) forecast shown in orange). The state objectives are shown as green dots. The gap between the orange and green needs to be achieved through local actions to further reduce GHG emissions.

Chart 1: Elk Grove Per Capita GHG Emissions Inventory, Forecast, and State Objective by Year



The GHG inventory for the Climate Compass was conducted in 2023 and finalized in early 2024. The base year used for the inventory was 2021, as it was the most recent year with complete data available at the time of the inventory. The results of the community GHG inventory are summarized in the table below. The largest emissions-generating sectors include on-road transportation (56 percent) and building energy (38 percent), which collectively accounted for approximately 94 percent of all community emissions in 2021.

Table 1: 2021 Elk Grove Communitywide GHG Emissions Inventory

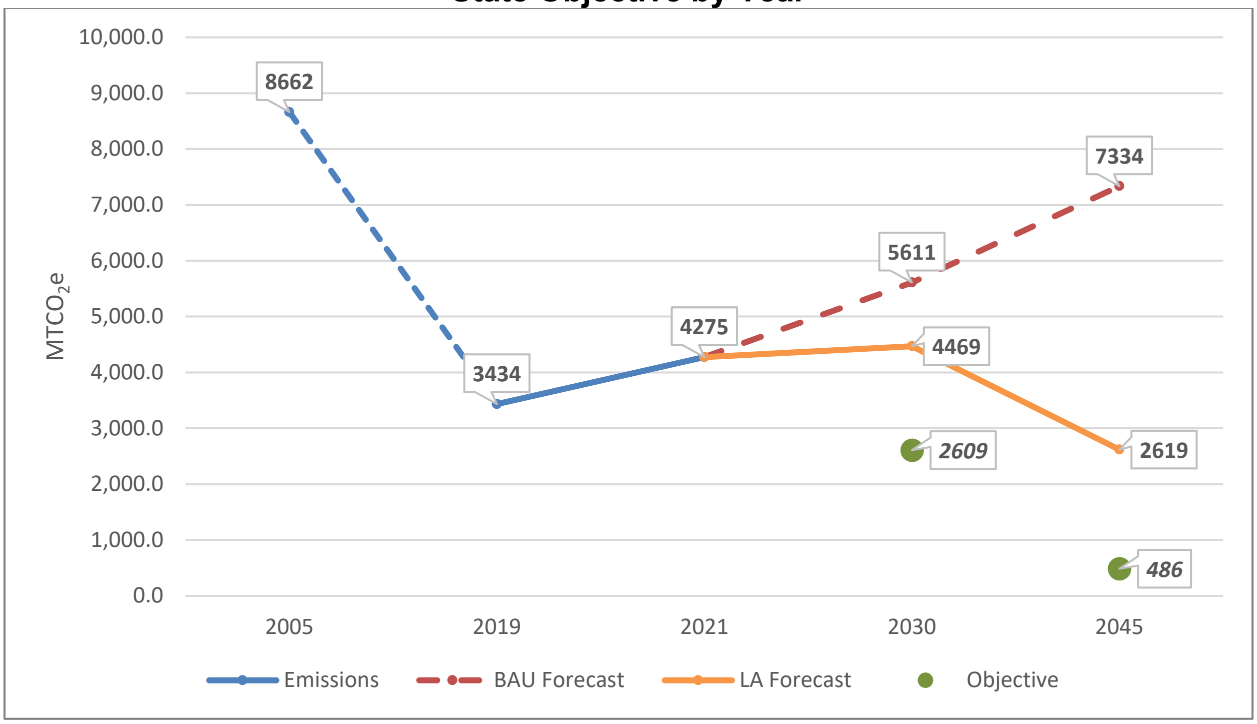
Sector	GHG Emissions ($MTCO_2e$)	Percent of Total
On-Road Transportation	586,220	56%
Building Energy (Includes Residential and Nonresidential)	398,365	38%
Solid Waste	20,222	2%
Off-Road Vehicles and Equipment	18,341	2%
Wastewater Treatment	2,957	<1%
Water Supply	2,802	<1%
Agriculture	10,275	<1%
Total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

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

Local Government Operations Emissions and Forecast

The results of the LGO GHG inventory and forecasting (Chart 2) show a significant drop in GHG emissions since the first LGO inventory was conducted in 2005. The BAU forecast shows that there would be a significant increase in emissions with no action. The current state and federal legislation/regulation (LA forecast) does achieve significant reductions by 2045, but these actions also would be insufficient to achieve state objectives for 2030 and 2045.

Chart 2: Local Government GHG Emissions Inventory, Forecast, and State Objective by Year



Proposed Strategies

The City is already working on reducing community-wide and LGO GHG emissions through the 2019 CAP and other sustainability efforts. As noted, the measures included in the 2019 CAP are insufficient to align with the newest state requirements. To reach the targets, further measures and actions will be needed.

There are many strategies and actions that the City can include in the Climate Compass to further reduce GHG emissions and align with the state targets. Receiving early Council input on strategy concepts will guide staff for further refinement before receiving public input and finalizing for adoption.

Some initial strategy concepts related to resilience and adaptation, resource consumption, and the green economy are presented below and will be discussed during the presentation. Strategies and actions related to the highest emission categories of buildings and energy, and transportation will be discussed at future City Council meetings. Staff is seeking initial feedback from Council on interest in the types of strategies. Based upon this input, staff will develop a comprehensive analysis of the benefits and costs associated with each prior to inclusion of the strategy in the final plan.

- Concept Strategy 1: Reduce Exposure to Extreme Heat and Mitigate the Urban Heat Island Effect
    - Action: Consider establishing heat mitigation measures for public spaces, including specific design features, cooling materials and treatments, and increased tree/landscaping requirements.
- Concept Strategy 2: Expand the Urban Tree Canopy
    - Action: Consider updates to the Tree Preservation and Protection Regulations to improve effectiveness and ensure tree canopy enhancement. Update tree planting requirements for new developments to increase tree canopy coverage.
- Concept Strategy 3: Expand Nature-Based Solutions
    - Action: Explore incentivizing climate smart land management in the rural area of the city, such as increasing tree canopy coverage, development that promotes groundwater recovery, and additional land use protections that restrict densification.
    - Action: Evaluate rural lands for current and historical carbon storage (including mapping and modeling), the potential for future carbon sequestration with restoration, avoided conversion, or management, and the stability of the stored carbon and risk of carbon loss due to climate change or land use change.
    - Action: Assist agricultural operations in developing and implementing climate change mitigation and adaptation plans, such as Carbon Farm Plans.
- Concept Strategy 4: Promote a Circular Economy[1]
    - Action: Undertake a Circular Economy Baseline Assessment of existing waste streams, resource flows, and economic activities to identify opportunities and areas of highest potential.
    - Action: Partner with the Sacramento Public Library to expand the Library of Things Program to Elk Grove.

[1] A circular economy keeps materials and products in circulation for as long as possible, through sharing, reusing, repairing, refurbishing, repurposing, and recycling.

- Concept Strategy 5: Reduce Water Use
  - Action: Mandate water efficiency standards for new construction that require water-neutral development for projects expected to exceed the historical water use of a parcel. If a project exceeds water use, the developer must offset the new water demand by installing water-efficient fixtures on the property or paying a fee to support fittings at existing properties elsewhere in the City.
- Concept Strategy 6: Conduct Meaningful Community Outreach
  - Action: Develop a neighborhood resilience committee program to increase connectedness among community members and provide support during climate hazard events, such as extreme heat events.

Ongoing Engagement Efforts
Community outreach and engagement are key activities in both the development of the Climate Compass and the long-term success of the strategies and actions, as voluntary behavior change by residents and business owners is foundational for achieving GHG emission reductions. Over the past 15 months, City staff have involved community members and stakeholders to gather input for the Climate Compass. Over 35 engagement opportunities have already taken place, and staff will continue outreach efforts by adopting and implementing the Climate Compass. Some of these efforts have included:

- Forming a Technical Advisory Group: This group includes representatives from local and regional climate-related organizations, utility providers, and stakeholders. This group reviewed current strategies and actions and identified additional actions to further GHG emission reductions.
- Creating a Climate Ambassador Program: This program has involved community members to support greater outreach and engagement efforts. The program provided training and information to volunteer residents and business owners from across the community's demographic spectrum and has greatly expanded the City's ability to gather broader input.
- Undertaking Community Engagement Activities: In addition to the Climate Ambassador Program, staff have undertaken broad engagement efforts, including in-person and virtual workshops, pop-up activities at local events, web-based data sharing and input, and online surveys.

The Climate Compass is anticipated to be completed in the spring of 2025 and returned to the City Council for consideration. This anticipated completion date is subject to adjustment depending on the progress of the development of the Climate Compass and associated environmental review.

FISCAL IMPACT:

Costs associated with preparing the Climate Compass were included in the current and prior Fiscal Year budgets. Implementation of the Climate Compass will include both City and private actions. For private development, these costs are the responsibility of the developer. However, several local, state, and federal incentives are available for certain requirements, including design funding and construction incentives from SMUD and tax credits. The Climate Compass will discuss funding strategies and costs for near-term actions.

ATTACHMENTS:

1. Summary of GHG Emissions Inventory and Forecast
2. Elk Grove GHG Inventory Memo
3. Elk Grove GHG Forecast Memo

Summary of Greenhouse Gas Emissions Inventory and Forecast

As noted, CEQA Guidelines 15183.5(b)(1)(A) require the quantification of GHG emissions and projections for a specific timeframe. Therefore, the Climate Compass work started with a GHG inventory for both community-wide emissions and local government operations (LGO) emissions. A GHG emissions inventory is a snapshot of the emissions associated with activities within the jurisdiction's boundaries in a given year or, for an LGO inventory, the emissions that are a result of day-to-day operations of City services and facilities. An inventory aims to understand the sectors and sources generating GHG emissions and their relative contribution to total emissions and to establish a baseline for monitoring future progress toward GHG reduction targets.

Projection of future GHG emissions, or forecasting, is also a part of the CEQA Guidelines. The purpose of a GHG emissions forecast for a CAP is to estimate how GHG emissions may evolve in the future given changes in population and housing, economic growth, and local operations, and how state and federal legislation may help to reduce local emissions. The forecast provides two scenarios: a baseline scenario where GHG emissions grow from 2021 levels at the same rates as housing, population, employment, and vehicle travel, which is known as a business-as-usual scenario (BAU) forecast; and a scenario which considers the local GHG reduction impact of state and federal legislation/regulation, which is known as a legislative-adjusted business-as-usual scenario (LA-BAU) forecast. The LA-BAU forecast shows how currently adopted state and federal legislation can help to meet local GHG reduction targets.

Communitywide Emissions and Forecast

The GHG inventory for the Climate Compass was initiated in 2023 and finalized in early 2024. The base year used for the inventory was 2021, the most recent year with complete data available at the time of the inventory. The results of the community GHG inventory are summarized in the table below. The largest emissions-generating sectors include on-road transportation (56 percent) and building energy (38 percent), which collectively accounted for approximately 94 percent of all community emissions in 2021.

Table 1: 2021 Elk Grove 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%
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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. $MTCO_2e$ = metric tons of carbon dioxide equivalent

The total of 1,039,181 $MTCO_2e$ translates to a per capita emission of 5.8 $MTCO_2e$ for 2021. The 2019 CAP included a target of 7.6 $MTCO_2e$ per capita for 2020 and 4.1 $MTCO_2e$ by 2030, meaning that the City is currently on track to achieve its current 2030 objectives. Calculating per capita emissions is useful for comparing and tracking emissions changes even as the population grows.

For the community-wide emissions, forecasts were modeled for every five years between 2030 and 2050 based on projected population, households, employment, and annual VMT. The forecasted emissions for 2030 and 2045 for both BAU and LA-BAU are shown in the tables below for total emissions and per capita emissions.

Table 2A: Forecasted Total Emissions

Sector	$MTCO_2e$				
	2021 actual emissions	2030		2045	
		BAU	LA-BAU	BAU	LA-BAU
On-Road Transportation	586,220	718,743	446,591	926,109	130,040
Residential Building Energy	271,900	347,631	299,782	466,486	178,777
Nonresidential Building Energy	126,465	193,762	152,746	298,428	55,643
Solid Waste	20,222	26,034	26,034	36,165	36,165
Off-Road Vehicles and Equipment	18,341	25,296	25,296	36,158	36,158

Agriculture[1]	10,275	4,372	3,869	1,154	575
Wastewater Treatment	2,957	6,707	6,707	9,317	9,317
Water Supply	2,802	3,731	2,875	5,183	0
Total	**1,039,181**	**1,326,277**	**963,901**	**1,779,000**	**446,674**
Percent Change from 2021 Levels	-	*28%*	*-7%*	*71%*	*-57%*
State Reduction Objective[2]		372,593		107,479	
Difference from Total		(953,684)	(699,743)	(1,671,521)	(530,618)

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent
[1] Agricultural emissions are anticipated to decrease in both forecast scenarios because the acres in agricultural production in the city limits are anticipated to decrease over the coming decades.

