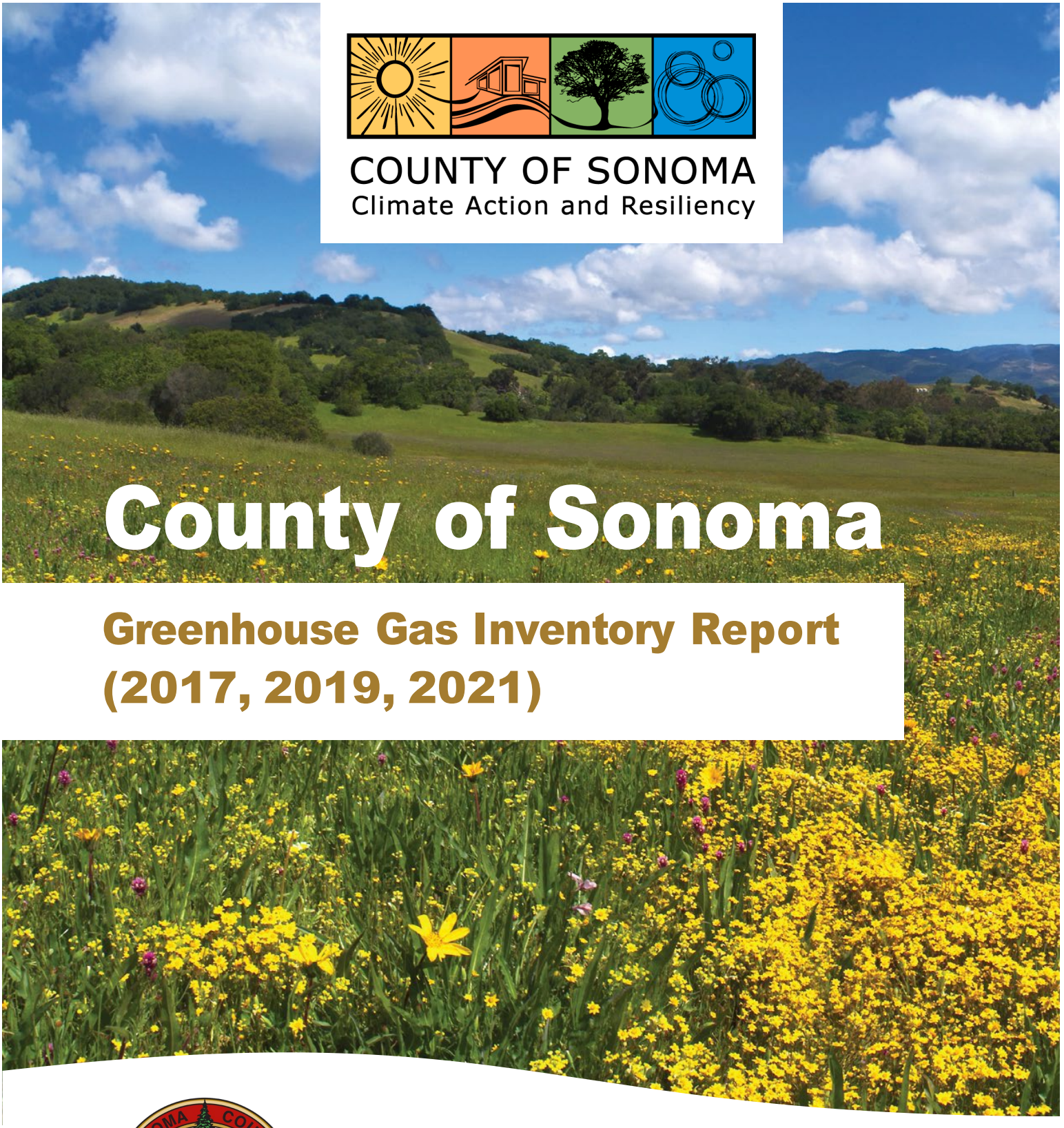


COUNTY OF SONOMA
Climate Action and Resiliency

County of Sonoma

Greenhouse Gas Inventory Report (2017, 2019, 2021)

June 2023

Table of Contents

Table of Figures

Glossary

Activity data	Data on the magnitude of human activity resulting in emissions taking place during a given period of time. Data on energy use, fuel use, miles traveled, input material flow and product output are all examples of activity data that might be used to compute GHG emissions.
Anthropogenic	Activity originated from, or directly caused by humans.
Base year	A specific year against which an entity's emissions are tracked over time.
Biogenic emissions from combustion	CO_2 emissions produced from combusting a variety of biofuels and biomass, such as biodiesel, ethanol, wood, wood waste and landfill gas.
Boundaries	GHG accounting and reporting boundaries can have several dimensions, i.e., organizational, operational and geographic. These boundaries determine which emissions are accounted for and reported by the entity. Protocols offer guidance and best practices in determining boundaries for GHG inventories.
British thermal unit (Btu)	The quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit at about 39.2 degrees Fahrenheit.
Carbon neutrality	Net-zero carbon emissions, achieved through a balance of emissions reductions and removal.
CO_2 equivalent (CO_2e)	The universal unit for comparing emissions of different GHGs expressed in terms of the global warming potential of one unit of carbon dioxide.
Direct emissions	Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions and fugitive emissions. All direct emissions are Scope 1 emissions, with the exception of biogenic CO_2 emissions from biomass combustion.

Emission factor	A unique value for determining an amount of a GHG emitted on a per unit activity basis (for example, metric tons of CO_2 emitted per million Btus of coal combusted, or metric tons of CO_2 emitted per kWh of electricity consumed).
Financial control	The ability to direct the financial and operating policies of an operation with an interest in gaining economic benefits from its activities.
Fugitive emissions	Emissions that are not physically controlled but result from the intentional or unintentional release of GHGs. They commonly arise from the production, processing, transmission, storage and use of fuels or other substances, often through joints, seals, packing, gaskets, etc. Examples include hydrofluorocarbons from refrigeration leaks, SF_6 from electrical power distributors and CH_4 from solid waste landfills.
Global warming potential	The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emission of one mass-based unit of a given GHG compared to one equivalent unit of carbon dioxide (CO_2) over a given period of time.
Government operations inventory	Includes all emissions that originate/occur within County of Sonoma's local government operations.
Greenhouse gases (GHGs)	Defined in the Local Government Operations Protocol as GHGs are the six gases identified in the Kyoto Protocol: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).
Indirect emissions	Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity. For example, emissions of electricity used by a manufacturing entity that occur at a power plant represent the manufacturer's indirect emissions.
Inventory	A comprehensive, quantified list of an organization's GHG emissions and sources.
Key performance indicators	Individual metrics that can be used to track an entity's progress toward established goals.

Kilowatt hour (kWh)	The electrical energy unit of measure equal to one thousand watts of power supplied to, or taken from, an electric circuit steadily for one hour. (A Watt is the unit of electrical power equal to one ampere under a pressure of one volt, or 1/746 horsepower.)
Metric ton (MT, tonne)	Common international measurement for the quantity of GHG emissions, equivalent to about 2,204.6 pounds or 1.1 short tons.
Natural gas	A naturally occurring mixture of hydrocarbons (e.g., methane, ethane or propane) produced in geological formations beneath the earth's surface that maintains a gaseous state at standard atmospheric temperature and pressure under ordinary conditions.
Non-greenhouse gas emissions analysis	Analysis of the impact of non-greenhouse gas emissions (such as particulate matter (PM) 2.5 and 10) produced through an entity's operations.
Operational control	Full authority to introduce and implement operating policies at an operation.
Protocol	A defined methodology for calculating and reporting GHG emissions.
Scope	Defines the operational boundaries in relation to indirect and direct GHG emissions.
Scope 1 emissions	All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.
Scope 2 emissions	Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.
Scope 3 emissions	All indirect emissions not covered in Scope 2. Examples include upstream and downstream emissions, emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, use of sold products and services, outsourced activities, recycling of used products, waste disposal, etc.
Sequestration	A process in which carbon is captured, removed and stored from the atmosphere in a solid or liquid form.

Stationary combustion	Emissions from the combustion of fuels to produce electricity, steam, heat or power using equipment (boilers, furnaces, etc.) in a fixed location.
Therm	A measure of one hundred thousand Btu.
Trend analysis	An analysis that identifies key inventory trends. In this report, the trend analysis examines trends from the County's 2017 to 2021 GHG inventories and provides narrative to explain the observed changes in emissions.
Wedge analysis	An analysis that visually represents forecasted future GHG emissions based on multiple scenarios including "business-as-usual" and "adjusted business-as-usual," which includes the projected impacts of federal, state and regional policies.

Acknowledgements

The County of Sonoma would like to express appreciation to the following individuals and organizations for their time and support in gathering and analyzing data and drafting this report.

Sonoma County Board of Supervisors

- Chair Chris Coursey, 3rd District
- Susan Gorin, 1st District
- David Rabbitt, 2nd District
- James Gore, 4th District
- Lynda Hopkins, 5th District

County of Sonoma Staff

- M. Christina Rivera, County Administrator
- Anna Yip, Principal Climate Resiliency Analyst – Project Lead
- Barbara Lee, Director of Climate Action and Resiliency
- Jane Elias, Energy and Sustainability Program Manager
- Christine Condon, Department Analyst
- Numerous other staff from across County departments and agencies

Partners

- Sonoma County Regional Climate Protection Authority
- Sonoma Water
- Sonoma County Agricultural Preservation and Open Space District

Cascadia Consulting Group

- Addie Bash
- Alicia Fennell
- Andrea Martin
- Angela Pietschmann
- Hailey Weinberg
- Jenna Decker
- Keiko Betcher
- Sebastian Espinosa

Executive Summary

In 2019, the County of Sonoma renewed its **commitment to climate action** through a collection of efforts, including declaring a climate emergency in Sonoma County, creating a Climate Action and Resiliency Division within the County Administrator's Office and setting a target of reaching carbon neutrality for all County operations by 2030.[1] To continue significant and meaningful progress toward reaching carbon neutrality and other sustainability goals, the County has completed a series of **local government operations greenhouse gas (GHG) emissions inventories** to understand its emissions profile and trends and inform future climate action efforts.