[2] State reduction objectives are calculated as 48% reduction from 1990 levels for 2030 and 85% reduction from 1990 levels for 2045 (1990 levels calculated as a 15% reduction from 2005 GHG inventory per CARB guidelines).

Table 2B: Forecasted Per Capita Emissions

Sector	$MTCO_2e$				
	2021 actual emissions per capita	2030		2045	
		BAU	LA-BAU	BAU	LA-BAU
On-Road Transportation	3.27	3.14	2.42	3.01	1.05
Residential Building Energy	1.52	1.52	1.31	1.52	0.58
Nonresidential Building Energy	0.71	0.85	0.67	0.97	0.18
Solid Waste	0.11	0.11	0.11	0.12	0.12
Off-Road Vehicles and Equipment	0.10	0.11	0.11	0.12	0.12
Agriculture[1]	0.06	0.02	0.02	0.00	0.00
Wastewater Treatment	0.02	0.03	0.03	0.03	0.03
Water Supply	0.02	0.02	0.01	0.02	0.00
Total	**5.80**	**5.79**	**4.68**	**5.78**	**2.07**
Percent Change from 2021 Levels	-	*-0.2%*	*-19.3%*	*-0.2%*	*-64.2%*
State Reduction Objective[2]		1.63		0.35	
Difference from Total		(4.16)	(3.05)	(5.43)	(1.73)

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent
[1] Agricultural emissions are anticipated to decrease in both forecast scenarios because the acres in agricultural production in the city limits are anticipated to decrease over the coming decades.

[2] State reduction objectives are calculated as 48% reduction from 1990 levels for 2030 and 85% reduction from 1990 levels for 2045 (1990 levels calculated as a 15% reduction from 2005 GHG inventory per CARB guidelines).

The reductions in emissions related to the LA-BAU forecast is due to several factors, including:

- a greater renewable mix in electricity as required by SB100 (60 percent by 2030 and 100 percent by 2045);
- improved building energy efficiency through compliance with the California Building Energy Efficiency Standards (Title 24); and
- reductions in on-road vehicle emissions resulting from state vehicle standards included in Advanced Clean Cars II (ACCII), and Advanced Clean Fleet (ACF) regulations.

Local Government Operations Emissions and Forecast

The results of the LGO GHG inventory are summarized in Table 3. The largest emissions-generating sectors also relate to transportation (including employee commute and vehicle fleet, which together account for 35 percent) and buildings and facilities (including buildings and facilities, and streetlights and traffic signals, which together account for 62 percent). These sectors collectively accounted for approximately 97 percent of all LGO emissions in 2021.

Table 3: Local Government Emissions

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

GHG emissions forecasts were also calculated for city operations and services using projected growth in City staff between 2021 and 2045. Both a BAU and LA-BAU scenario were calculated and are shown in Table 4.

Table 4: Local Government Emissions Forecast with Legislative Reductions

Sector	2021 actual emissions	MTCO2e			
		2030		2045	
		BAU	LA-BAU	BAU	LA-BAU
Buildings and Facilities	1,741	2,304	2,054	2,987	1,588
Streetlights and Traffic Signals	893	1,136	907	1,532	0
Employee Commute	835	1,104	769	1,432	201
Vehicle Fleet	620	820	497	1,064	533
Solid Waste	139	184	184	239	239
Wastewater Treatment	7	8	7	11	3
Water Supply	9	12	9	16	0
Process and Fugitive Emissions	32	42	42	55	55
Total	**4,275**	**5,611**	**4,470**	**7,334**	**2,619**
Percent Change from 2021 Levels	—	*31%*	*5%*	*72%*	*-39%*

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

Similar to the community-wide forecast, the reductions in emissions related to the LA-BAU 2045 forecast are primarily due to several factors, including:

- a greater renewable mix in electricity as required by SB100, which results in the elimination of emissions from streetlights and traffic signals by 2045, since these are all electric; and
- reductions in on-road vehicle emissions resulting from state vehicle standards included in Advanced Clean Cars II (ACCII) regulations, resulting in significant emissions reductions from employee commutes.

Memo

455 Capitol Mall, Suite 300
Sacramento, CA 95814
916.444.7301

Date: November 1, 2023

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

From: Lisa Fenton, Hannah Kornfeld, Brenda Hom, and Honey Walters (Ascent)

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	Off-road vehicles and equipment activity and emissions factors data from CARB
	Emissions factor	
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.

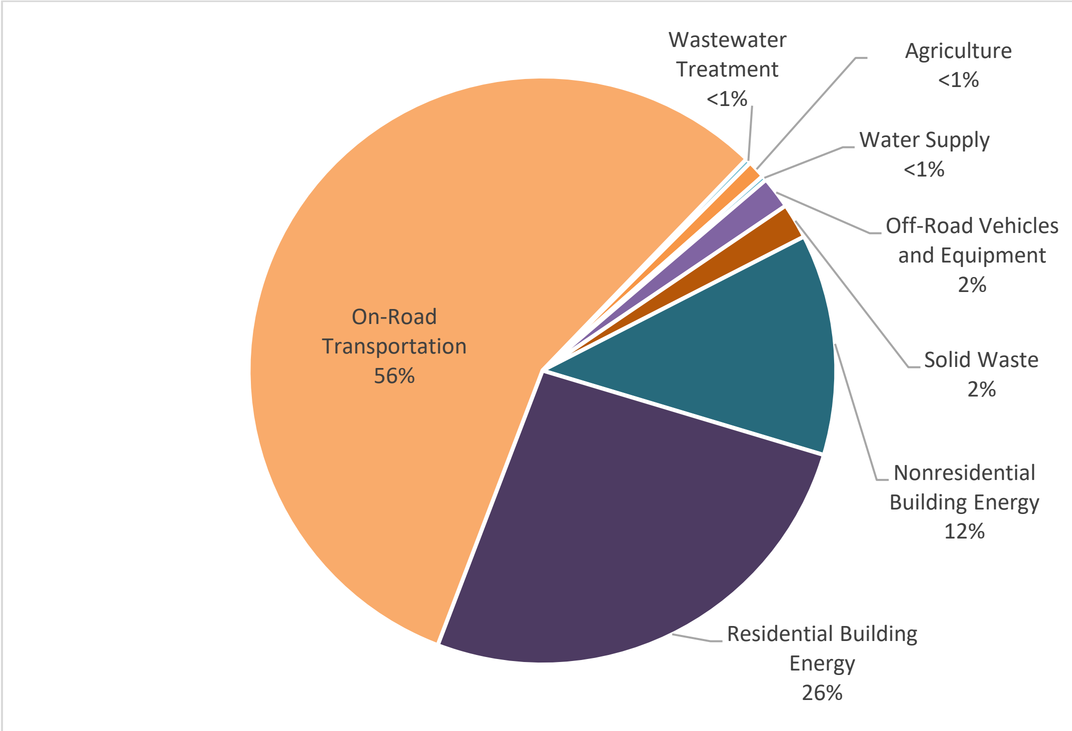

Figure 1 2021 City of Elk Grove Community GHG Emissions Inventory

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.

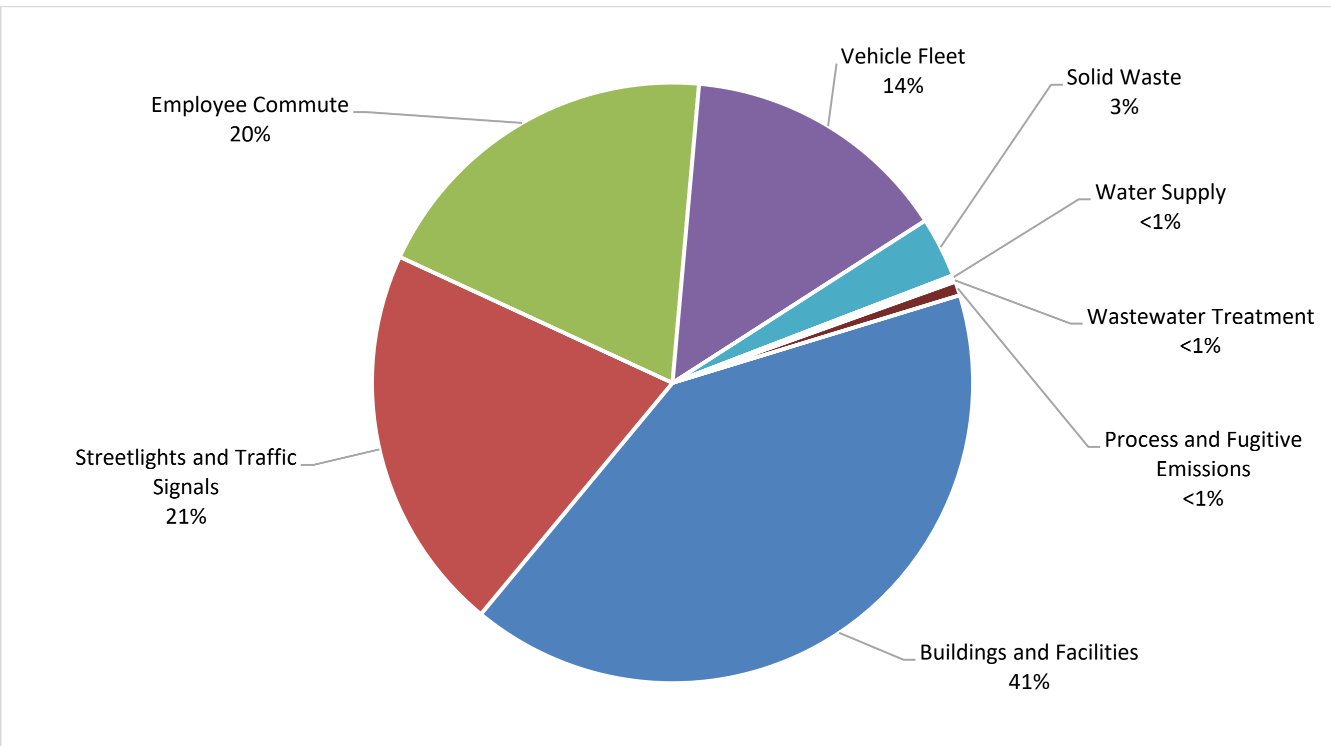

Figure 2 2021 City of Elk Grove City Operations GHG Emissions Inventory

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.

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Memo

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Date: March 20, 2024

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

From: Brenda Hom, Hannah Kornfeld, Sonam Sahu, and Honey Walters (Ascent)

Subject: **City of Elk Grove Climate Compass: Final Greenhouse Gas Emissions Forecasts Memorandum**

INTRODUCTION

The City of Elk Grove (COEG) is developing its *Climate Compass: A Plan for Implementing Elk Grove's Climate, Sustainability, and Resilience Goals* (Climate Compass), the update to the City's 2019 Climate Action Plan (CAP). The goal of the Climate Compass is to provide a comprehensive and transformative framework for both mitigating and adapting to climate change while also supporting COEG's broader sustainability and resilience goals.

In preparation of the Climate Compass, COEG first completed a baseline greenhouse gas (GHG) emissions inventory to estimate emissions from the community and from COEG operations in 2021. The next step in this process is to forecast these GHG emissions and establish reduction targets. This technical memorandum provides the results of these forecasts as well as associated methods, assumptions, emissions factors, and data sources. The GHG emissions forecasts will provide the foundation for the forthcoming steps of the Climate Compass planning process, including the development and quantification of GHG emissions reduction measures and "gap analysis" evaluation (i.e., the calculated gap between the estimated GHG reductions from local action and the established targets).

ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of two main parts:

- **Section 1: Summary of Inventory Results** presents an overview of the city's 2021 community and COEG operations inventories.
- **Section 2: Greenhouse Gas Emissions Forecasts** summarizes the forecasted GHG emissions under "business-as-usual" (BAU) and legislative-adjusted BAU scenarios for years 2030, 2035, 2040, 2045 and 2050 for the community inventory and for years 2030 and 2045 for COEG operations inventory.

1 SUMMARY OF INVENTORY RESULTS

1.1 2021 COMMUNITY INVENTORY

Based on the modeling conducted, community activities in the city generated approximately 1,039,181 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2021. The largest emissions-generating sectors include on-road transportation and building energy. The 2021 inventory serves as the city's GHG emissions baseline for the Climate Compass to forecast emissions and set emissions reduction targets. Table 1 and Figure 1 present the results of the city's 2021 community GHG emissions inventory by sector. A description of each emissions sector, including key sources of emissions, is provided in further detail in the *City of Elk Grove Climate Compass: Greenhouse Gas Inventory Update Technical Memorandum*.

Table 1 2021 Elk Grove Community GHG Emissions Inventory

Sector	GHG Emissions ($MTCO_2e$)	Percent of Total
On-Road Transportation	586,220	56%
Building Energy	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.

Source: Data modeled by Ascent in 2023.

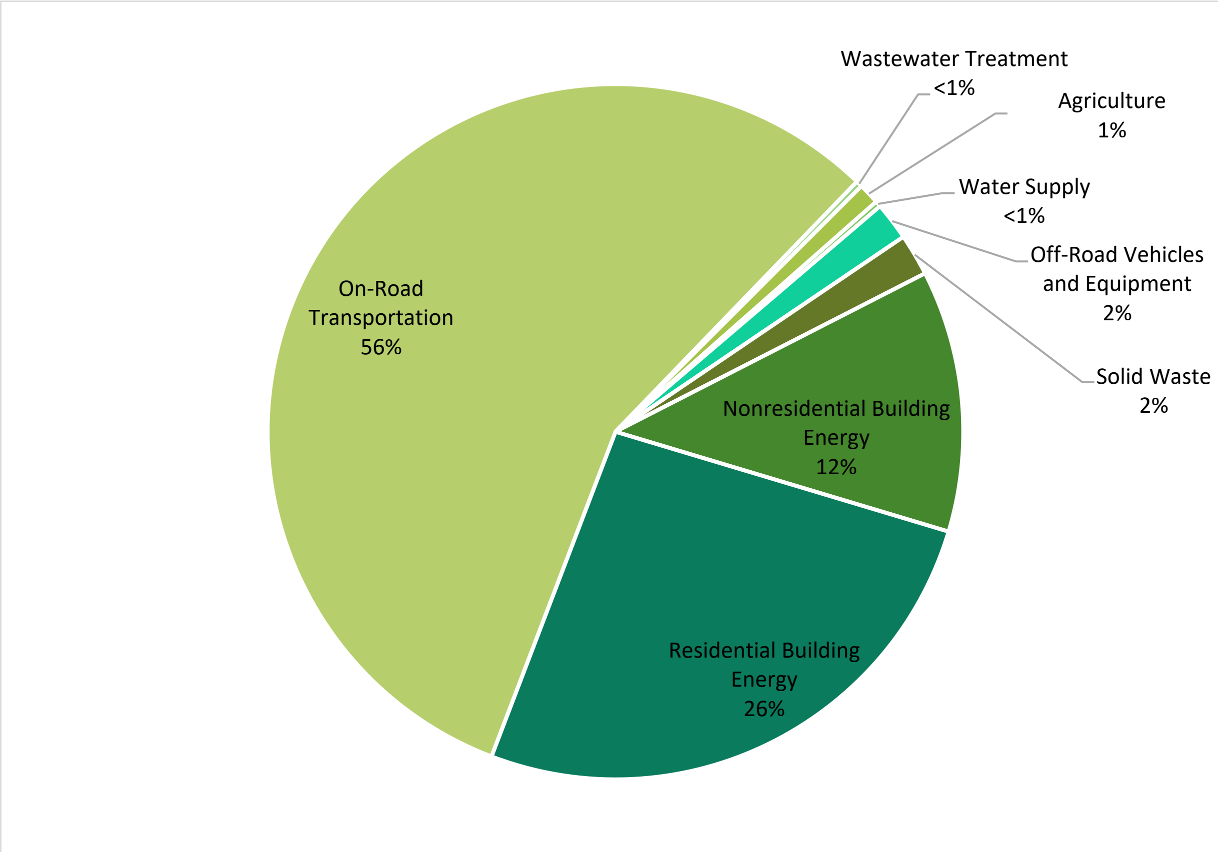

Figure 1 **2021 City of Elk Grove Community GHG Emissions Inventory**
Source: Prepared by Ascent in 2023.

1.2 2021 CITY OF ELK GROVE'S OPERATIONS INVENTORY

Based on modeling conducted, COEG operations generated approximately 4,275 $MTCO_2e$ in 2021, which makes up less than one percent of the community emissions. Buildings and facilities, streetlights and traffic signals, and employee commute are the largest emissions-generating sectors. The 2021 City operations inventory serves as the baseline for forecasting COEG operations. Table 2 and Figure 2 present COEG's 2021 operations GHG emissions inventories by sector. A description of each emissions sector, including key sources of emissions, is provided in further detail in the *City of Elk Grove Climate Compass: Greenhouse Gas Inventory Update Technical Memorandum*.

Table 2 2021 City of Elk Grove 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	14%
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. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

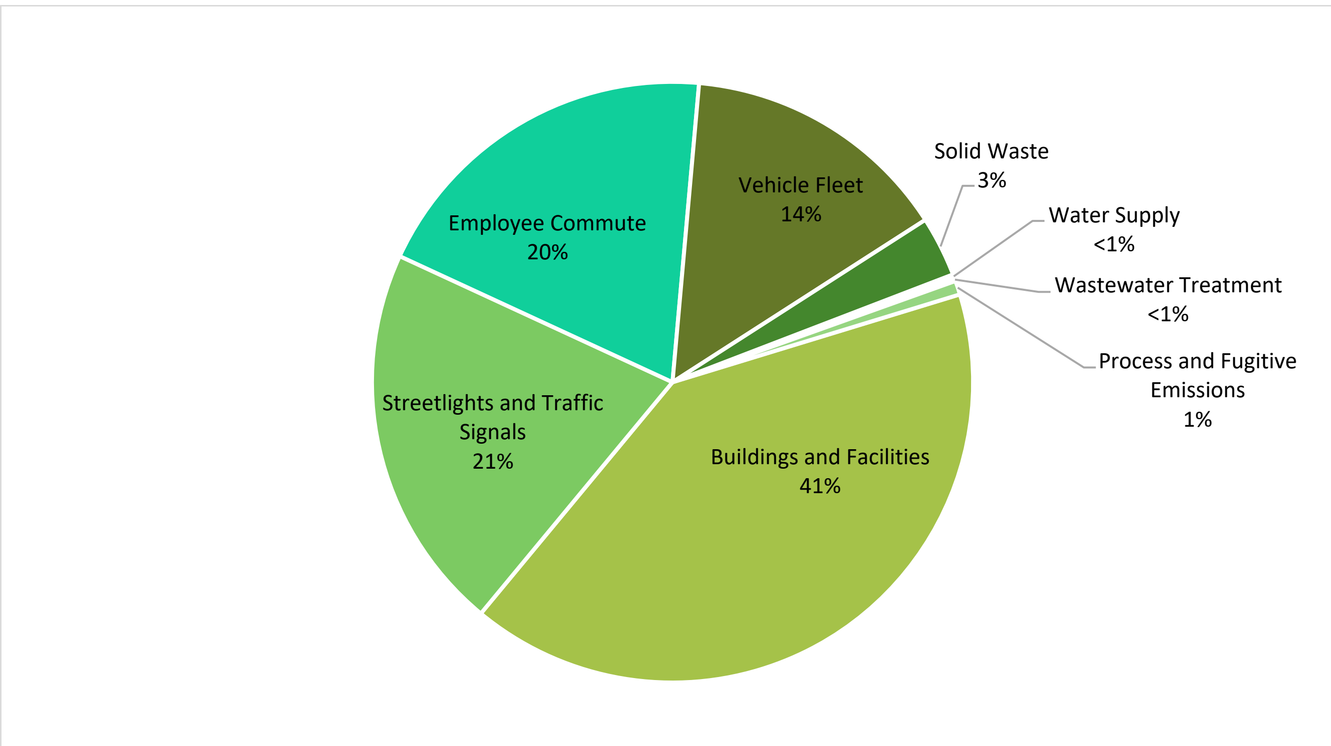

Figure 2 2021 City of Elk Grove Operations GHG Emissions Inventory
Source: Prepared by Ascent in 2023.

2 GREENHOUSE GAS EMISSIONS FORECASTS

The purpose of GHG emissions forecast for a CAP prepared by a local agency is to estimate how community and government operations GHG emissions may evolve in the future given changes in population and housing, economic growth, and local operations, and how state and federal legislation may help to reduce local emissions. Developing a GHG emissions forecast is an essential step in the climate action planning process, as it provides insight into what future emissions levels may be, and the necessary scale of action that may be needed in each GHG emissions sector to reduce emissions within local control for state GHG reduction target alignment.

The updated GHG emissions forecast prepared for the city is presented as a sector-level assessment of GHG emissions forecasts based on current conditions under two scenarios. The first scenario is a baseline scenario where GHG emissions grow from 2021 levels at the same rates as housing, population, employment, and vehicle travel, which is known as a business-as-usual scenario (BAU) forecast. The BAU forecast serves as a basis for understanding how emissions levels may change with growth, and how far GHG emissions will need to be reduced in future years to meet GHG reduction targets. The second scenario considers the local GHG reduction impact of state and federal legislation, which is known as a legislative adjusted business-as-usual scenario (legislative-adjusted BAU) forecast. The legislative-adjusted BAU forecast shows how currently adopted state and federal legislation can help the city to meet its GHG reduction targets.

As mentioned above, the Climate Compass uses an updated calendar year 2021 GHG emissions inventory for both the community and COEG operations (City of Elk Grove Climate Compass: Greenhouse Gas Inventory Update Technical Memorandum, completed November 2023), to provide a baseline for forecasting future emissions from the most recently available data.

2.1 COMMUNITY GREENHOUSE GAS EMISSIONS FORECASTS

The BAU GHG emissions forecasts provide an assessment of how emissions generated by community activities will change over time without further state, federal, regional, or local action. In addition to accounting for the city's population, employment, and land use change(s) under a BAU scenario, an adjusted BAU forecast (i.e., the legislative-adjusted BAU forecast) was prepared, which includes adopted policies and regulations at the state and federal levels that would affect emissions without any local action, such as regulatory requirements to increase vehicle fuel efficiency and increase renewable energy sources in grid electricity portfolios. These forecasts provide COEG with the information needed to focus efforts on certain emissions sectors and sources that have the greatest opportunities for GHG emissions reductions. It is important to note that the legislative-adjusted BAU forecasts only account for emissions reductions associated with adopted policies and regulations; they do not account for goals established by regional, state, and federal agencies or executive orders outside of adopted legislation and regulations.

The GHG emissions forecasts for 2030, 2035, 2040, 2045, and 2050 described in this section are aligned with the state's GHG reduction target years established in key legislation and policies, including Senate Bill (SB) 32 and Assembly Bill (AB) 1279, as well as the city's General Plan.

The adopted statewide GHG reduction targets and goals are:

- 40 percent below 1990 levels by 2030 (SB 32),
- 85 percent below 1990 levels by 2045 (AB 1279), and
- to achieve carbon neutrality no later than 2045 (AB 1279).

2.1.1 Activity Growth Forecast

The GHG emissions forecasts were based on projected changes in city demographics (i.e., population, employment, and service population [residents plus employees]) and land use between 2021 and 2050, which was provided by Fehr & Peers. These growth factors were used to forecast emissions for 2030, 2035, 2040, 2045, and 2050 for most sectors in the inventory. Additional information regarding growth factors used for each sector is included in the following sections.

Vehicle miles traveled (VMT) data were obtained from a VMT analysis conducted by Fehr & Peers using the EGSIM20 travel model. It considered daily VMT in the city and annualized the daily VMT using a factor of 334.[1] VMT estimates are associated with trips that begin or end in the city. VMT estimates included 100 percent of vehicle trips modeled to 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 0 percent of vehicle trips that are 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 SB 375 and California Air Resources Board recommendations.

VMT estimates were provided for 2021 and forecasted for 2030, 2035 2040, 2045, and 2050. Table 3 shows anticipated growth in the city for the forecast years. It is important to note that 2021 VMT is for the city limits only but forecast years include the city limits and study areas to accommodate future annexures. Both the city limit and study area VMT estimates use the RTAC method.

Table 3 Elk Grove Community Demographic and Vehicle Miles Traveled Forecasts

Forecast Factor	2021	2030	2035	2040	2045	2050
Population	179,287	229,222	255,346	281,470	307,593	333,717
Households	55,507	70,967	79,055	87,142	95,230	103,318
Employment	46,757	71,638	84,538	97,437	110,336	123,235
Annual VMT	1,136,700,664	1,362,762,808	1,481,202,826	1,599,642,844	1,718,082,863	1,836,522,881
Annual VMT per capita	6,340	5,945	5,801	5,683	5,586	5,503

Notes: VMT = vehicle miles traveled.

Sources: Modeling conducted by Fehr & Peers in 2023.

STUDY AREAS INCLUDED IN GHG EMISSIONS FORECASTS

The growth in housing units and number of employees used in the GHG emissions forecast includes growth expected to occur in Elk Grove with the annexure of four study areas. Table 4 outlines reasonably foreseeable growth assumed in the city by 2050 within the city limits and study areas.

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

Table 4 Demographic Assumptions for 2050 Included in the GHG Emissions Forecast

Plan Area	Households	Employees
City Limit (Excluding East Study Area)	76,449	74,738
East Study Area	4,806	9,183
North Study Area	323	0
South Study Area	11,379	33,694
West Study Area	10,361	5,620
Total	**103,318**	**123,235**

Source: Modeling conducted by Fehr & Peers in 2023.

2.1.2 Community Business-as-Usual Scenario Greenhouse Gas Emissions Forecast

For the community BAU forecast, the activity growth in each emissions sector was scaled using the appropriate growth scaling factors without considering the local GHG reduction impact of the state and federal legislation. The results of the community BAU forecast show that community GHG emissions would be expected to grow through 2050, given no further GHG reduction efforts beyond 2021, as shown in Table 5. Emissions are presented in units of metric tons of carbon dioxide equivalent ($MTCO_2e$). While a more realistic scenario for future GHG emissions can be provided with a legislative-adjusted BAU forecast, the BAU provides the basis for understanding the GHG impact of growth in the city.