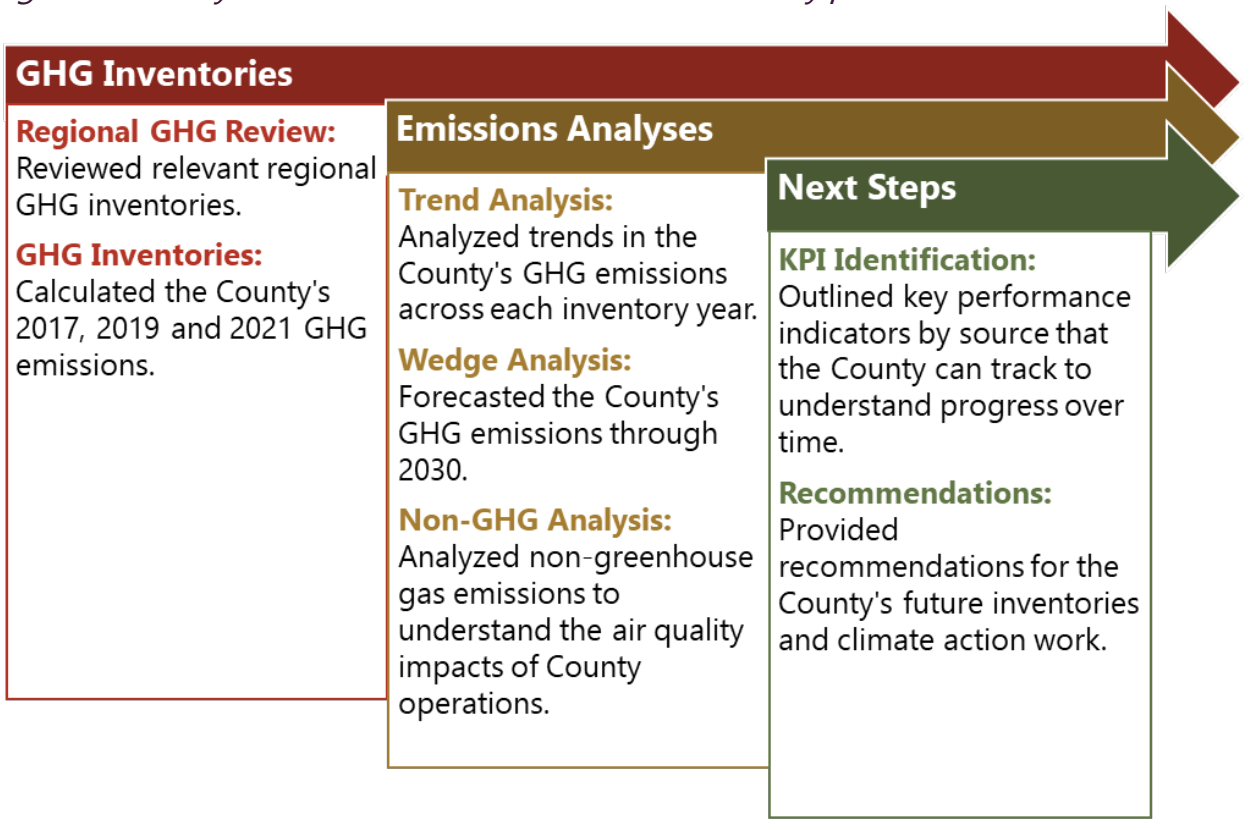
These inventories were prepared in accordance with the Local Government Operations Protocol (LGOP),[2] an **established methodology that is regarded as the industry standard** for government operations GHG inventories. Using the LGOP's methodology helps ensure that inventories are accurate, replicable and comparable to other local governments. These 2017, 2019 and 2021 County inventories use the U.S. Community Protocol[3] and other standard protocols where the LGOP does not provide specific guidance. The inventories **quantified emissions produced through local government operations that fall within the County's operational control**, including emissions generated by facilities and sources that the County owns, operates or has full authority over.

GHG inventories were completed for the County's operations in 2017, 2019 and 2021 to provide a **trending analysis across several years, including through the COVID-19 pandemic**, which impacted emissions-producing activities worldwide.

This GHG analysis effort included a review of relevant local inventories, multiple quantitative analyses focused on calculating current emissions and forecasting future emissions, and identification of key indicators and recommendations to guide the County's future climate action work. The full scope of these activities is outlined in Figure 1 below.

[1] Climate Action and Resiliency | socostrategicplan.org
[2] Local Government Operation Protocol
[3] U.S. Community Protocol

Figure 1. County of Sonoma's 2022–2023 GHG inventory process.

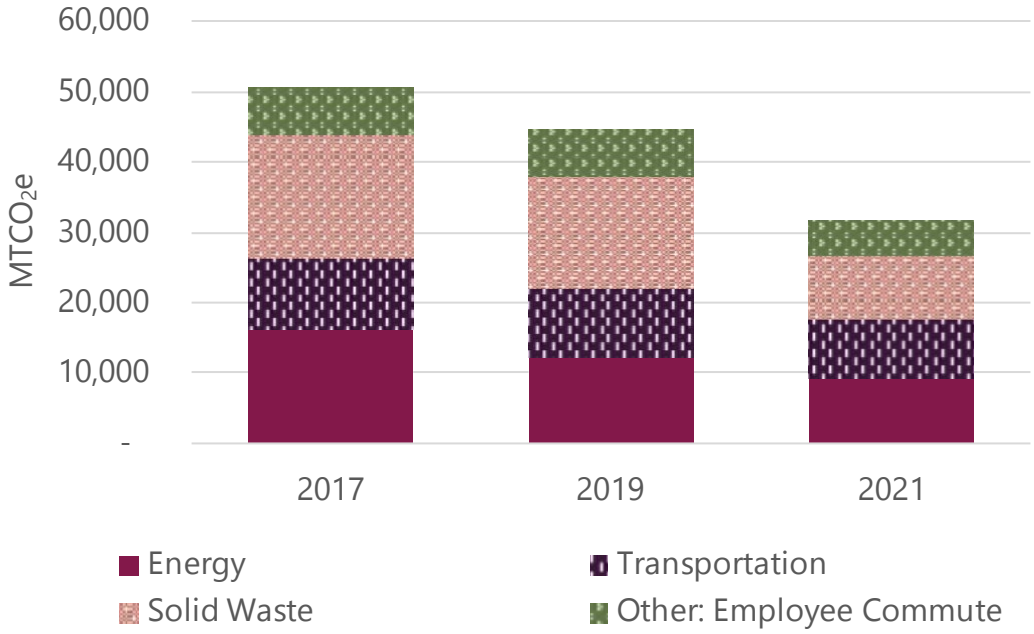


Greenhouse Gas Inventory

As shown graphically in Figure 2, County operations produced 50,635 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2017, 44,756 $MTCO_2e$ in 2019 and 31,712 $MTCO_2e$ in 2021.

Total emissions decreased 37% from 2017 to 2021. Emissions decreased 12% between 2017 and 2019 (the most recent inventory year before the COVID-19 pandemic) and 29% between 2019 and 2021.

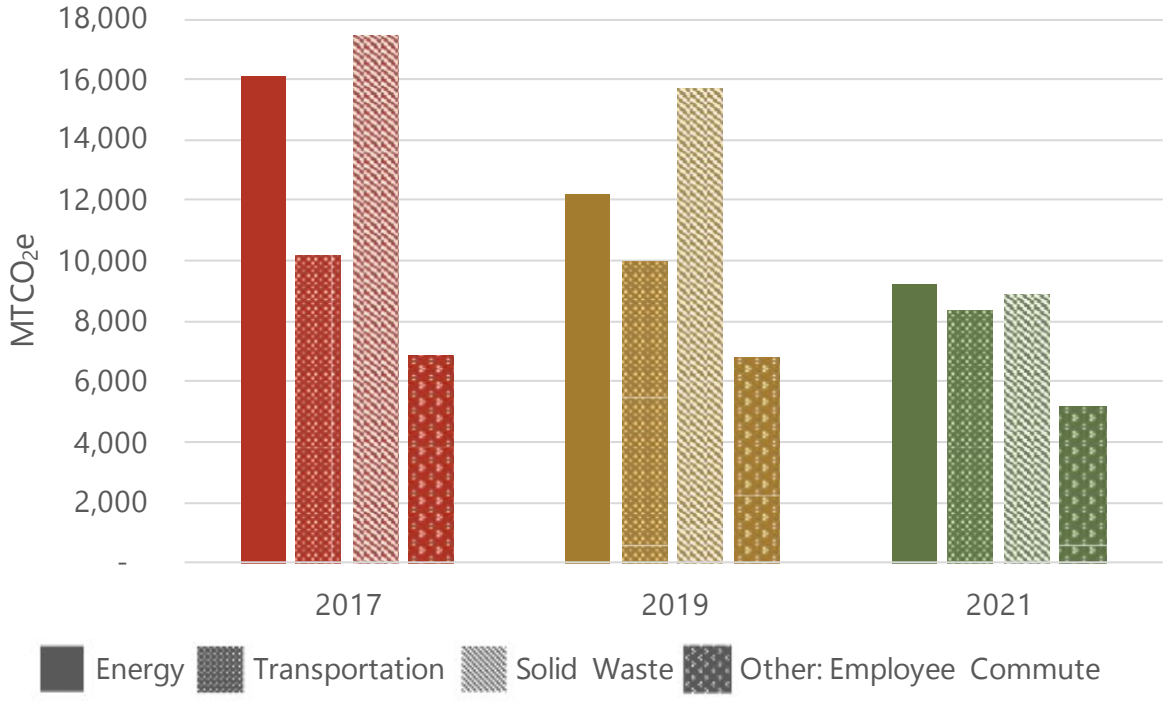
Figure 2. Total greenhouse gas emissions for 2017, 2019 and 2021.



As shown in Figure 3, **in 2017 and 2019, solid waste was the largest source of emissions** (35% of total emissions both years), followed by energy (27–32% of total emissions). **In 2021, energy was the largest source of emissions** (29%), with solid waste as the next highest source (28%).

- For the County of Sonoma, solid waste represented a higher than usual proportion of total emissions; for governments and municipalities that do not own and operate landfills, emissions from solid waste are generally a small proportion of total emissions. Unlike most other sectors in these inventories—which only measured activity related to County government operations—solid waste included emissions from **closed landfills** that served residents and businesses countywide, which inflated the sector's total emissions in comparison to the rest of the inventory.

Figure 3. GHG emissions by source for 2017, 2019 and 2021.