Table 5 Elk Grove Community GHG Emissions Inventory and BAU Forecasts ($MTCO_2e$)

Sector	2021	2030	2035	2040	2045	2050
On-Road Transportation	586,220	718,743	787,865	856,987	926,109	995,231
Residential Building Energy	271,900	347,631	387,249	426,868	466,486	506,104
Nonresidential Building Energy	126,465	193,762	228,650	263,539	298,428	333,316
Solid Waste	20,222	26,034	29,411	32,788	36,165	39,542
Off-Road Vehicles and Equipment	18,341	25,296	28,917	32,537	36,158	39,778
Agriculture[1]	10,275	4,372	1,154	1,154	1,154	1,154
Wastewater Treatment	2,957	6,707	7,577	8,447	9,317	10,187
Water Supply	2,802	3,731	4,214	4,698	5,183	5,666
Total	**1,039,181**	**1,326,277**	**1,475,038**	**1,627,018**	**1,779,000**	**1,930,979**
Percent Change from 2021 Levels	-	28%	42%	57%	71%	86%

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

[1] Agricultural emissions are anticipated to decrease under the business-as-usual forecast because the acres in agricultural production in the city limits are anticipated to decrease over the coming decades.

Source: Data modeled by Ascent in 2023.

2.1.3 Community Legislative-Adjusted Business-as-Usual Scenario Greenhouse Gas Emissions Forecast

Legislative-adjusted BAU emissions forecasts were prepared using the same demographic and VMT data that were used for the BAU forecasts, while also accounting for state and federal policies and regulations that would affect local emissions. For example, growth in residential building electricity consumption was scaled using housing units as the growth scaling factor, and a legislative reduction was applied to incorporate the California Code of Regulations, Title 24, Part 6 building energy efficiency standards for new development. The GHG reductions considered in the legislative-adjusted BAU forecast fall generally into four categories: building energy efficiency standards, fuel efficiency standards, electric vehicle sales requirements, and renewable and zero carbon electricity requirements. The primary drivers of the emissions reductions are the requirements of SB 100 and SB 1020, as well as increased electric vehicle penetration from the Advanced Clean Cars II (ACC II) regulation. These forecasts provide COEG with a more robust understanding of future community emissions to assist with the prioritization of emissions reduction measures developed to meet GHG targets. The full list of legislation considered is provided in Table 6.

Table 6 Federal and State Legislative Reductions Applied under the Legislative-Adjusted BAU Scenario

Source	Legislative Reduction	Description	Sectors Applied
State	SB 100 (The 100 Percent Clean Energy Act of 2018)	Requires that 60 percent of retail electricity sold in California must come from renewable or zero-carbon resources by 2030 and 100 percent by 2045.	Building Energy
State	SB 1020 (Clean Energy, Jobs, and Affordability Act of 2022)	Requires that eligible renewable energy resources and zero-carbon resources supply 90 percent of all retail sales of electricity to California end-use customers by December 31, 2035, 95 percent of all retail sales of electricity to California end-use customers by December 31, 2040, 100 percent of all retail sales of electricity to California end-use customers by December 31, 2045, and 100 percent of electricity procured to serve all state agencies by December 31, 2035.	Building Energy
State	California's Building Energy Efficiency Standards (2019 and 2022 Title 24, Part 6)	Effective January 1, 2023, new residential and nonresidential buildings in California are required to comply with energy efficiency standards established by the California Energy Commission (CEC 2022). The 2022 standards establish energy performance requirements that require energy-efficient approaches to building decarbonization by emphasizing electric heat pumps for space heating and water heating and extending the benefits of photovoltaic and battery storage systems and other demand flexible technology to work in combinations with heat pumps.	Building Energy
State	Advanced Clean Car I Regulations	Establishes GHG emission reduction standards for model years 2017 through 2025 that are more stringent than federal CAFE standards.	On-Road Vehicles
State	Advanced Clean Cars II Regulations	Establishes a target for all new passenger cars, trucks, and SUVs sold in California to be 100 percent zero-emission vehicles by 2035.	On-Road Vehicles
State	Advanced Clean Fleets	Starting in 2036, all medium- and heavy-duty trucks sold in California must be zero emissions with limited exceptions. In addition to this sales mandate, fleet owners must also purchase electric trucks on an accelerated timeline.	Vehicle Fleet
State	Truck and Bus Regulation	Requires diesel trucks and buses that operate in California to be upgraded to reduce GHG emissions.	On-Road Vehicles
Federal	Fuel Efficiency Standards for	Establishes fuel efficiency standards for medium- and heavy-duty engines and vehicles.	On-Road Vehicles

	Medium- and Heavy-Duty Vehicles		
Federal	EPA Off-Road Compression-Ignition Engine Standards	Establishes standards for phasing of EPA diesel engine tiers for off-road compression-ignition equipment.	Off-Road Vehicles and Equipment

Notes: CAFE = Corporate Average Fuel Economy; CEC = California Energy Commission; EPA = US Environmental Protection Agency; GHG = greenhouse gas; SUV = sports utility vehicle; SB = Senate Bill.

Source: Compiled by Ascent in 2024.

The results of community legislative-adjusted BAU forecasts show that emissions are expected to decline from 2021 levels through 2045 and then slightly increase by 2050, as shown in Table 7.

Table 7 Elk Grove Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Sector	2021	2030	2035	2040	2045	2050
On-Road Transportation	586,220	446,591	326,936	212,048	130,040	94,359
Residential Building Energy	271,900	299,782	199,731	191,876	178,777	190,410
Nonresidential Building Energy	126,465	152,746	77,061	68,787	55,643	61,825
Solid Waste	20,222	26,034	29,411	32,788	36,165	39,542
Off-Road Vehicles and Equipment	18,341	25,296	28,917	32,537	36,158	39,778
Agriculture	10,275	3,869	686	630	575	575
Wastewater Treatment	2,957	6,707	7,577	8,447	9,317	10,187
Water Supply	2,802	2,875	812	453	0	0
Total	**1,039,181**	963,901	671,131	547,567	446,674	436,676
Percent Change from 2021 Levels		-7%	-35%	-47%	-57%	-58%

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

The community BAU and legislative-adjusted BAU forecast results presented together demonstrate the impact of the state and federal legislation on the city's community GHG emissions profile over time, as shown in Figure 3.

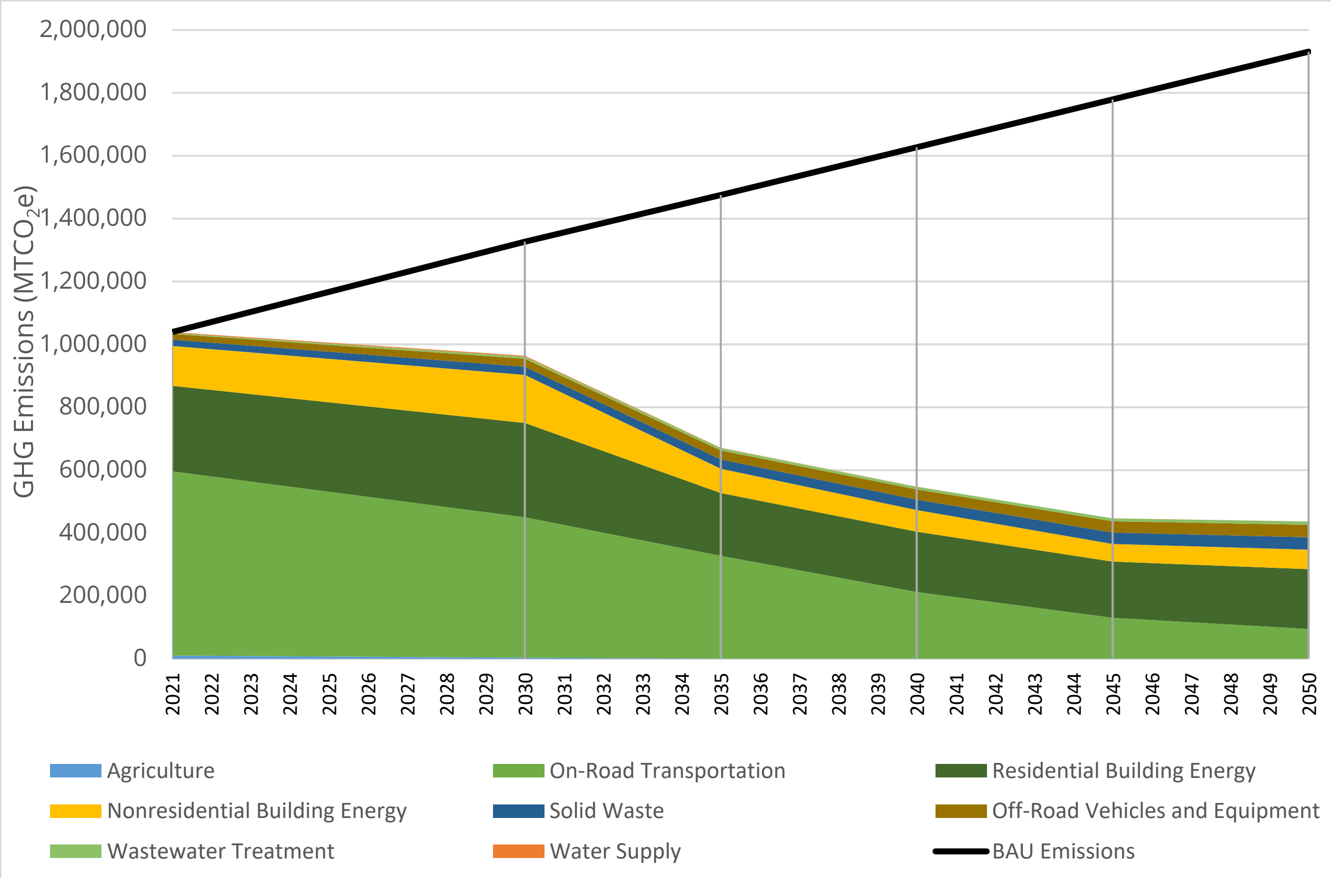

Figure 3 **Elk Grove Community GHG Emissions Inventory and Forecasts**
Source: Prepared by Ascent in 2024.

2.1.4 Discussion

As shown in Table 7 and Figure 3, the city's legislative-adjusted BAU community emissions would decrease modestly by approximately 7 percent between 2021 and 2030 and would see an accelerated decrease after 2030 through 2045. Between 2021 and 2045, emissions are expected to decrease by 57 percent. However, forecasted reductions are expected to level out by 2050. This is primarily due to the continued increase in natural gas in residential and nonresidential buildings. Electricity-related emissions would continue to be zero through 2050 and the city would continue to see a moderate decrease in on-road transportation emissions due to ACCII and the Advanced Clean Fleets regulation (ACF). With these anticipated trends, building energy (residential and nonresidential building combined) would replace on-road transportation as the largest emissions-generating sector in the city, accounting for more than 50 percent of total emissions through 2045. On-road transportation is also expected to contribute to emissions significantly.

Without legislative adjustments, BAU emissions would increase baseline emissions by approximately 28 percent between 2021 and 2030 and 86 percent between 2021 and 2050. The relatively lower increase under the legislative-adjusted BAU forecast scenario in 2030, despite significant growth projected in the city, is associated with reductions that would be achieved from several legislative actions, including:

- a greater renewable mix in electricity (60 percent by 2030, 90 percent by 2035, 95 percent by 2040, and 100 percent by 2045 and 2050),
- improved building energy efficiency through compliance with Title 24 standards, and
- reductions in on-road vehicle emissions factors from state vehicle standards as forecasted in EMFAC2021, ACCII, and ACF.

Going forward, new legislative actions that would affect emissions may be adopted by regional, state, and federal agencies; however, because information regarding these regulatory changes is currently unknown, emissions reductions from future potential legislative actions are not quantified in this memorandum. Where new regulations or actions are imminent and reasonably foreseeable, they can be incorporated as complementary actions to locally based GHG reduction measures.

2.2 CITY OF ELK GROVE OPERATIONS GREENHOUSE GAS EMISSIONS FORECASTS

The estimated COEG operations BAU emissions forecast was based on projected growth in COEG employment between 2021 and 2045 and is based on the emissions levels of the 2021 COEG operations GHG emissions inventory (City of Elk Grove Climate Compass: Greenhouse Gas Inventory Update Technical Memorandum).

2.2.1 Activity Growth Forecast

The number of COEG employees was the sole factor used to forecast BAU emissions for 2030 and 2045 for all sectors in the COEG operations inventory. Table 8 shows 2021 COEG employment and anticipated change in COEG employment for the forecast years.

Table 8 City of Elk Grove City Operations Demographic Forecasts

Forecast Factor	2021	2030	2045
City Employment	424	561	727

Source: Data provided by City of Elk Grove; calculations by Ascent in 2023.