Trend Analysis

Many factors can affect government operations and cause fluctuations in GHG emissions, including changing electric utility providers, implementing telework policies and decommissioning or opening new facilities. Building on the GHG inventories, the County conducted a **trend analysis** to review its carbon footprint, understand existing trends and identify anomalies across years. High-level trends are summarized below.

- **Energy emissions decreased 43%** from 2017 to 2021, driven by a **40% decrease in natural gas consumption from 2017 to 2021**. One main driver of this reduction was the **decommissioning of the Sonoma County Fuel Cell** (a power generation plant that converted natural gas into electricity) at the end of 2020. The County also reduced propane usage 97% during this period. Although electricity emissions increased, the decrease in natural gas and propane consumption (which have higher emissions intensities) resulted in a net decrease in energy emissions.
- **Transportation emissions decreased 18%** from 2017 to 2021. This decrease was likely influenced by the **COVID-19 pandemic,** which began significantly disrupting County operations in March 2020. Emissions decreased from all transportation sub-sources: on-road vehicles (-16%), off-road vehicles and equipment (-21%) and transit vehicles (-19%).

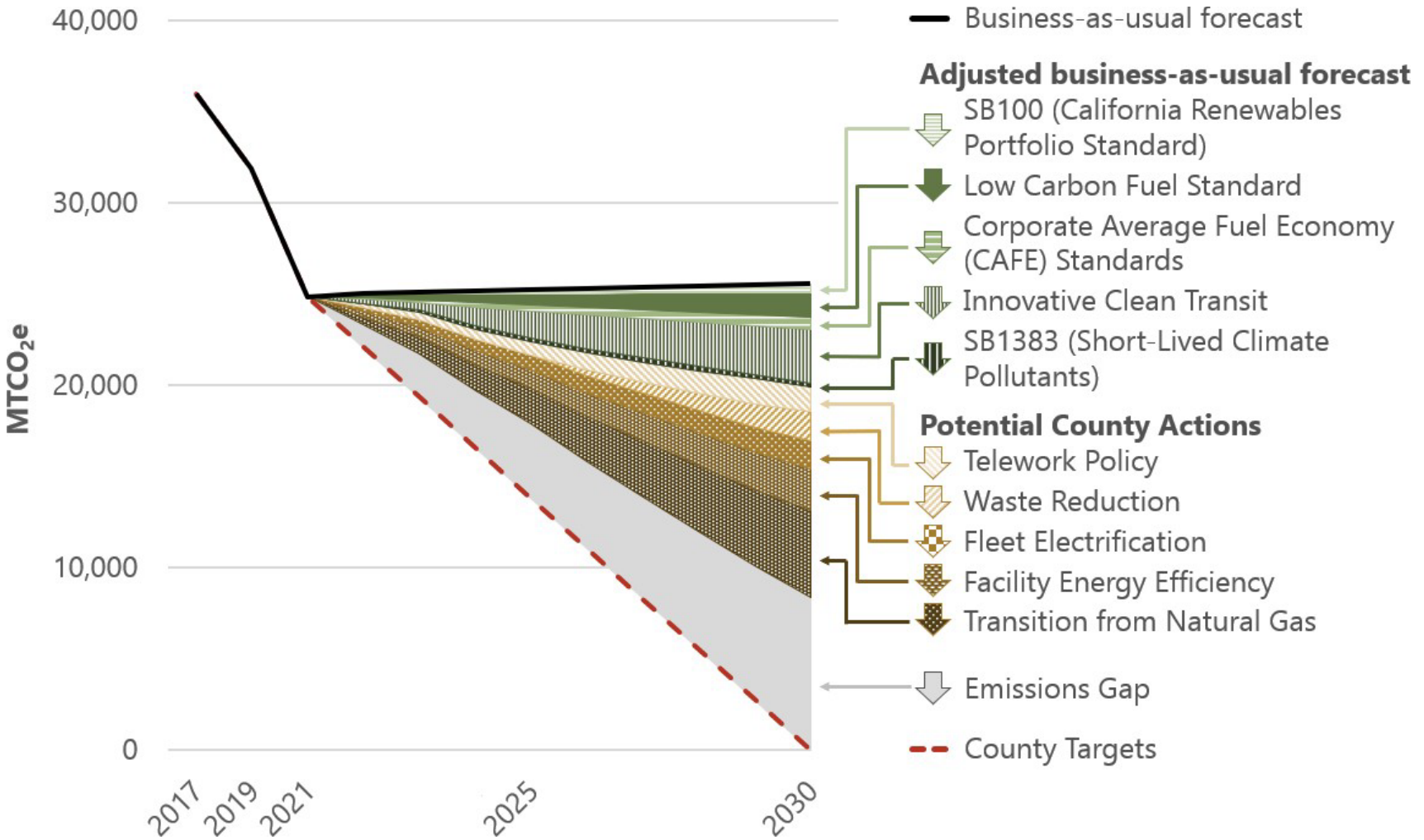
- **Solid waste emissions decreased 49%** from 2017 to 2021. This source includes emissions from closed landfills that the County owns and operates—which were responsible for 77–84% of solid waste emissions—and emissions from solid waste generated by the County. It is typical for gas production to decline over time in closed landfills.
- **Employee commute emissions decreased 25%** from 2017 to 2021, due to an increase in the percentage of employees who telework, influenced by the COVID-19 pandemic.
- **Water and wastewater emissions from County operations decreased 2%** from 2017 to 2021 and comprise less than 0.1% of total emissions. (These emissions were excluded from Figure 3 because they were too small to be seen.)

Wedge Analysis

Building on the results of the 2017, 2019 and 2021 GHG inventories, the County conducted a wedge analysis—a visual representation of **potential future emissions based on different scenarios**—to forecast the County's GHG emissions through 2030 and inform future climate action efforts. This analysis can be used to understand how the County can best make progress toward achieving its goal of reaching net zero emissions by 2030.[1]

The wedge model projects the County's emissions two ways: including and excluding emissions from closed landfills. Closed landfills are a significant portion of the County's emissions which the County has minimal control over. As such, Figure 4 represents the County's emissions under a scenario that **excludes** emissions from closed landfills.

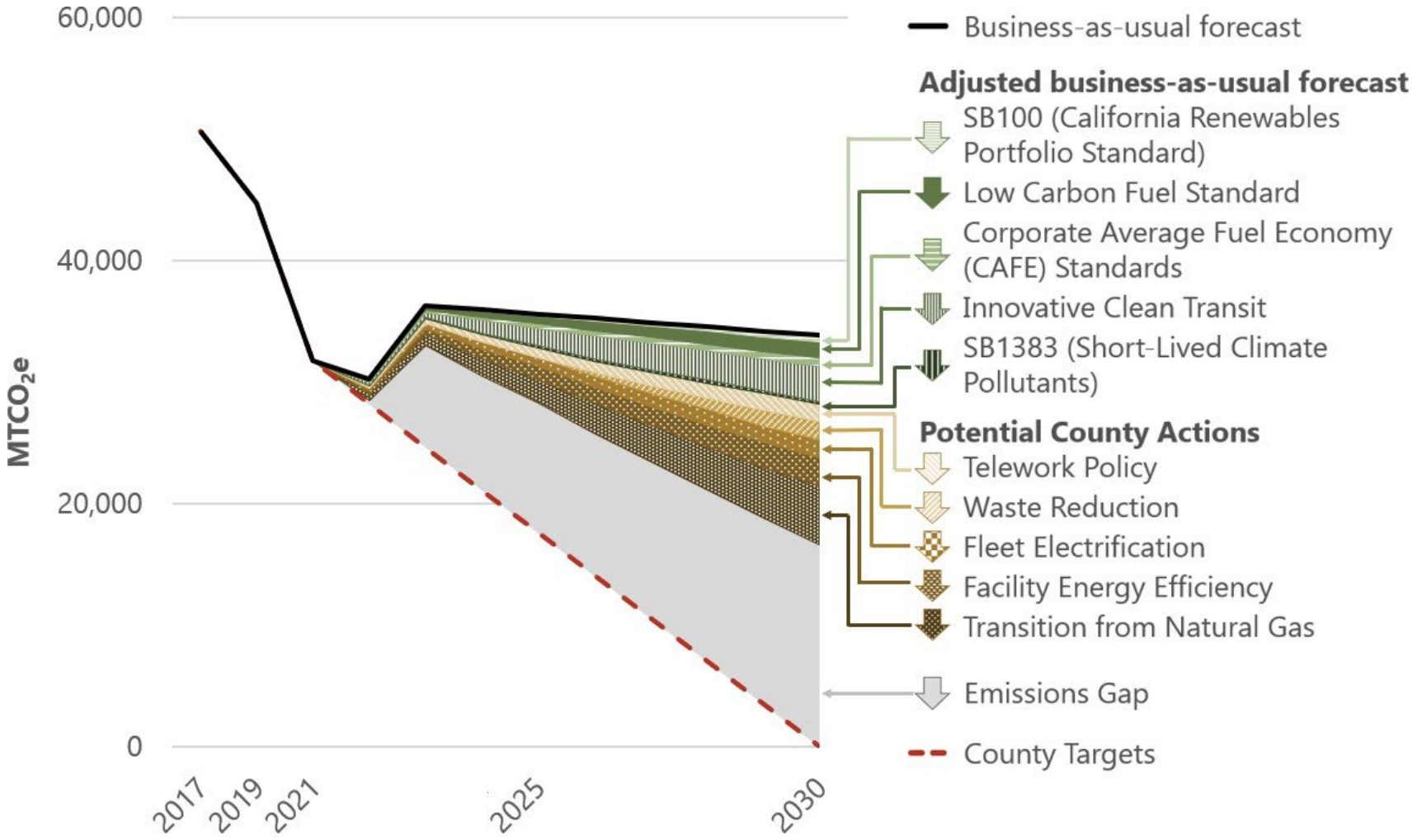
Figure 4. Forecasted County GHG emissions through 2030, excluding landfills.



- If no federal, state or local climate action is taken, the County's emissions are projected to increase **3%** by 2030.
- Considering the impacts of existing federal and state climate policies and regulations, emissions are expected to decrease **20%** by 2030.
- If the County implements high-level strategies to reduce emissions from some of its largest emission sources, emissions are expected to decrease **66%** by 2030. These actions include improving facility energy efficiency, retrofitting buildings to transition buildings from natural gas to electricity or renewable energy sources, continuing to electrify the County's vehicle fleet, achieving zero waste by 2030 and modifying the County's telework policy.
- When considering the estimated collective impact of federal and state policies and regulations and potential County climate action implementation, remaining County emissions will largely consist of:
    - Employee commute (**35%** of remaining emissions).
    - Electricity consumption (**25%** of remaining emissions).
    - On-road vehicle fleet (**23%** of remaining emissions).