2.2.2 City of Elk Grove Operations Business-as-Usual Scenario Greenhouse Gas Emissions Forecast

COEG operations BAU forecast was developed by scaling COEG operations GHG emissions from the 2021 emissions inventory by the growth in number of employees. The results of COEG operations BAU forecast show that emissions would be expected to grow, given no further GHG reduction efforts beyond 2021, as shown in Table 9. While a more realistic scenario for future GHG emissions can be provided with a legislative-adjusted BAU forecast, the BAU provides the basis for understanding the GHG impact of growth at COEG.

Table 9 City of Elk Grove Operations GHG Emissions Inventory and BAU Forecasts (Annual $MTCO_2e$)

Sector	2021	2030	2045
Buildings and Facilities	1,741	2,304	2,987
Streetlights and Traffic Signals	893	1,136	1,532
Employee Commute	835	1,104	1,432
Vehicle Fleet	620	820	1,064

Solid Waste	139	184	239
Process and Fugitive Emissions	32	42	55
Water Supply	9	12	16
Wastewater Treatment	7	8	11
Total	**4,275**	**5,611**	**7,334**
Percent Change from 2021 Levels	—	31%	72%

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

2.2.3 City of Elk Grove Operations Legislative-Adjusted Business-as-Usual Scenario Greenhouse Gas Emissions Forecast

COEG operations legislative-adjusted BAU forecast was developed by accounting for the expected GHG reductions in COEG operations GHG emissions incorporating new State and federal legislation, such as SB 100, SB 1020, ACC II, ACF. The full list of legislation considered is provided in Table 10. The results of COEG operations legislative-adjusted BAU forecasts show that emissions are expected to slightly increase by 2030 with the city's rapid population growth and then decline by 2045 with the zero-carbon electricity legislation under SB 100. Legislative-adjusted BAU forecast results are shown in Table 11 and Figure 4.

Table 10 Buildings and Facilities Energy Emissions Forecast Legislative Reductions by Energy Type

Source	Legislative Reduction	Description	Sectors Applied
State	SB 100 (The 100 Percent Clean Energy Act of 2018)	Requires that 60 percent of retail electricity sold in California must come from renewable or zero-carbon resources by 2030 and 100 percent by 2045.	Buildings and Facilities; Streetlights and Traffic Signals
State	SB 1020 (Clean Energy, Jobs, and Affordability Act of 2022)	Requires that eligible renewable energy resources and zero-carbon resources supply 90 percent of all retail sales of electricity to California end-use customers by December 31, 2035, 95 percent of all retail sales of electricity to California end-use customers by December 31, 2040, 100 percent of all retail sales of electricity to California end-use customers by December 31, 2045, and 100 percent of electricity procured to serve all State agencies by December 31, 2035.	Buildings and Facilities; Streetlights and Traffic Signals
State	Advanced Clean Car I Regulations	Establishes GHG emission reduction standards for model years 2017 through 2025 that are more stringent than federal CAFE standards.	Vehicle Fleet; Employee Commute
State	Advanced Clean Cars II Regulations	Establishes a target for all new passenger cars, trucks, and SUVs sold in California to be 100 percent zero-emission vehicles by 2035.	Vehicle Fleet; Employee Commute
State	Truck and Bus Regulation	Requires diesel trucks and buses that operate in California to be upgraded to reduce GHG emissions.	Vehicle Fleet
Federal	Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles	Establishes fuel efficiency standards for medium- and heavy-duty engines and vehicles.	Vehicle Fleet; Employee Commute
State	Advanced Clean Fleets	Except for small government fleets of 10 or fewer vehicles and those in designated counties, starting in 2024, state and local agencies would be required to ensure 50% of vehicle purchases are zero emissions. This requirement is increased to 100% starting in 2027.	Vehicle Fleet

Notes: CAFE = Corporate Average Fuel Economy; GHG = greenhouse gas; SB = Senate Bill.

Source: Compiled by Ascent in 2023.

Table 11 City of Elk Grove Operations GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Sector	2021	2030	2045
Buildings and Facilities	1,741	2,054	1,588
Streetlights and Traffic Signals	893	907	0
Employee Commute	835	769	201
Vehicle Fleet	620	497	533
Solid Waste	139	184	239
Water Supply	9	9	0
Wastewater Treatment	7	7	3
Process and Fugitive	32	42	55
Total	**4,275**	**4,470**	**2,619**
Percent Change from 2021 Levels	—	*5%*	*-39%*

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

Figure 4 also shows the emissions trend that would occur without anticipated legislative reductions, accounting only for changes in COEG employment (i.e., BAU emissions). Without the legislative reductions, emissions would be higher in 2045 compared to the legislative-adjusted BAU forecast.

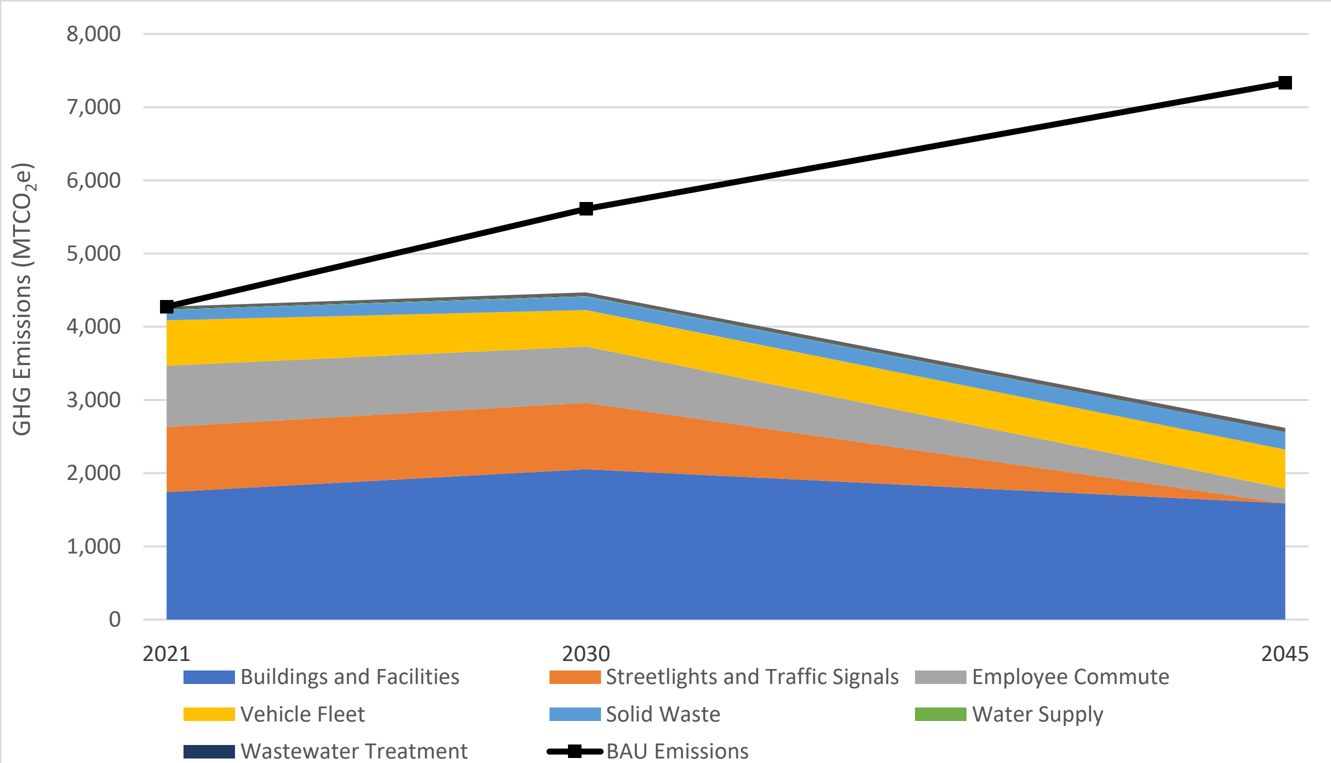

Figure 4 City of Elk Grove Operations GHG Emissions Inventory and Forecasts

Source: Prepared by Ascent in 2024.

2.2.4 Discussion

As shown in Table 11 and Figure 4, COEG's operational legislative-adjusted BAU emissions would decrease by approximately 31 percent in 2030 and by 40 in 2045 compared to 2021. This reduction in emissions would be achieved from several legislative actions including:

- a greater renewable mix in electricity (60 percent by 2030 and 100 percent by 2045),
- improved building energy efficiency through compliance with Title 24 standards, and
- reductions in on-road vehicle emissions factors from state vehicle standards as forecasted in EMFAC2021, ACC II, and ACF standards.

Going forward, new legislative actions that would affect emissions may be adopted by state and federal agencies; however, because information regarding these regulatory changes is currently unavailable or not final, emissions reductions from future potential legislative actions are not quantified in this forecast. Where new state regulations or programs are imminent and reasonably foreseeable, they can be incorporated as complementary actions to locally based GHG reduction measures.

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California Energy Commission. 2022. 2022 Building Energy Efficiency Standards. Available at: 2022 Building Energy Efficiency Standards (ca.gov). Accessed January 22, 2024.

CEC. *See* California Energy Commission.

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Appendix A

City of Elk Grove Climate Compass: Final Greenhouse Gas Emissions Forecasts Technical Memorandum

INTRODUCTION

This document is an appendix to the City of Elk Grove (COEG) Climate Compass: Final Greenhouse Gas Emissions Forecasts Technical Memorandum (hereafter referred to as "Forecast Memorandum") to provide technical documentation for the results presented in the memorandum. This document presents the summary of the community and COEG operations emissions forecasts and explains the forecast methodology.

1 GREENHOUSE GAS EMISSIONS FORECASTS METHODOLOGY

For estimating community forecast, the 2021 community greenhouse gas (GHG) emissions are forecasted for 2030, 2035, 2040, 2045, and 2050 based on growth scaling factors and known impacts of currently adopted legislation on GHG emissions (e.g., adopted federal and California regulations, policies, and programs affecting fuels and energy efficiency). The growth scaling factors (e.g., population, housing, employment, and service population[1]) are applied to activity growth factors (electricity consumption per housing unit and vehicle miles traveled [VMT] per service population).

For estimating COEG operations forecast, the 2021 COEG operations GHG emissions are forecasted for 2030 and 2045 based on number of COEG employees and known impacts of currently adopted legislation on GHG emissions. These future growth factors were applied to the electricity, natural gas, water consumption, and waste generation in COEG buildings and facilities and fuel consumed by COEG's on-road vehicle fleet and employee commute.

The following section describes the methodology behind forecasting both the community and COEG operations business-as-usual (BAU) and legislative-adjusted BAU emissions for each sector. The BAU emissions forecast provides an assessment of how emissions generated by activities in the city will change over time without further state or federal action. The legislative-adjusted BAU emissions forecast includes adopted legislative and regulatory actions at the state and federal levels that would affect emissions without additional action.

1.1 COMMUNITY GREENHOUSE GAS EMISSIONS FORECASTS

1.1.1 Business-as-Usual Forecast

The community BAU forecasted emissions are estimated by scaling the 2021 baseline emissions by four growth scaling factors: housing, population, employment, and service population in the city. These scaling factors are used as a basis for the forecasts of activity for most sectors. The scaling factors are assigned to different activities for emissions sectors and sub-sectors depending on how each sector or sub-sector is affected. These assignments are shown in Table 1. For example, the activity for both the residential building energy sector and the nonresidential building energy sector is in kilowatt-hours (kWh) of electricity and therms of natural gas. Increases in residential building energy (in kWh and therms) are assumed to be proportional to the growth in households, whereas increases in nonresidential building energy (also in kWh and therms) are assumed to be proportional to the growth in employment. These projections in the activities are then translated to emissions using 2021 emission factors to represent the BAU scenario. Under the BAU scenario, it is assumed that baseline emission factors remain unchanged in the future. The resulting scaled activity growth factor are shown in Table 2.

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[1] Service population is the sum of population and number of employment in the city.

Table 1 Community BAU Growth Scaling Methods by Emissions Sector for Community Forecast

Sector	Sub-Sector	Activity Growth Method
Building Energy	Nonresidential	Employment
	Residential	Population
	Backup Generator	Employment
On-Road	Passenger	Estimated VMT forecast
	Commercial	Estimated VMT forecast
Off-Road	Construction Equipment[1]	Service Population
	Industrial	Employment
	Lawn and Garden Equipment	Population
	Light Commercial Equipment	Employment
	Portable Equipment	Employment
	Recreational Equipment	Population
	Transport Refrigeration Units	Service Population
Solid Waste	Waste Generation	Service Population
Wastewater Treatment	Septic System	Service Population
	Waste Water Treatment Plant (WWTP)	Service Population
Agriculture	Fertilizer Application	Agricultural Acres
	Irrigation Pumps	Agricultural Acres
	Livestock	Agricultural Acres
	Agricultural Offroad	Agricultural Acres
	Agricultural Building Energy	Agricultural Acres
Water Supply	NA	Service Population

Notes: BAU = business-as-usual; kWh = kilowatt-hours; NA = not applicable; VMT = vehicle miles traveled

[1] This is part of the "construction and mining" combined category in CARB's OFFROAD model. Mining does not occur within the city, therefore this subsector is used to represent the construction-related emissions in the city.