Figure 5 represents the County's forecasted emissions **including** emissions from closed landfills.

Figure 5. Forecasted County GHG emissions through 2030, including landfills.



- Without any climate action efforts, the County's emissions are projected to increase **7%** by 2030.
- Considering existing federal and state climate policies and regulations, emissions are expected to decrease **11%** by 2030.
- By implementing the same high-level emission reduction strategies, emissions are expected to decrease **48%** by 2030.
- Remaining County emissions will largely consist of:
    - Landfills (**50%** of remaining emissions).
    - Employee commute (**18%** of remaining emissions).
    - Electricity consumption (**13%** of remaining emissions).

Key Performance Indicators

The results of the GHG inventories, trend analysis and emissions forecast through 2030 were used to develop a series of **key performance indicators** (KPIs) that the County can use to track progress toward its goal of net zero government operations emissions by 2030. KPIs are organized by GHG source; a subset of the KPI list is included below.

Source	Key Performance Indicator
Energy	• Total energy consumption (electricity and natural gas) by government operations (kWh/therms or MMBtu).
Transportation	• Total milage, fuel consumption, and kWh consumption by vehicles and equipment.
Solid Waste	• Tons of solid waste, recyclable material and compost produced at County facilities.
Employee Commute	• Miles commuted by County employees. • Percentage of full-time employee equivalents teleworking.

Recommendations

The inventory and analysis results were also used to inform **high-level emissions reduction recommendations** and **considerations for future inventories**. Recommendations are organized by GHG source; a subset of the recommendations related to emissions reduction is included below.

High-level Strategies	Notes
Shift County accounts to Sonoma Clean Power's Evergreen program and complete energy efficiency upgrades and retrofits, as feasible.	Medium-priority focus area due to small proportion of past emissions (electricity: 1–4%) but should be a higher priority in future years as electricity consumption becomes a larger percent of emissions; high degree of County control.
Electrify County buildings and complete energy efficiency upgrades and retrofits.	High-priority focus area due to large proportion of emissions (natural gas: 24–26%) and high degree of County control.
Electrify County fleet (on-road, transit and off-road vehicles and equipment).	High-priority focus area due to large proportion of emissions (transportation: 20–26%) and high degree of County control.
Increase diversion of waste from landfills through education and improved waste receptacles.	Low/medium-priority focus area due to small proportion of emissions (solid waste generation: 6%); relatively high degree of County control.
Maintain flexible work schedules and increase telework where feasible.	High-priority focus area due to large proportion of emissions (employee commute: 14–16%); moderate degree of County control.

Please see the full report for more information on these local government operations emissions inventories and analyses.

Introduction

Sonoma County sits on 50 miles of the Pacific Coastline of Northern California. The county hosts ample vineyards, fruitful and sustainable agricultural lands, rolling hills, the Russian River, redwood forests and the Sonoma and Mayacamas mountain ranges.[4] Approximately 485,000 residents call Sonoma County home[5] and the area boasts a successful tourism industry, attracting people from around the world to visit its wineries, museums, natural areas and more.

The **County of Sonoma** is the legal entity that governs Sonoma County, including agencies and departments that manage natural resources, administer health and human services and provide administrative support to the Sonoma County community. The greenhouse gas inventories described in this report pertain only to **emissions generated by the County of Sonoma's local government operations and do not include emissions produced by Sonoma County's community** (more detail can be found in the *Inventory Scope* section).

County of Sonoma's Commitment to Climate Action

The County of Sonoma has demonstrated a meaningful commitment to climate action over the past several years. In addition to creating a new **Climate Action and Resiliency Division** within the County Administrator's Office, the County also recently dedicated nearly $10 million to near- and mid-term climate projects.[6]

In 2019, the Sonoma County Board of Supervisors declared a **climate emergency**, publicly establishing climate as a top priority.[7] In response, the County established Climate Action and Resiliency as one of the five main pillars in its **Five-Year Strategic Plan**, identifying a vision for carbon-free, zero-waste and resilient County operations, with the ultimate goal of achieving carbon neutrality by 2030.[1]

In support of this strategic plan, the County conducted **local government operations greenhouse gas (GHG) emissions inventories** to understand the County's primary emission sources and how emissions have changed over time. These inventories build on previous GHG inventories completed by Sonoma County Regional Climate Protection Authority, Sonoma County Water Agency (Sonoma Water), and the County's Regional Parks department.

---

[4] Sonoma County Tourism Official Site | SonomaCounty.com
[5] U.S. Census Bureau QuickFacts: Sonoma County, California
[6] Climate Resilience Fund | sonomacounty.ca.gov
[7] Sonoma County Declares Climate Emergency | sonomacounty.ca.gov

Greenhouse gas inventories provide vital baseline data that help underpin ambitious mitigation actions. With climate change impacts significantly affecting the region—from increased heat, drought and wildfires to storm surges and flooding—the need to **better understand and aggressively reduce emissions** is both timely and essential.

Greenhouse Gas Inventories and Analyses

The GHG inventories described in this report provide a detailed **baseline analysis of the County's local government operations emissions**. Establishing this baseline allows the County to **understand** its operational emissions, **identify** areas of opportunity to reduce these emissions and **track progress** toward achieving its carbon neutrality target as it implements climate action initiatives in the years ahead.

These inventories are also accompanied by **key performance indicators** and metrics, which will help the County track progress and challenges associated with reducing GHG emissions over time (see *Key Performance Indicators and Metrics* for more information).

Inventories were completed using **industry best practices** to ensure that they are accurate and replicable. The methodology used to calculate emissions allows for future independent third-party verification—a process in which a third party reviews an inventory to confirm its accuracy and legitimacy—if desired by the County.

These GHG inventories provide a complementary analysis to the communitywide GHG inventories performed by Sonoma County Regional Climate Protection Authority. For more information about the scope of these inventories, see the *Inventory Scope* section below.

Report at a Glance

This section provides an overview of the chapters of this report.

Inventory Scope

The *Inventory Scope* section discusses **emission sources, inventory years and inventory methodology**. These inventories provide a baseline analysis of the County's GHG emissions produced by activities occurring under the County's jurisdictional control in 2017, 2019 and 2021. The inventories follow the Local Government Operations Protocol's operational control approach to calculating emissions. The data was collected, calculated and analyzed using Microsoft Excel and Power BI, data processing and visualization tools.

Inventory Results & Analysis

The *Inventory Results and Analysis* section provides a comprehensive **summary of emissions for calendar years 2017, 2019 and 2021**. Inventory results are presented by the following emission sources: energy, transportation, solid waste and other emission sources. Categorizing emissions by major sources can help the County better understand its emissions and prioritize emissions-reduction efforts.

Additional Analyses

The *Additional Analyses* section explores the results of the following analyses:

- Trend Analysis Summary summarizes trends in emissions over time and identifies causal links to understand changes in emissions.
- Wedge Analysis forecasts County emissions from 2022 through 2030 under various scenarios, using inventory results.
- Non-GHG Analysis analyzes non-GHG emissions to understand air quality impacts related to County operations.

Key Performance Indicators & Metrics

The *Key Performance Indicators and Metrics* section proposes a series of indicators and metrics for **tracking progress over time** across emission sources.

Recommendations

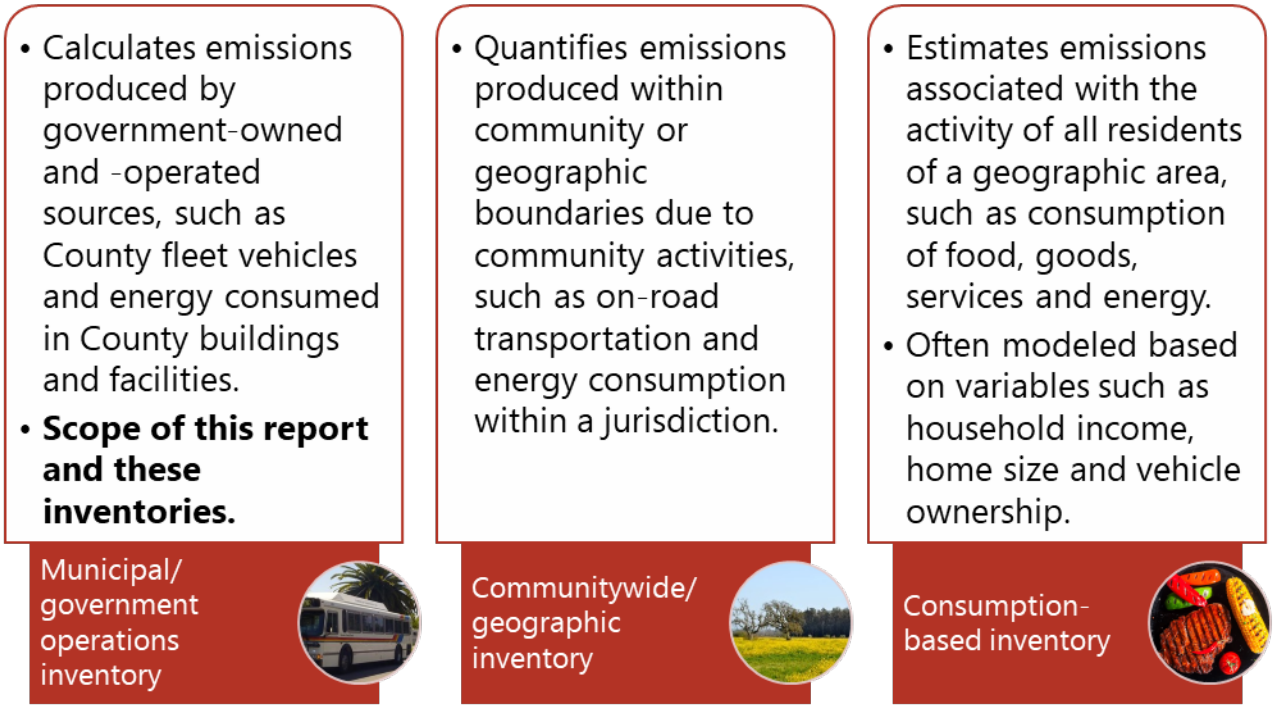
The *Recommendations* section includes a series of recommendations, based on the inventory results, analysis and KPIs, that can **guide the County's emissions reductions**. This section also includes recommendations related to conducting **future inventories**, including preferred data sources, data collection efficiencies and increased data granularity.

Inventory Scope

Emission Sources

The emissions quantified in these GHG inventories include those generated from **operations under the County's jurisdictional control** and as a result of local government operations activities, such as electricity consumption in County facilities. Therefore, these inventories do not include "upstream" or "consumption-based" emission sources, such as the production, transportation and disposal of goods and services consumed by the County. These inventories also do not include "geographic" or "communitywide" emission sources, such as all energy consumption within the Sonoma County geographic boundaries. Figure 6 summarizes different inventory types and the scope of emissions included in each.

Figure 6. Summary of different inventory types and scopes.



Because these County inventories *only* quantify local government operations emissions, the County relies heavily on communitywide greenhouse gas inventories completed by Sonoma County Regional Climate Protection Authority (RCPA) to understand broader regional emissions.[8] Communitywide GHG inventories quantify emissions generated by

[8] Greenhouse Gas Inventory | rcpa.ca.gov

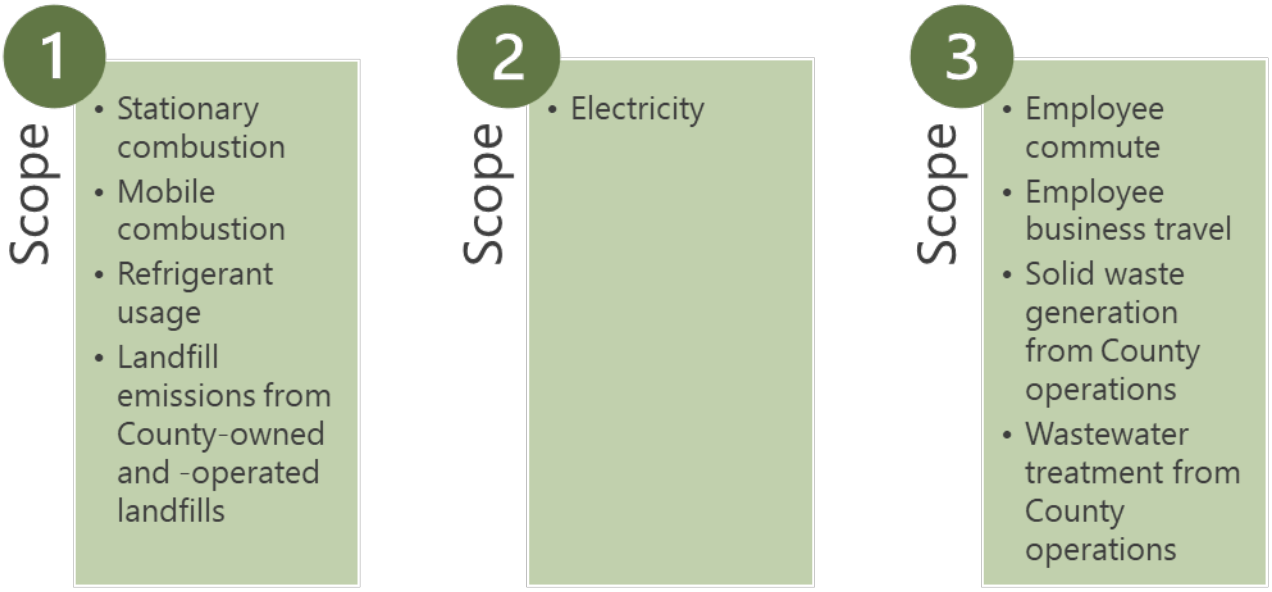
residents, businesses, and visitors to Sonoma County in both incorporated and unincorporated areas. Emissions from County operations are included within RCPA's community inventories due to the geographic scope of RCPA's inventories—as such, the County's operational inventories add a greater level of detail to the existing community inventories completed by RCPA.

GHG emissions can be categorized into **three "scopes" related to the extent of control** over the emission source. The Local Government Operations Protocol (LGOP) requires a jurisdiction to calculate its Scope 1 and 2 emissions but considers Scope 3 emissions as optional to include in an inventory.

- **Scope 1**. Direct emissions from stationary and mobile combustion, such as gasoline consumption by County-owned vehicles and natural gas consumption in County facilities.
- **Scope 2**. Indirect emissions that result from the purchase of electricity, steam, or other heating and cooling sources.
- **Scope 3**. Indirect emissions resulting from activities the jurisdiction has less influence over, such as employee commuting and business travel; considered optional to include.

The County's GHG emissions included in these inventories are categorized by scope in Figure 7.

Figure 7. Emission sources included within each LGOP scope.



Emissions from these sources are produced across the County's departments, facilities, equipment and operations. **Jurisdictions have varying levels of control over specific emission sources**. For example, the County can greatly influence mobile combustion emissions based on what types of vehicles it keeps in the fleet, but it has less influence over wastewater treatment emissions, since the County does not operate wastewater treatment facilities. For a list of the County's departments, see *Appendix B: County Departments*.

This analysis also considers emissions from land use change, which are not included in the LGOP scopes but were estimated using the ICLEI – Local Governments for Sustainability Land Emissions and Removals Navigator (LEARN) tool in alignment with the U.S. Community Protocol to understand emissions resulting from land that the County owns and manages.

Inventory Years

Inventories were completed for the **calendar years 2017, 2019 and 2021**. These years were selected strategically:

- **2017:** selected for **historical trending** analysis.
- **2019:** selected as the County's **baseline** inventory year (most recent "pre-COVID-19" year).
- **2021:** selected to reflect impacts on emissions from **systemic changes due to COVID-19** (for example, reduced employee commuting due to increased telework).

By selecting these inventory years, the County has established a baseline of completing inventories every other year; this cadence will help the County track progress toward its carbon neutrality goal.

Inventory Methodology

The 2017, 2019 and 2021 inventories were prepared in accordance with the **Local Government Operations Protocol (LGOP)**,[9] commonly recognized as the industry standard for GHG emissions accounting for local governments. The LGOP is one of the most consistently used standards for local governments in the United States and is recommended for use by the U.S. Environmental Protection Agency in its "Local

[9] Local Government Operation Protocol

Greenhouse Gas Inventory" tool,[10] developed for local governments to quantify their emissions.

The LGOP was developed from the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard[11] to fill the gap for measuring and reporting emissions specifically for the local government sector. Where the LGOP did not include methodology for certain emission sources such as land use, emissions were calculated using industry best practices or reputable calculation tools.

The LGOP allows local governments to complete an inventory using either operational or financial control as an organizational boundary. For this effort, the County of Sonoma used the **operational control approach** as recommended and defined by the LGOP. In this approach, local governments report **all emissions from facilities and sources they own or operate—that is, sources over which they have full authority to determine operational policies and processes**.

The County completed these inventories through an iterative process that included data collection from key County contacts, consultation of regional GHG inventory efforts and implementation of industry best practices. Where possible, these inventories align with other local inventories, including those performed by other internal County of Sonoma departments (Regional Parks) and external partners (Sonoma Water, Sonoma County Regional Climate Protection Authority).

These inventories were completed using a combination of Microsoft Excel and Power BI, with the ability to be replicated in future years to ensure consistency and accuracy. The emissions calculated for the County's 2017, 2019 and 2021 inventories were thoroughly reviewed in a quality control process that occurred at each step of inventory completion—from initial data collection to final emissions reporting.

For more information regarding the inventory completion process, reference *Appendix A: Inventory Methodology*.

[10] Local Greenhouse Gas Inventory Tool | US EPA
[11] Corporate Standard | Greenhouse Gas Protocol (ghgprotocol.org)

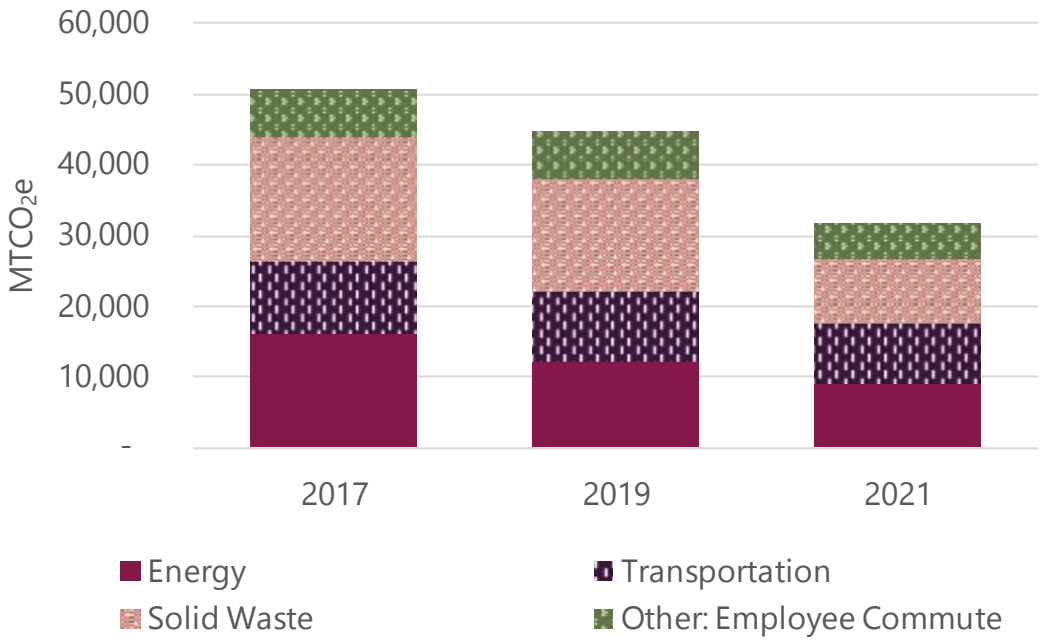
Inventory Results and Analysis

This report provides the GHG emissions inventory findings for the County of Sonoma's local government operations for calendar years 2017, 2019 and 2021. High-level results are summarized below in *Overview of Inventory Results,* and emissions are broken out by source and summarized in *Inventory Results by Emission Source.*

Overview of Inventory Results

- As shown graphically in Figure 8, County operations produced 50,635 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2017, 44,756 $MTCO_2e$ in 2019 and 31,712 $MTCO_2e$ in 2021.
- **Total emissions decreased 37% from 2017 to 2021**. Emissions decreased 12% between 2017 and 2019 (the most recent inventory year before the COVID-19 pandemic) and 29% between 2019 and 2021.