Source: Compiled by Ascent in 2023.

Table 2 Community BAU Activity Data Forecast by Emissions Sector

Sector	Source	Quantity Type	Quantity Units	Quantity				
				2030	2035	2040	2045	2050
Building Energy	Residential	Electricity	kWh	789,582,752	879,568,854	969,554,956	1,059,541,058	1,149,527,159
	Nonresidential	Electricity	kWh	637,878,776	752,734,947	867,591,117	982,447,288	1,097,303,459
	Electricity Total		kWh	1,427,461,528	1,632,303,800	1,837,146,073	2,041,988,346	2,246,830,618
	Residential	Natural Gas	therms	29,225,349	32,556,064	35,886,780	39,217,495	42,548,210
	Nonresidential	Natural Gas	therms	7,225,582	8,526,617	9,827,652	11,128,687	12,429,722
	Natural Gas Total		therms	36,450,931	41,082,681	45,714,431	50,346,182	54,977,932
	Backup Generators (Nonresidential)	Diesel	gal	10,663	12,583	14,503	16,423	18,343
	Backup Generators (Nonresidential)	Natural Gas	therms	214	252	291	329	368

Sector	Source	Quantity Type	Quantity Units	Quantity				
				2030	2035	2040	2045	2050
	Backup Generators (Nonresidential)	LPG	gal	174	205	237	268	300
On-Road Transportation	On-Road Passenger Transportation	Annual VMT	miles	1,114,891,221	1,204,569,915	1,294,248,608	1,383,927,302	1,473,605,996
	On-Road Commercial Transportation	Annual VMT	miles	247,871,587	276,632,912	305,394,236	334,155,561	362,916,885
	Total	Annual VMT	miles	1,362,762,808	1,481,202,826	1,599,642,844	1,718,082,863	1,836,522,881
Off-Road Vehicles and Equipment [1]	NA	NA	NA	NA	NA	NA	NA	NA
Solid Waste	Community-Generated Solid Waste	Waste	tons	86,100	97,268	108,435	119,603	130,770
	Compost	Waste	tons	32,582	36,808	41,034	45,260	49,486
	Total	Waste	tons	118,682	134,076	149,469	164,863	180,256
Water Supply	Elk Grove Water District	Electricity	kWh	3,623,489	4,093,471	4,563,452	5,033,434	5,503,415
	Sacramento County Water Agency	Electricity	kWh	11,709,337	13,228,086	14,746,835	16,265,584	17,784,333
	Wells	Electricity	kWh	11,694	13,211	14,728	16,244	17,761
	Total	Electricity	kWh	15,344,520	17,334,768	19,325,015	21,315,262	23,305,509
Wastewater Treatment [2]	NA	NA	NA	NA	NA	NA	NA	NA
Agriculture	Fertilizer Application (Lime)	NA	tons	13	3	3	3	3
	Fertilizer Application (Nitrogen)	NA	tons	133	35	35	35	35
	Off-Road Agricultural Equipment	NA	NA	NA	NA	NA	NA	NA
	Diesel-Powered Irrigation Pumps	Pumps	NA	1	0	0	0	0
	Cattle and Calves	Heads	NA	246	65	65	65	65
	Sheep and Lambs	Heads	NA	57	15	15	15	15
	Goats	Heads	NA	64	17	17	17	17
	Poultry	Heads	NA	78	21	21	21	21
	Swine	Heads	NA	4	1	1	1	1
	Horses	Heads	NA	31	8	8	8	8
	Agricultural Building Energy	Electricity	kWh	9,022,676	2,381,934	2,381,934	2,381,934	2,381,934

Notes: BAU = business-as-usual; gal = gallon; kWh = kilowatt-hours; NA = not applicable; VMT = vehicle miles traveled.

1 Activity data has not been scaled for Off-Road Vehicles and Equipment. CARB's 2021 OFFROAD model was used to estimate emissions forecasts.

[2] Activity data has not been scaled for Wastewater Treatment. Forecast emissions are estimated by scaling 2021 inventory emissions directly.

Source: Data modeled by Ascent in 2023.

1.1.2 Legislative-Adjusted Business-as-Usual Forecast

The legislative-adjusted BAU scenario accounts for the effect of adopted legislative and regulatory actions at the state and federal levels on local emissions without additional action by COEG. For the building energy sector, legislative reductions affect energy use through energy efficiency standards and electricity emission factors to account for increased zero-carbon requirements for the electricity sector. For on-road transportation, agricultural building energy sub-sector, and water supply sectors, legislative reductions affect emissions factors only. For solid waste, wastewater treatment, off-road vehicles and equipment, and agriculture sectors (excluding agricultural building energy sub-sector), the legislative-adjusted BAU forecast is equivalent to the BAU forecast. Although legislation exists that would affect these sectors (e.g., Senate Bill [SB] 1383 would impact the solid waste sector), there is not sufficient information to quantify the legislative reductions from these sectors. As such, any additional GHG reductions in these sectors would be factored as part of local actions as part of the Climate Compass's GHG reduction measures and not as part of the forecasts.

Table 6 in the Forecast Memorandum presents a summary of the legislative adjustments applied to the activity data and emissions factors by sector under the legislative-adjusted BAU scenario. Table 3 below lists community forecast sectors where activity data is affected by legislative reductions. A detailed discussion of each sector is provided in Section 1.1.3.

Table 3 Community Legislative-Adjusted BAU Activity Data Forecast by Emissions Sector Affected by Legislative Reductions

Sector	Source	Quantity Type	Quantity Units	Quantity				
				2030	2035	2040	2045	2050
Building Energy	Residential	Electricity	kWh	831,404,941	943,270,190	1,055,135,440	1,167,000,689	1,278,865,939
	Nonresidential	Electricity	kWh	616,743,756	720,642,952	824,542,148	928,441,344	1,032,340,540
	Electricity Total		kWh	1,448,148,697	1,663,913,142	1,879,677,588	2,095,442,034	2,311,206,479
	Residential	therms	therms	27,037,421	29,223,528	31,409,635	33,595,742	35,781,850
	Nonresidential	therms	therms	6,949,873	8,107,973	9,266,073	10,424,173	11,582,273
	Natural Gas Total		therms	33,987,294	37,331,501	40,675,708	44,019,915	47,364,122
	Backup Generators (Nonresidential)	Diesel	gal	10,663	12,583	14,503	16,423	18,343
	Backup Generators (Nonresidential)	Natural Gas	therms	214	252	291	329	368
	Backup Generators (Nonresidential)	LPG	gal	174	205	237	268	300

Notes: BAU = business-as-usual; gal = gallon; kWh = kilowatt-hours; LPG = liquid propane gas.

Data modeled by Ascent in 2023.

1.1.3 Forecast Details by Emissions Sector

BUILDING ENERGY

Building Energy Assumptions

Building energy emissions in the city result directly from onsite combustion of natural gas and indirectly from electricity consumption. The combustion of fossil fuels (i.e., diesel, liquid propane gas [LPG], propane and natural gas) in backup generators also contributes to the city's building energy emissions. This section presents the methodology behind forecasting the energy consumption for residential and nonresidential sources and estimating future emission factors. BAU forecasted energy consumption for residential building energy is estimated by scaling 2021 energy consumption using population. For nonresidential sources, BAU forecasted energy consumption is estimated by scaling 2021 energy consumption using employment. BAU forecasted energy consumption in buildings using backup generators is estimated by scaling 2021 energy consumption using employment. The BAU forecast uses the GHG emissions factors used to calculate emissions in the 2021 inventory for all forecast years. The legislative-adjusted BAU forecast considers the effects of legislation on energy use in new residential and nonresidential buildings pursuant to California's Building Energy Efficiency Standards (California Code of Regulations Title 24 Part 6, hereafter referred to as "Title 24"). The legislative-adjusted BAU forecast also considers changes to the carbon intensity of electricity generation under SB 100 and SB 1020 that would affect future electricity emission factors. Emissions are calculated by multiplying the annual projected building energy use by the respective emission factors.

Emission Factor Forecasts

Electricity

Sacramento Municipal Utility District (SMUD) provides all electricity in the city. Under BAU forecasts, SMUD's 2021 electricity supply emissions factor is assumed to remain unchanged through 2045 because the BAU forecast does not account for the effects of SB 1020 and SB 100 beyond the inventory year (2021). According to The Climate Registry (TCR), SMUD's emissions factor in 2021 was 535 pounds of carbon dioxide equivalent per megawatt-hour and represented a 48 percent carbon-free electricity mix (TCR 2021), meaning that 48 percent of the electricity generated by SMUD in 2021 was generated by sources that emit no GHG emissions.

Under the legislative-adjusted BAU forecasts, SMUD's carbon-free mix for 2030 through 2050 is set to align with the mandates outlined in SB 1020 and SB 100. Thus, under legislative-adjusted BAU forecast, the emissions factors align with California Public Utilities Commission's Renewables Portfolio Standard (RPS) which are set through SB 1020 and SB 100 (see Emission Factor Forecasts in Forecast Details by Emissions Sector 1.1.3 for details). Through SB 100, RPS requires that "all electricity providers procure a minimum 60% eligible renewable energy by 2030" (State of California 2023a). And through SB 1020, RPS requires that "eligible renewable energy resources and zero-carbon resources supply 90% of electricity to end-use customers by 2035, 95% by 2040, and 100% by 2045" (State of California 2023b). Given that SB 1020 and SB 100 have set 2045 as the ultimate target year by which carbon-free electricity mix is achieved and the heavy investments needed to achieve that target, the 100-percent GHG-free mix was assumed to continue from 2045 through 2050. To calculate future emission factors, SMUD's 2021 electricity supply emissions factor was adjusted to reflect the additional carbon-free electricity mix percentage to meet the minimum RPS standards. As a result, the legislative-adjusted BAU emission factors for all future years are estimated by incorporating SMUD's 2021 carbon-free electricity mix for each forecast year and carbon-free mix set by RPS standard. The emission factors and carbon-free mix of electricity and associated GHG emissions factors for the legislative-adjusted BAU forecast are presented in Table 4.

Table 4 Emission Factors and Carbon-Free Mix of Electricity Used in Elk Grove

	2021	2030	2035	2040	2045	2050
Emission Factor (lb CO_2e/MWh)	536	413	103	52	0	0
Carbon-Free Electricity Mix (%)	48	60	90	95	100	100

Notes: lb CO_2e/MWh = pounds of carbon dioxide equivalent per megawatt-hour.

Source: Compiled by Ascent in 2023.

Natural Gas

Natural gas in the city is provided by Pacific Gas & Electric (PG&E). According to TCR, 11.73 pounds of carbon dioxide equivalent is released for every therm of natural gas combusted (TCR 2021). Emissions factors associated with natural gas combustion are not anticipated to change over time, as there are no legislative actions that would reduce the carbon intensity of natural gas. The emission factors of natural gas for PG&E supplied natural gas are presented in Table 5.

Table 5 Natural Gas Emission Factors in (lb CO_2e/therm) Used in Elk Grove

Provider	2021	2030	2035	2040	2045	2050
PG&E	11.73	11.73	11.73	11.73	11.73	11.73

Notes: PG&E = Pacific Gas and Electric Company; lb CO_2e/therm = pounds of carbon dioxide equivalent per therm.

Source: Compiled by Ascent in 2023.

Backup Generator Fuel

Emissions from diesel fuel used to power backup generators are based on emissions factors obtained from TCR, using a regional-specific average consumption of 22.55 pounds of carbon dioxide equivalent per gallon (lb CO_2e/gal). Emissions factors associated with diesel combustion are not anticipated to change over time, as there are no legislative actions that would reduce the carbon intensity of diesel.

Emissions from propane and LPG used to power backup generators are also based on emissions factors from TCR and are estimated to be 0.9 lb CO_2e/gal and 0.34 pounds of carbon dioxide equivalent per standard cubic feet, respectively. These emissions factors are also not anticipated to change over time, as there are no legislative actions that would reduce the carbon intensity of propane and LPG. The emission factors of backup generator fuels are presented in Table 6.

Table 6 Backup Generator Fuel Emission Factors Used in the City of Elk Grove

Provider	Units	2021	2030	2035	2040	2045	2050
Diesel	lb CO_2e/gal	22.55	22.55	22.55	22.55	22.55	22.55
Propane	lb CO_2e/gal	0.9	0.9	0.9	0.9	0.9	0.9
LPG	lb CO_2e/scf	0.34	0.34	0.34	0.34	0.34	0.34

Notes: lb CO_2e/gal = pounds of carbon dioxide equivalent per gallon; lb CO_2e/scf = pounds of carbon dioxide equivalent per standard cubic foot.

Source: Compiled by Ascent in 2023.