Figure 8. Total GHG emissions for 2017, 2019 and 2021.



- As shown in Figure 9, in 2017 and 2019, solid waste was the largest source of emissions (35% of total emissions both years), followed by energy (27–32% of total emissions). In 2021, energy was the largest source of emissions (29%), with solid waste as the next highest source (28%).
- For the County of Sonoma, solid waste represented a higher than usual proportion of total emissions; for governments and municipalities that do not own and operate

landfills, emissions from solid waste are generally a small proportion of total emissions. Unlike most other sectors in these inventories—which only measured activity related to County government operations—solid waste included emissions from **closed landfills** that served residents and businesses countywide, which inflated the sector's total emissions in comparison to the rest of the inventory.

Figure 9. GHG emissions by source for 2017, 2019 and 2021.

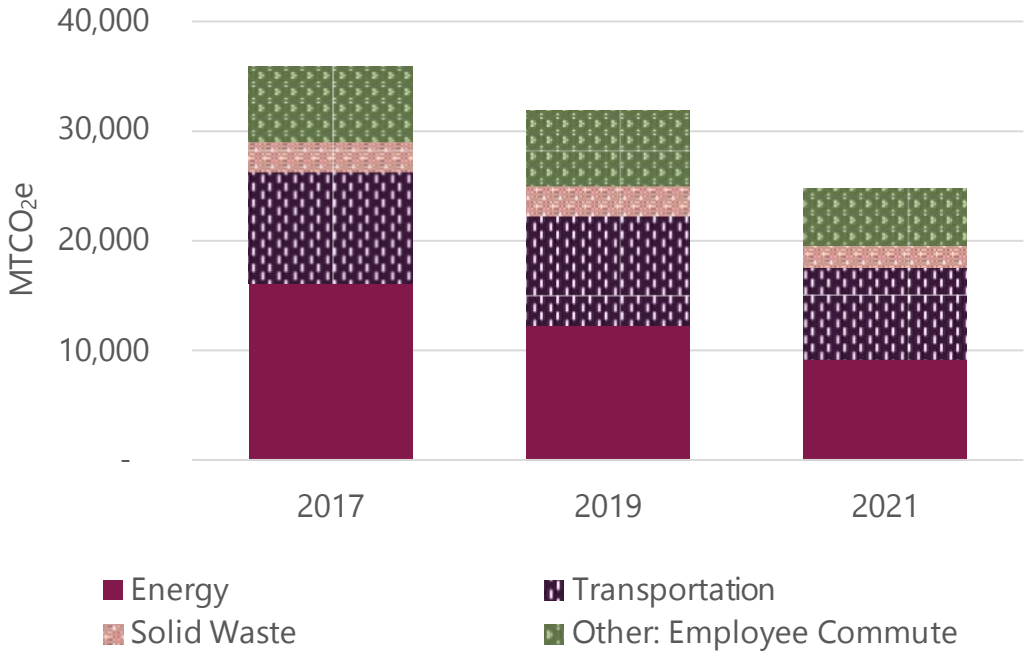
- Changes in emissions were observed worldwide in 2020 from a reduction in high-emitting activities such as air travel as a result of the **COVID-19 pandemic**.[12] Emissions from County operations were affected in a variety of ways (e.g., a shift from in-person to remote work), which likely contributed to the more significant decrease in emissions between 2019 and 2021 than between 2017 and 2019. Many factors contribute to changes in emissions over time; these factors are explored below in the "**Trend analysis**" sections of *Inventory Results by Emission Source* and in the *Trend Analysis Summary*.
- It can be **helpful to examine emissions excluding closed landfills** for several reasons. As noted, the closed landfills served all County residents and therefore

[12] Emission Reductions from Pandemic Had Unexpected Effects on Atmosphere | nasa.gov

make up a larger-than-usual proportion of the County's inventory; the County also has limited pathways to reduce these emissions.

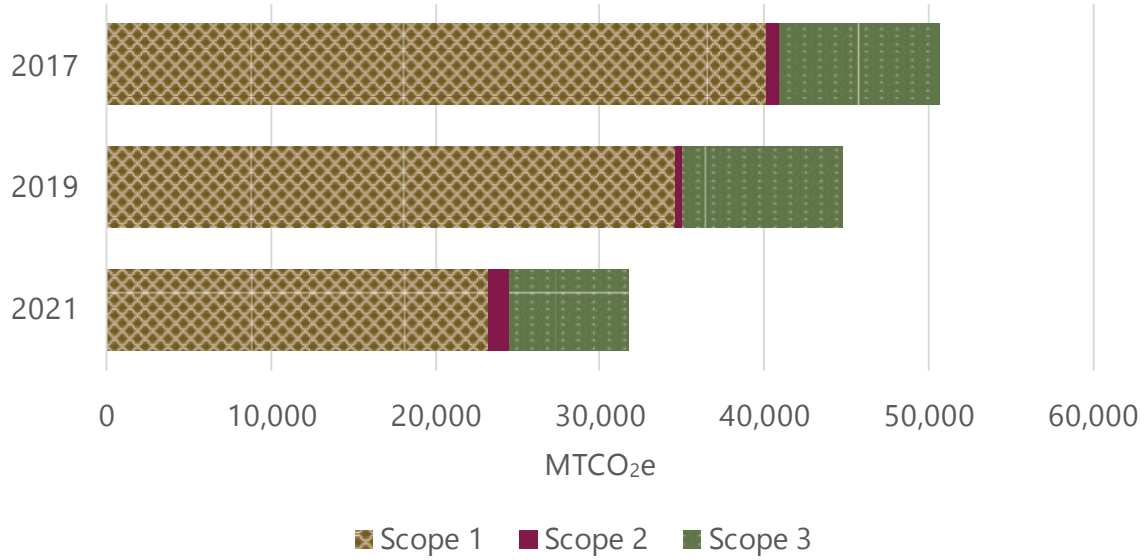
- When closed landfill emissions are filtered out, energy consumption produced 37–45% of total emissions, followed by transportation, which produced 28–34% of total emissions.
- Excluding closed landfills, total County emissions would be 35,947, 31,845 and 24,824 $MTCO_2e$ in 2017, 2019 and 2021, respectively (Figure 10).

Figure 10. GHG emissions by source for 2017, 2019 and 2021, excluding emissions from closed landfills.



- Another helpful method of examining emissions is **by scope** (Figure 11) to understand which emissions are direct emissions (Scope 1), indirect emissions (Scope 2) or additional indirect emissions that are considered optional to include (Scope 3). Scope 1 includes stationary combustion from the consumption of fuels, mobile combustion from vehicles and emissions from closed landfills; Scope 2 includes electricity consumption; Scope 3 includes employee commute and solid waste generation and wastewater emissions from County operations.

Figure 11. Total GHG emissions by LGOP Scopes 1, 2 and 3.



- Emission totals are presented below for each inventory year by emission source and sub-source (Table 1).

Table 1. Total GHG emissions by emission source, sub-source and year.

Total Emissions

GHG Emissions by Source ($MTCO_2e$)

	2017	2019	2021
Energy	16,130	12,225	9,254
Electricity	785	521	1,264
Natural Gas	13,278	10,821	7,925
Other Fuels: Propane	2,067	883	64
Transportation	10,157	9,993	8,358
Fleet Vehicles	5,383	5,143	4,496
On-Road	4,724	4,443	3,974
Off-Road	659	701	522
Transit Vehicles	4,774	4,850	3,862
Fixed Route Bus	3,906	4,068	3,347
Paratransit Bus	811	746	494
Support Vehicles	58	36	21
Water & Wastewater	29	29	28
Solid Waste	17,474	15,736	8,912
Landfills	14,688	12,911	6,888
Scope 3 Waste Generation	2,786	2,825	2,024
Other: Employee Commute	6,845	6,773	5,159
Total	**50,635**	**44,756**	**31,712**

Inventory Results by Emission Source

To better understand emission sources and avenues for GHG reductions, inventory results are broken out by source below. Trends over time are presented and explained for each source.

Energy

Energy consumption is one of the County's largest sources of GHG emissions and accounted for **32%, 27% and 29% of total County emissions in 2017, 2019 and 2021, respectively**.

The consumption of electricity is a Scope 2 emission source, and the stationary combustion of natural gas and other fuels is a Scope 1 emission source. The County has a relatively high degree of control over the energy emission source, and the source

spans across all departments and locations within County operations; therefore, this source—especially natural gas—should be a high priority focus area for the County to address through its climate action planning process.

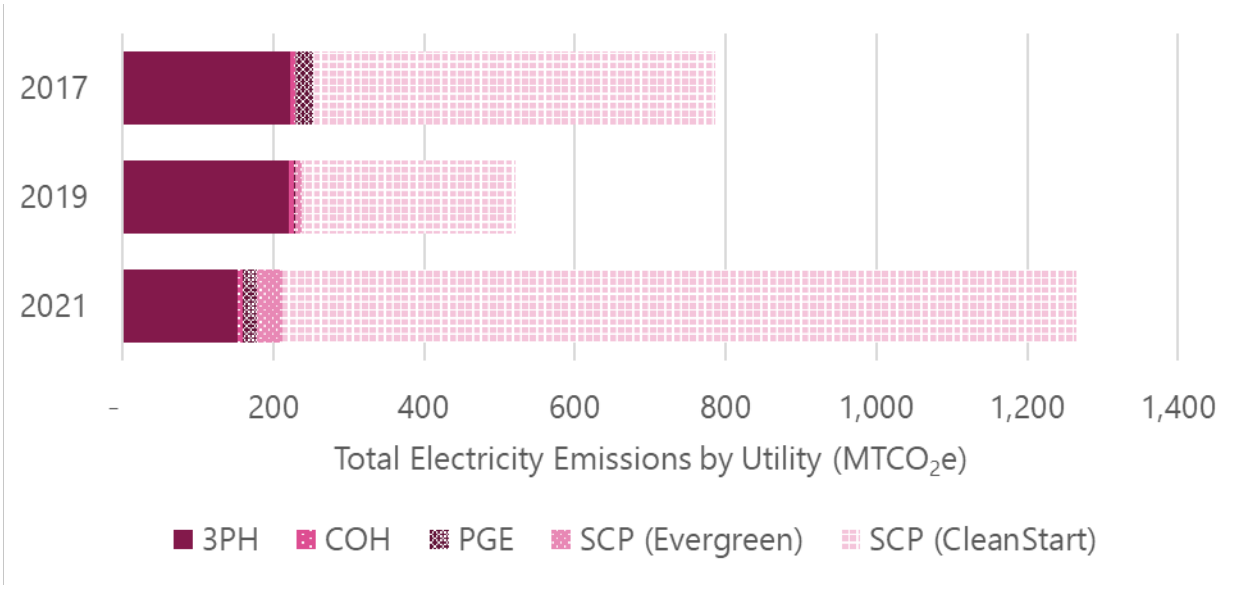
Electricity

Scope 2

The County of Sonoma purchases electricity from four sources: Sonoma Clean Power (SCP), Pacific Gas & Electric (PG&E), 3 Phases Renewables and the City of Healdsburg. **Electricity accounted for 2%, 1% and 4% of total County emissions in 2017, 2019 and 2021, respectively**. Electricity consumption produced 785 $MTCO_2e$ in 2017, 521 $MTCO_2e$ in 2019 and 1,264 $MTCO_2e$ in 2021, as shown in Figure 12 below.

Figure 12. Electricity emissions by utility ($MTCO_2e$).

3PH = 3 Phases Renewables; COH = City of Healdsburg; PGE = Pacific Gas & Electric; SCP = Sonoma Clean Power

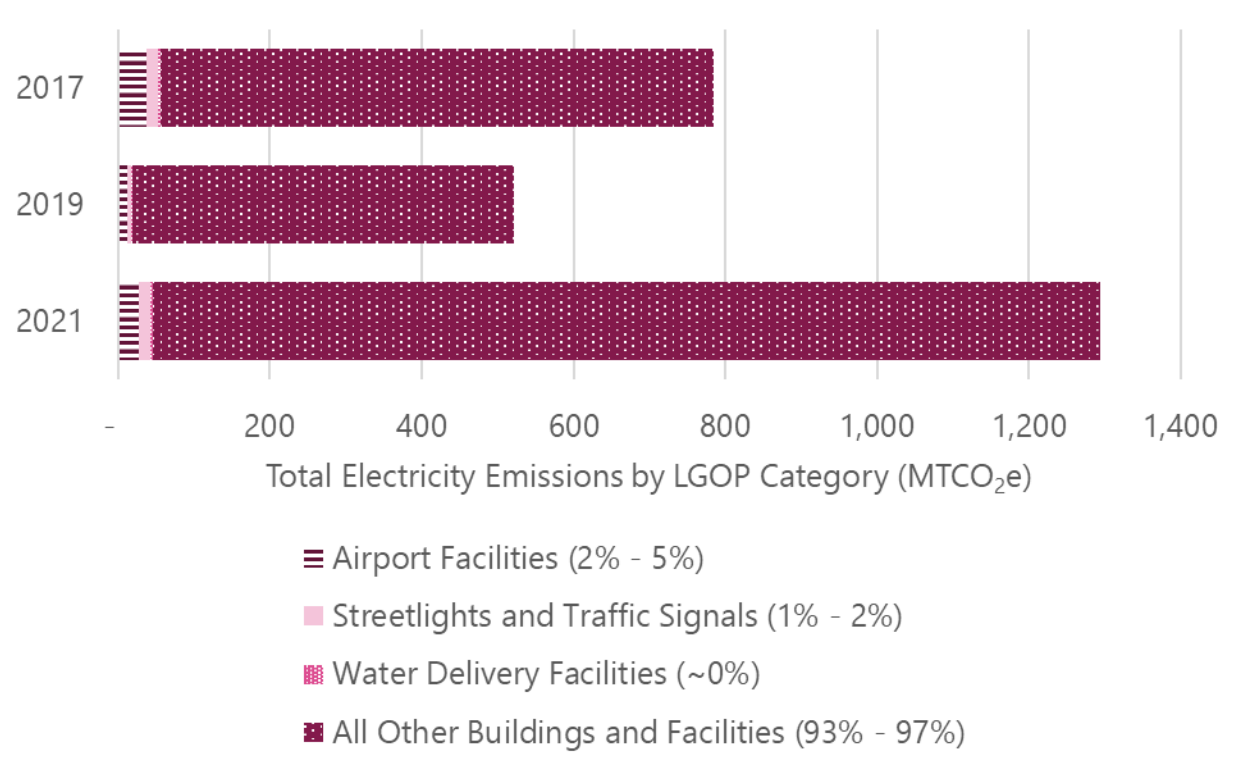


The following five **County facilities** produced the most electricity emissions across all inventory years:

- 2680 Ventura Ave., Santa Rosa (Facilities Operation building).
- 2455 Airport Blvd., Santa Rosa (Sonoma County Airport).
- 2200 Airport Blvd., Santa Rosa (Sonoma County Airport).
- 7440 Rancho Los Guilicos Road, Santa Rosa (Sonoma County Juvenile Probation Department).
- 3313 Chanate Road, Santa Rosa (Public Health Lab and Morgue and Coroner's Office; sold in 2021).

In accordance with the Local Government Operations Protocol, electricity consumption was grouped into the categories shown in Figure 13. However, due to data disaggregation limitations, some of the "All other buildings and facilities" category likely includes electricity consumption from other categories.

Figure 13. 2021 electricity emissions by LGOP category ($MTCO_2e$).



A very small amount of electricity emissions (estimated to be less than 1% of all electricity emissions) should be attributed to electricity consumption by electric vehicles in the County's fleet. Due to data disaggregation limitations, these emissions are included in energy totals, rather than in the transportation category.

Trend Analysis

Although electricity consumption increased 74%, emissions only increased 61% between 2017 and 2021, driven in part by the type of electricity the County purchased from Sonoma Clean Power. Emissions are calculated by multiplying activity data (energy consumption: number of kWh used) by an emission factor (greenhouse gas intensity: emissions per kWh used). Electric utilities have different emission factors, based on the type of energy they source; utilities sourcing renewable energy have lower emission factors than those using fossil fuel-based energy sources.

In August and September of 2019, the County shifted 34 accounts **from CleanStart to Evergreen, which typically has a lower emissions intensity**. CleanStart and Evergreen are program options offered by Sonoma Clean Power that source different energy mixes (e.g., geothermal, solar, general system power).[13]

Electricity emissions were also influenced by **annual changes in utilities' energy mix** and corresponding impact on the utility-specific emission factors. Sonoma Clean Power's 2019 emission factors differed from other years. Generally, Sonoma Clean Power's Evergreen program has a lower emission factor than the CleanStart program; however, over 46% of CleanStart's power came from large hydro in 2019, which resulted in CleanStart having a lower emissions intensity than Evergreen.

PG&E's 2019 emission factor was also significantly lower than other years. This difference is explained on the PG&E website:

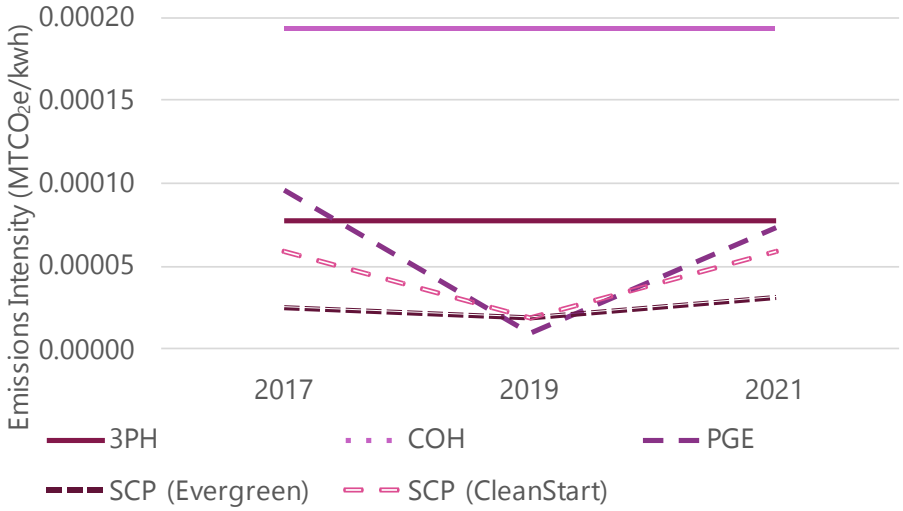
"For 2019 emissions reporting, PG&E used the CEC's Power Source Disclosure program methodology to calculate the CO_2 emission rate associated with the electricity delivered to retail customers. As required by AB 1110, the CEC modified the Power Source Disclosure program methodology in 2020 for the 2019 reporting year. This methodology differed from prior reporting years and results in a significantly lower emissions rate."[14]

Emission factors for PG&E and Sonoma Clean Power's Evergreen program decreased in 2019, but both rose in again 2021, as shown in Figure 14.

[13] Power Sources | sonomacleanpower.org
[14] Climate Change | pgecorp.com

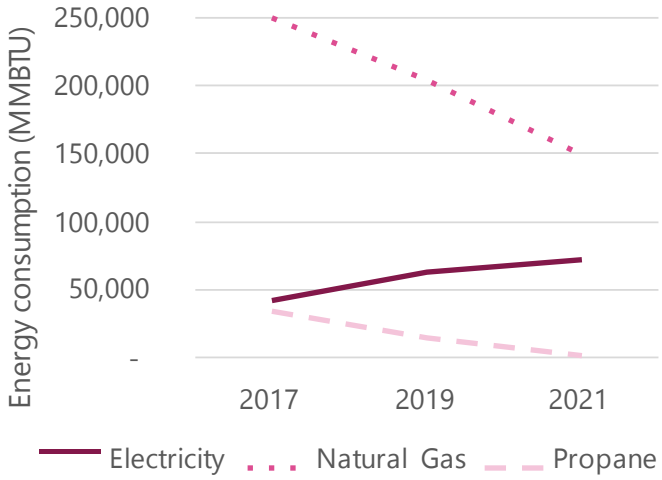
Figure 14. Utility-specific emission factors for each electric utility and program used by the County.