ENERGY USE FORECASTS

For new buildings, energy use is adjusted to reflect increased stringency under Title 24. Title 24 standards apply to new construction. The 2019 Title 24 standards apply to projects constructed after January 1, 2020; 2022 Title 24 standards apply to projects constructed after January 1, 2023; and the next standards will apply after January 1, 2026. To estimate adjusted future energy consumption resulting from Title 24 requirements in new residential and nonresidential building construction, electricity- and natural gas-specific adjustment factors are calculated using the difference in the average energy use in residential and nonresidential buildings between those built to 2019 Title 24 standards and those built to 2022 Title 24 standards. Adjustment factors are calculated using data available from the California Energy Commission (CEC) that were developed for the 2022 Title 24 standards. In addition to accounting for Title 24 requirements by land use type (i.e., residential and nonresidential), CEC also developed estimates for energy usage rates by climate zone, and the county's climate zone (Zone 12) is used for the residential buildings analysis. Climate zone-specific data for nonresidential buildings are unavailable; therefore, nonresidential adjustment factors relied on statewide averages.

The adjustment factors (specific to both building type and energy type) are applied to the projected fuel use that is estimated by scaling 2021 energy use by the appropriate scaling factor (population for residential buildings and employment for non-residential buildings). Title 24 adjustment factors are then applied to this projected energy use to estimate legislative-adjusted BAU energy consumption and associated GHG emissions of future development with legislative adjustments. The adjustment factors are shown in Table 7. They are presented in terms of the percent change in energy use for buildings compliant with the 2022 Title 24 standards compared to those built to meet the 2019 Title 24 standards. Positive values indicate an anticipated increase in energy use (e.g., increased electrical demands from additional appliances, electrification of natural gas appliances), while negative values indicate an anticipated decrease in energy use (e.g., more energy efficiency, shifting away from natural gas appliances). It is important to note that although average electricity use in new residential buildings is anticipated to rise (due to an increase in electrical demand associated with electric appliances installed instead of natural gas appliances), emissions from new residential buildings are expected to be lower than they would be under 2019 Title 24 as a result of overall lower building emissions intensities (due to lower emissions factors associated with electricity compared to natural gas).

Table 7 Title 24 Building Energy Adjustment Factors for 2022 Standards Compared to 2019 Standards

Building Type	Electricity	Natural Gas
Residential Buildings	24%	-34%
Nonresidential Buildings	-10%	-11%

Source: Compiled by Ascent in 2023.

BUILDING ENERGY RESULTS

Based on the building energy legislative reductions for new buildings and the expected net growth in the city's housing and employment, Table 8 shows the legislative-adjusted BAU forecast results for residential buildings and Table 9 shows legislative-adjusted BAU forecast results for nonresidential buildings. Under the BAU scenario, the 2021 emission factors would remain unchanged through 2045.

Table 8 Residential Building Energy Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Energy Type	2021	2030	2035	2040	2045	2050
Electricity	150,260	155,905	44,220	24,732	0	0
Natural Gas	121,641	143,877	155,511	167,144	178,777	190,410
Total	**271,900**	**299,782**	**199,731**	**191,876**	**178,777**	**190,410**

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

Source: Data modeled by Ascent in 2023.

Table 9 Nonresidential Building Energy Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Energy Type	2021	2030	2035	2040	2045	2050
Electricity	101,296	115,651	33,784	19,327	0	0
Natural Gas	25,096	143,877	155,511	167,144	178,777	190,410
Backup Generators	73	111	131	151	171	191
Total	**126,465**	**259,640**	**189,426**	**186,622**	**178,948**	**190,602**

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

Source: Data modeled by Ascent in 2023.

ON-ROAD TRANSPORTATION

The emissions projections associated with the on-road transportation sector are calculated by multiplying the projected annual VMT and the vehicle emission factors by vehicle category. VMT projections were developed using data provided by Fehr & Peers and the origin-destination method, consistent with SB 375. For the BAU forecast, the applied future emission factors are based on 2021 emission factors. For the legislative-adjusted BAU forecast, the future vehicle emission factors are based on those from the CARB EMFAC2021 webtool which includes legislative adjustments from state and federal policies and regulations including the Pavley Clean Car Standards, Advanced Clean Car I (ACC I) regulation, and fuel efficiency standards for medium- and heavy-duty vehicles. It should be noted that the Low Carbon Fuel Standard was excluded in EMFAC2021 forecasts because the emissions benefits originate from upstream fuel production and do not directly reduce vehicle tailpipe emissions that affect the city's GHG emissions forecasts. Additionally, the effects of the Advanced Clean Cars II (ACC II) and Advanced Clean Fleets (ACF) regulation were incorporated in this forecast. For ACC II, sales of electric vehicles are adjusted upwards from the default EMFAC values to be consistent with the state's target where 100 percent of new passenger vehicle sales are plug-in hybrids or battery electric vehicles by 2035 (California Air Resources Board 2022). The total estimated VMT and corresponding legislative-adjusted BAU emissions from on-road transportation for each forecast year are given in Table 10 and Table 11 respectively.

Table 10 On-Road Transportation Community Total Estimated VMT

Source	2021	2030	2035	2040	2045	2050
On-Road Passenger Transportation	944,367,693	1,114,891,221	1,204,569,915	1,294,248,608	1,383,927,302	1,473,605,996
On-Road Commercial Transportation	192,332,970	247,871,587	276,632,912	305,394,236	334,155,561	362,916,885
Total	1,136,700,663	1,362,762,808	1,481,202,826	1,599,642,844	1,718,082,863	1,836,522,881

Notes: VMT= vehicle miles traveled.

Source: Compiled by Ascent in 2023.

Table 11 On-Road Transportation Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Source	2021	2030	2035	2040	2045	2050
On-Road Passenger Transportation	339,716	279,273	200,153	122,018	69,997	41,927
On-Road Commercial Transportation	246,504	275,753	261,297	250,448	251,466	262,644
Total	586,220	555,026	461,450	372,466	321,463	304,571

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

OFF-ROAD VEHICLES AND EQUIPMENT

Emissions for different sources under the off-road vehicles and equipment sector were estimated by scaling 2021 inventory emissions by growth factors listed in Table 12. This approach was used instead of using CARB's 2021 OFFROAD model to account for the growth in various emission sources by the various scaling methods (for example, growth in employment, change in agricultural acres). No legislative reductions could be applied to this sector, so legislative-adjusted BAU emissions are equivalent to BAU emissions.

Table 12 Off-Road Vehicles and Equipment Forecast Methods by Source

Source	Forecast Methods	
	Scale Factor	Applied Legislative Reductions
Construction Equipment[1]	Service Population	OFFROAD2021 emissions factor considerations include EPA off-road compression-ignition engine standards implementation schedule.
Industrial Equipment	Employment	
Lawn and Garden Equipment	Population	
Light Commercial Equipment	Employment	
Portable Equipment	Employment	
Recreational Equipment	Population	
Transport Refrigeration Units	Service Population	

Notes: EPA = US Environmental Protection Agency; OFFROAD2021 = California Air Resources Board's OFFROAD2021 model.

[1] This is part of the "construction and mining" combined category in CARB's OFFROAD model. Mining does not occur within the city, therefore this subsector is used to represent the construction-related emissions in the city.

Source: Compiled by Ascent in 2023.

Table 13 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from the off-road vehicles and equipment sector for 2030, 2035, 2040, 2045, and 2050.

Table 13 Off-Road Vehicles and Equipment Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Source	2021	2030	2035	2040	2045	2050
Construction Equipment	9,033	12,023	13,583	15,142	16,701	18,261
Industrial Equipment	1,219	1,868	2,204	2,540	2,876	3,213
Lawn and Garden Equipment	2,817	3,602	4,012	4,423	4,833	5,243
Light Commercial Equipment	2,071	3,173	3,745	4,316	4,888	5,459
Portable Equipment	1,905	2,918	3,444	3,969	4,495	5,020
Recreational Equipment	229	293	326	360	393	426
Transport Refrigeration Units	1,066	1,419	1,603	1,787	1,971	2,155
Total	**18,341**	**25,296**	**28,917**	**32,537**	**36,158**	**39,778**

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

Source: Data modeled by Ascent in 2023.

SOLID WASTE

Solid waste sector emissions are associated primarily with the decomposition of mixed municipal solid waste generated in landfills by community activities, while a smaller proportion of emissions are produced by the decomposition of composted yard trimmings. No legislative reductions could be applied to this sector, so legislative-adjusted BAU emissions are equivalent to BAU emissions, which were scaled by service population growth within the city. Table 14 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from the solid waste sector for 2030, 2035, 2040, 2045, and 2050.

Table 14 Solid Waste Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Source	2021	2030	2035	2040	2045	2050
Community-Generated Solid Waste	18,508	23,754	26,835	29,916	32,997	36,078
Compost	1,714	2,281	2,577	2,872	3,168	3,464

Total	**20,222**	**26,034**	**29,411**	**32,788**	**36,165**	**39,542**

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

Source: Data modeled by Ascent in 2023.

WATER SUPPLY

Water supply emissions occur indirectly from the consumption of electricity associated with extracting, conveying, treating, and distributing imported water to the city. For water supplied from local sources (i.e., water supplied by the Elk Grove Water District and Sacramento County Water Agency), the electricity usage associated with extracting, conveying, treating, and distributing water is captured in the building energy sector because these activities take place within the city and SMUD provided electricity usage data that reflects electricity consumption for all end uses within the city. Energy consumption for future years is estimated by scaling 2021 energy consumption using population. The BAU forecast uses the GHG emissions factors used to calculate emissions in the 2021 inventory for all forecast years. Under the legislative-adjusted BAU forecast, the emissions factors align with RPS, consistent with the requirements of SB 1020 and SB 100 (see emission factor forecasts in Forecast Details by Emissions Sector 1.1.3 for details). To calculate future emission factors, SMUD's 2021 electricity supply emissions factor was adjusted to reflect the additional carbon-free electricity mix percentage obtained to meet the minimum RPS standards. As a result, the emission factors are estimated by incorporating the associated carbon-free mix in SMUD's 2021 carbon-free electricity mix for each forecast year. The emission factors and carbon-free mix of electricity and associated GHG emissions factors for the legislative-adjusted BAU forecast are presented in Table 4. Emissions are calculated by multiplying the annual projected energy use by the respective emission factors. Table 15 presents projected fuel consumption and Table 16 presents 2021 inventory and legislative-adjusted BAU forecasted emissions from the water supply sector for 2030, 2035, 2040, 2045, and 2050.

Table 15 Water Supply Community Electricity Consumption in kWh

Source	2021	2030	2035	2040	2045	2050
EGWD	2,722,412	3,623,489	4,093,471	4,563,452	5,033,434	5,503,415
SCWA	8,797,498	11,709,337	13,228,086	14,746,835	16,265,584	17,784,333
Wells	8,786	11,694	13,211	14,728	16,244	17,761
Total	**11,528,696**	**15,344,520**	**17,334,768**	**19,325,015**	**21,315,262**	**23,305,509**

Notes: Totals may not sum exactly due to independent rounding. EGWD = Elk Grove Water District; kWh = kilowatt-hours; SCWA = Sacramento County Water Agency.

Source: Data modeled by Ascent in 2023.

Table 16 Water Supply Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Source	2021	2030	2035	2040	2045	2050
EGWD	662	679	192	107	0	0
SCWA	2,140	2,196	620	346	0	0
Wells	0	0	0	0	0	0
Total	2,802	2,875	812	453	0	**0**

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

Source: Data modeled by Ascent in 2023.

WASTEWATER TREATMENT

Emissions projections associated with the wastewater treatment sector account for emissions generated from several different sources during the treatment and collection of wastewater from centralized wastewater treatment plants (WWTPs) in the city. 2021 emissions are directly scaled to estimate emissions forecast in future years using service population growth within the city. No legislative reductions could be applied to this sector, so legislative-adjusted BAU emissions are equivalent to BAU emissions. Table 17 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from the wastewater treatment sector for 2030, 2035, 2040, 2045 and 2050.

Table 17 Wastewater Treatment Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Source	2021	2030	2035	2040	2045	2050
Centralized WWTP	2,791	6,485	7,326	8,167	9,009	9,850
Septic Systems	167	222	251	280	309	337
Total	**2,957**	**6,707**	**7,577**	**8,447**	**9,317**	**10,187**

Notes: Totals may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; WWTP = wastewater treatment plant.

Source: Data modeled by Ascent in 2023.

AGRICULTURE

Emissions projections associated with the agriculture sector include emissions from livestock management, fertilizer application, use of off-road equipment on agricultural land, and electricity consumption in agricultural buildings. 2021 activity data for this sector is scaled using growth in agricultural land to estimate future emissions. Agricultural land use acres in the city are projected to decline from 2021 through 2035 and remain steady after 2035. This projected change in agricultural land acres was used to scale GHG emissions from livestock management, fertilizer application, and agricultural off-road vehicles and equipment. As a result, emissions from these sources are projected to decline through 2035 and remain steady through 2050. The projected decline in agricultural emissions is also associated with a decline in emissions from agricultural buildings as a result of the reduction in electricity emission factors through SB 100 and SB 1020 (see Emission Factor Forecasts in Forecast Details by Emissions Sector 1.1.3 for details). Table 18 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from agriculture for 2030, 2035, 2040, 2045, and 2050.

Table 18 Agriculture Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Source	Livestock Management		Fertilizer Application		Agricultural Equipment		Agricultural Building Energy		Total	
	BAU	Legislative-Adjusted BAU	BAU	Legislative-Adjusted BAU	BAU	Legislative-Adjusted BAU	BAU	Legislative-Adjusted BAU	BAU	Legislative-Adjusted BAU
2021	2,779	2,779	1,518	1,518	875	875	5,104	5,104	**10,275**	**10,275**
2030	1,195	1,195	653	653	329	329	2,195	1,692	**4,372**	**3,869**
2035	316	316	172	172	87	87	580	112	**1,154**	**686**
2040	316	316	172	172	87	87	580	56	**1,154**	**630**
2045	316	316	172	172	87	87	580	0	**1,154**	**575**
2050	316	316	172	172	87	87	580	0	**1,154**	**575**

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

Source: Data modeled by Ascent in 2023.

1.2 CITY OF ELK GROVE OPERATIONS GREENHOUSE GAS EMISSIONS FORECASTS

1.2.1 Business-as-Usual Forecast

Estimated COEG operations BAU emissions forecasts were based on predicted growth in COEG employment between 2021 and 2045. Change in employment was the sole factor used to forecast BAU emissions for 2030 and 2045 for all sectors in COEG operations inventory. COEG staff provided employment estimates for 2030 and 2045 forecasts were based on the city's overall employment growth between 2021 and 2045. Table 19 shows 2021 COEG employment and anticipated change in employment for the forecast years.

Table 19 City of Elk Grove Operations Demographic Forecasts

Forecast Factor	2021	2030	2045
City of Elk Grove Employment	424	561	727
Percent Growth from 2021	NA	32%	72%

Notes: NA = Not applicable.

Source: Data provided by City of Elk Grove; calculations by Ascent in 2023.

BAU projections in activity growth (e.g., electricity use, vehicle fuel use) are translated to emissions using emission factors from the 2021 inventory year. Under the BAU scenario, it is assumed that baseline emission factors remain unchanged in the future because without adopted legislation requiring reduced emissions from such sources as electricity generation and vehicles (e.g., SB 100), future emission factors would stay the same as they do currently. The resulting scaled activity growth factors are shown in Table 20.

Table 20 City of Elk Grove Operations BAU Activity Data Forecast by Emissions Sector

Emissions Sector	Source	Units	Activity levels in 2030	Activity levels in 2045
Buildings and Facilities	Electricity	MWh	4,435	5,751
	Natural Gas	therms	229,728	297,883
	Backup Generators (Diesel)	gallons	239	310
Streetlights and Traffic Signals	Streetlights Electricity	MWh	4,093	5,308
	Traffic Signals Electricity	MWh	763	989
Employee Commute	Employee Commute	VMT	3,069,503	3,980,157
Vehicle Fleet	Combustion Vehicles	VMT	1,864,742	2,417,969
	Electric Vehicles	VMT	1,932	2,505
Solid Waste	Landfill	tons	496	644
	Compost	tons	606	786
Water Supply	EGWD	MWh	1	2
	SCWA	MWh	48	62
Wastewater Treatment	NA	NA	NA	NA
Process & Fugitive Emissions	NA	therms	229,728	297,883

Note: BAU = Business-as-usual forecast; EGWD = Elk Grove Water District; MWh = megawatt-hours; NA = Not applicable; SCWA = Sacramento County Water Agency; VMT = vehicle miles traveled.

Source: Data modeled by Ascent in 2023.

1.2.2 Legislative-Adjusted Business-as-Usual Forecast

The legislative-adjusted BAU scenario accounts for the effect of adopted legislative and regulatory actions at the state and federal levels on local emissions without additional action by COEG. For building energy, streetlights and traffic signals, and water supply sectors, legislative reductions affect electricity emission factors through SB 100 and SB 1020 to account for increased carbon-free requirements for the electricity sector. For the employee commute sector and vehicle fleet sectors, legislative reductions affect emissions factors through ACC II and ACF. The wastewater treatment and solid waste sectors do not incorporate legislative reductions. Table 10 in the Forecast Memorandum presents a summary of the legislative adjustments applied to COEG operations activity data and emissions factors by sector under the legislative-adjusted BAU scenario. A detailed discussion of each sector is presented in section 1.2.3.

1.2.3 Forecast Detail by Emissions Sector

BUILDINGS AND FACILITIES ENERGY

Emissions associated with COEG-owned buildings and facilities are generated from the upstream generation of electricity and on-site combustion of natural gas and diesel (in backup generators). Emissions from future electricity, natural gas, and backup generator use in COEG buildings and facilities were estimated by multiplying anticipated energy use by forecasted emissions factors. Forecasted energy consumption for COEG buildings and facilities is estimated by scaling 2021 energy consumption using COEG employment. The BAU forecast uses the GHG emissions factors used to calculate emissions in the 2021 inventory for all forecast years. The legislative-adjusted BAU forecast considers changes to the carbon intensity of electricity generation under SB 100 and SB 1020 that would affect future electricity emission factors. Emissions are calculated by multiplying the annual projected building energy use by the respective emission factors.

Emission Factor Forecasts

Electricity

Under BAU forecasts, SMUD’s 2021 emissions factor is assumed to remain unchanged through 2045. Under the legislative-adjusted BAU forecast, the emissions factors align with RPS standards which are set through SB 1020 and SB 100 (see Emission Factor Forecasts in Forecast Details by Emissions Sector 1.1.3 for details). To calculate future emission factors, SMUD’s 2021 electricity supply emissions factor was adjusted to reflect the additional carbon-free electricity mix percentage obtained to meet the minimum RPS standards. As a result, the emission factors are estimated by incorporating the associated carbon-free mix in SMUD’s 2021 carbon-free electricity mix for each forecast year. The emission factors and carbon-free mix of electricity and associated GHG emissions factors for the legislative-adjusted BAU forecast are presented in Table 4.

Natural Gas

Emissions factors associated with natural gas combustion are based on emissions factors from TCR, as described in Section 1.1.3 under natural gas emission factors. These emissions factors are not anticipated to change over time, as there are no legislative actions that would reduce the carbon intensity of natural gas. The emission factors of natural gas for PG&E supplied natural gas are presented in Table 5.

Diesel

Emissions from diesel fuel used to power backup generators are based on emissions factors from TCR, as described in Section 1.1.3. Emissions factors associated with diesel combustion are not anticipated to change over time, as there are no legislative actions that would reduce the energy intensity of diesel. The emission factors of diesel fuel used to power backup generators are presented in Table 6. Table 21 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions for COEG buildings and facilities energy sector by energy type for 2030 and 2045.

Table 21 Buildings and Facilities Energy GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Energy Type	2021	2030	2045
Electricity	815	829	0
Natural Gas	924	1,222	1,585
Backup Generators	2	2	3
Total	**1,741**	**2,054**	**1,588**

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

Source: Data modeled by Ascent in 2023.

STREETLIGHTS AND TRAFFIC SIGNALS

Emissions projections associated with the streetlights and traffic signals sector account for emissions generated from purchased electricity from SMUD to operate the streetlights and traffic signals. Forecasted electricity consumption is estimated by scaling 2021 electricity use using COEG's employment factor. The BAU forecast uses the GHG emissions factors used to calculate emissions in the 2021 inventory for all forecast years. Under the legislative-adjusted BAU forecast, the emissions factors align with RPS standards which are set through SB 1020 and SB 100 (see Emission Factor Forecasts in Forecast Details by Emissions Sector 1.1.3 for details). To calculate future emission factors, SMUD's 2021 electricity supply emissions factor was adjusted to reflect the additional carbon-free electricity mix percentage obtained to meet the minimum RPS standards. As a result, the emission factors are estimated by incorporating the associated carbon-free mix in SMUD's 2021 carbon-free electricity mix for each forecast year. The emission factors and carbon-free mix of electricity and associated GHG emissions factors for the legislative-adjusted BAU forecast are presented in Table 4. Emissions are calculated by multiplying the annual projected electricity use by the respective emission factors. Table 22 presents 2021 inventory and legislative-adjusted BAU forecasted emissions for the streetlights and traffic signals sector for 2030 and 2045.

Table 22 Streetlights and Traffic Signals GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2021	2030	2045
Streetlights and Traffic Signals	893	907	0

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

EMPLOYEE COMMUTE

The emissions projections associated with the employee commute sector are calculated by multiplying the projected annual VMT and the vehicle emission factors by vehicle category in 2030 and 2045. According to an employee commute survey that COEG conducted in 2022, 97 percent of employees drove to work alone. To be conservative, it was assumed that employees that commute to work all use passenger vehicles based on the 2022 employee commute survey conducted by COEG. Annual VMT for the sector is projected by scaling the 2021 annual COEG employee VMT using the number of COEG employees. For the BAU forecast, the applied future emission factors are based on 2021 emission factors. For the legislative-adjusted BAU forecast, the future vehicle emission factors are based on those from the CARB EMFAC2021 webtool and are adjusted to account for the effects of ACC II. For ACC II, sales of electric vehicles are adjusted upwards from the default EMFAC values to be consistent with the state's target where 100 percent of new passenger vehicle sales are plug-in hybrids or battery electric vehicles by 2035 (California Air Resources Board 2022). Table 23 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from COEG employee commutes for 2030 and 2045.

Table 23 Employee Commute GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2021	2030	2045
Employee Commute	835	769	201

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

VEHICLE FLEET

Vehicle fleet VMT data for 2021 were provided by COEG for all COEG-owned vehicles by vehicle class. The BAU forecast uses the GHG emissions factors used to calculate emissions in the 2021 inventory for all forecast years. Under the legislative-adjusted BAU forecast, the total VMT was adjusted to incorporate the impacts of ACC II and ACF under which additional electric vehicles are expected to be added to COEG's vehicle fleet. This will spread the total VMT into VMT by conventional vehicles and VMT by electric vehicles. Under ACC II and ACF, vehicle emission factors will also decrease due to better fuel efficiency. Table 24 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from the vehicle fleet sector by fuel source for 2030 and 2045. As shown by the increase in fleet emissions from 2045 to 2050, the forecasted growth in COEG's fleet is expected to outpace the applied legislative reductions.

Table 24 Vehicle Fleet GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2021	2030	2045
Vehicle Fleet	620	497	533

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled

Source: Data modeled by Ascent in 2023.

SOLID WASTE

Emissions projections associated with the solid waste sector include emissions from the landfill and compost. Waste tonnage projections are based on the growth in the number of employees in COEG. Emissions were calculated using the ClearPath[2] tool. No legislative reductions were applied to this sector. This is because SB 1383 (legislation applicable to the solid waste sector) requires COEG to take actions locally, hence these reductions will be applied as part of the Climate Compass's GHG reduction measures and not as part of the forecasts. Therefore, the legislative-adjusted BAU emissions forecast for the solid waste sector is equivalent to BAU emissions forecast. Table 25 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from the municipal operations solid waste sector for 2030 and 2045.

Table 25 Solid Waste GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2021	2030	2045
Landfill Disposed Waste	107	142	184
Compost	32	42	55
Total	**139**	**184**	**239**

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by ClearPath in 2023.

[2] ClearPath is an online software platform for estimating emissions. ClearPath was used for this sector because it provides geographically specific results.

WATER SUPPLY

For the water supply from local sources within the city, the electricity usage associated with extracting, conveying, treating, and distributing water is captured in the buildings and facilities energy sector because these activities take place within the city. Therefore, the electricity usage and emissions associated with extracting, conveying, treating, and distributing water from outside the city boundary were applied to the municipal water supply sector. Table 26 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from municipal operations water supply for 2030 and 2045.

Table 26 Water Supply GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Activity	2021	2030	2045
EGWD	0.27	0	0
SCWA	8.8	9	0
Total	**9.1**	**9**	**0**

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; EGWD = Elk Grove Water District; SCWA = Sacramento County Water Agency.

Source: Data modeled by Ascent in 2023.

WASTEWATER TREATMENT

Emissions projections associated with the wastewater treatment sector account for emissions generated from several different sources during the treatment and collection of wastewater. Although by 2050, electricity emissions factors are reduced to zero, increases in process and fugitive emissions resulting from wastewater collection and treatment would offset decreased electricity emissions. Table 27 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from wastewater treatment for 2030 and 2045.

Table 27 Wastewater Treatment GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2021	2030	2045
Wastewater Treatment	7	7	3

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2023.

PROCESS AND FUGITIVE EMISSIONS

Emissions in this sector are generated from the natural gas that escapes into the atmosphere during different processes and pipeline leakages. Activity projections are based on the growth in the number of employees at COEG. Emissions were calculated using the ClearPath tool for consistency with previous COEG operations inventories. No legislative reductions were applied to this sector. Table 28 shows the 2021 inventory and legislative-adjusted BAU forecasted emissions from process and fugitive emissions sector for 2030 and 2045.

Table 28 Process and Fugitive Emissions GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2021	2030	2045
Process and Fugitive Emissions	32	42	55

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by ClearPath in 2023.

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