3PH = 3 Phases Renewables; COH = City of Healdsburg; PGE = Pacific Gas & Electric; SCP = Sonoma Clean Power



Electricity consumption increased each inventory year, with a total increase of 74% from 2017 to 2021. This increase could be due, in part, to the **decommissioning of the County's fuel cell** (see *Energy Generation: Sonoma County Fuel Cell* below), which previously supplied some County facilities with electricity. Figure 15 shows trends in total electricity, natural gas, and propane usage over time.

Figure 15. Electricity, natural gas and propane consumption across inventory years (MMBTU).



Electricity consumption is expected to continue increasing as the County **electrifies** more buildings and vehicles (i.e., switching to electric vehicles and completing building retrofits to move away from natural gas use). Although electricity consumption and emissions will likely continue to increase over time, these emissions will be much lower than the

avoided emissions from stationary and mobile combustion.

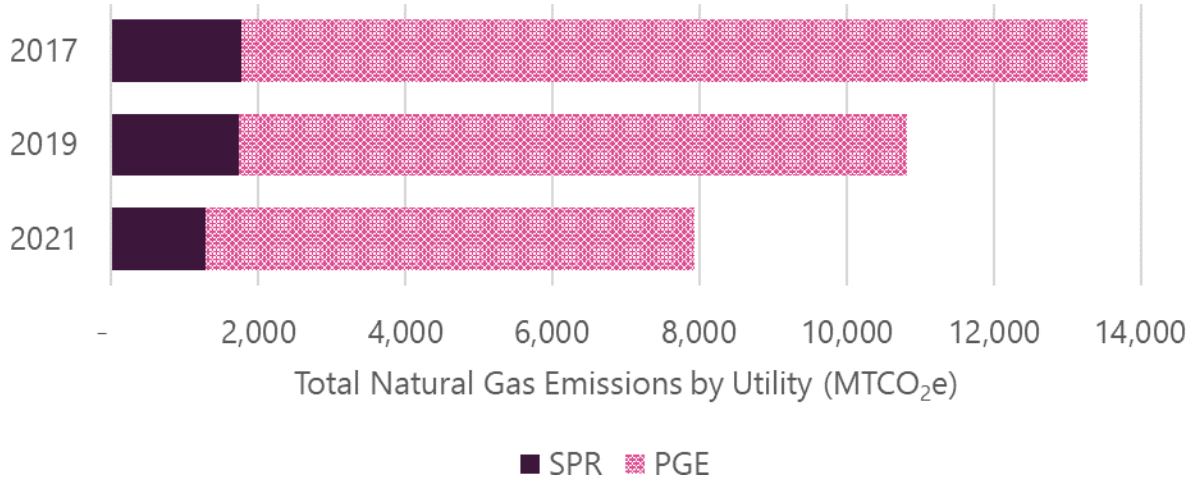
Natural Gas

Scope 1

The County of Sonoma purchases natural gas from Pacific Gas & Electric and SPURR. Natural gas usage accounted for **26%, 24% and 25% of total County emissions in 2017, 2019 and 2021, respectively**. Stationary combustion of natural gas produced 13,278 $MTCO_2e$ in 2017, 10,821 $MTCO_2e$ in 2019 and 7,925 $MTCO_2e$ in 2021, as shown in Figure 16 below.

Figure 16. Natural gas emissions by utility ($MTCO_2e$).

SPR = SPURR; PGE = Pacific Gas & Electric

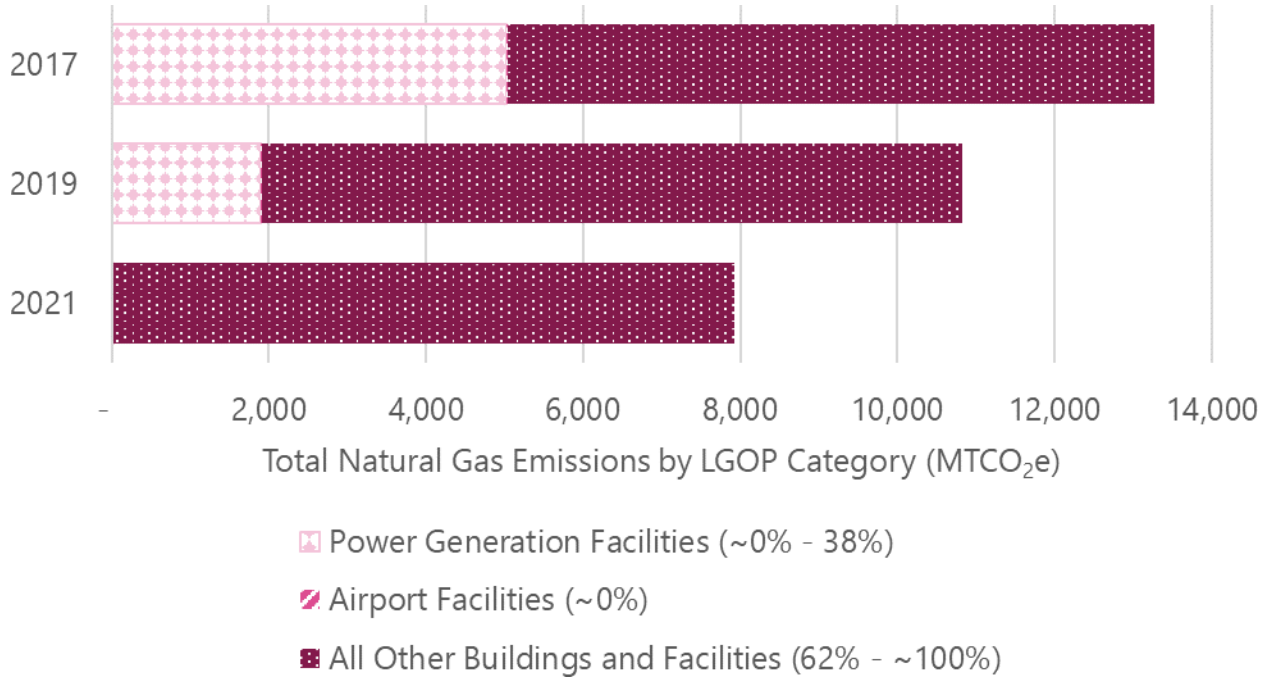


The following five **County facilities** produced the most natural gas emissions across all inventory years:

- 2680 Ventura Ave., Santa Rosa (Facilities Operation building).
- Todd Road & Standish Ave., Santa Rosa (specific location/facility unidentifiable).
- 7440 Rancho Los Guilicos Road, Santa Rosa (Sonoma County Juvenile Probation Department).
- 2455 Airport Blvd., Santa Rosa (Sonoma County Airport).
- 600 Administration Drive, Santa Rosa (Superior Court of CA, Public Defender, District Attorney, Adult Probation).

In accordance with the LGOP, stationary combustion was grouped into the categories shown in Figure 17. However, due to data limitations, some of the "All other buildings and facilities" category likely includes stationary combustion from other categories.

Figure 17. Natural gas emissions by LGOP category ($MTCO_2e$).



Energy Generation: Sonoma County Fuel Cell

Stationary combustion that results in power generation is a Scope 1 emission source that includes natural gas emissions from a County-owned and -operated natural gas fuel cell (**officially decommissioned December 31, 2020**). The Sonoma County Fuel Cell, located at the County Government Complex in Santa Rosa, was a **power generation plant that converted natural gas into electricity**, which was then delivered through the County's 12 kVa electricity loop, supplying electricity to much of the County Government Complex.

- Natural gas consumption to generate power at the fuel cell produced 5,024 $MTCO_2e$ in 2017, 1,891 $MTCO_2e$ in 2019 and 7 $MTCO_2e$ in 2021.
- The fuel cell accounted for 38% of County natural gas emissions in 2017, 17% in 2019 and approximately 0% in 2021, as seen in Figure 17 above (Power Generation Facilities).

History of the Sonoma County Fuel Cell.[14, 15, 16]

The Sonoma County Fuel Cell was installed in 2010 as part of the County's Comprehensive Energy Project, one element of the County's 2006 Climate Protection Action Plan (CPAP)—a plan that included a goal of reducing emissions from County operations to **20% below 2000 levels by 2010**. Fuel cell systems can produce electricity at a higher efficiency (up to 60%) than a typical combustion-based power plant, which usually generates electricity at an efficiency of 33–35%, therefore increasing the amount of electricity produced per unit of fuel consumed. The fuel cell produced electricity at approximately one fifth of the cost of purchasing electricity from the power grid—reducing utility bills and GHG emissions as well as providing heat to the County's campus through a waste heat recovery system. This fuel cell system enabled the County to reach the CPAP's building-related emissions reduction goals.

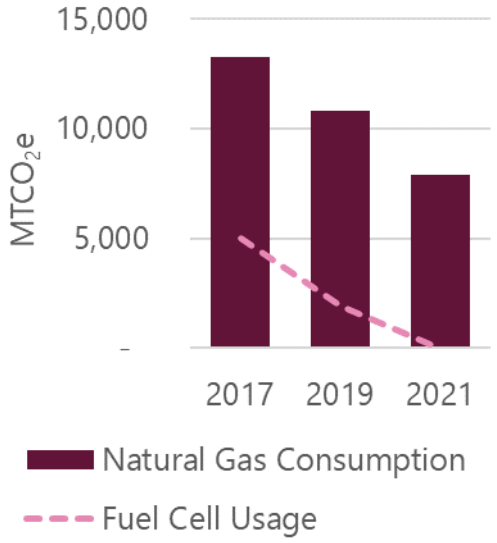
However, the fuel cell did not operate according to plan, malfunctioning 222 times over its initial five-year contract, compared to the predicted 25–30 malfunctions expected from this kind of fuel cell. The County Board of Supervisors approved a plan to renew the fuel cell service agreement in 2015, with the aim of monitoring the fuel cell's performance to maximize benefit while preparing to decommission the fuel cell within this contract period. Due to the fuel cell's mechanical malfunctions, which resulted in additional electricity demand and utility fees and lower-than-expected electricity generation, the fuel cell was ultimately decommissioned at the end of 2020.

[15] 2016 Fuel Cell Service Agreement | sonoma-county.granicus.com
[16] Meeting the Challenge: Sonoma County's Comprehensive Energy Project | counties.org
[17] Fuel Cells Fact Sheet (energy.gov)

Trend Analysis

The County's total **natural gas consumption decreased 40% from 2017 to 2021**, as shown in Figure 18. One main driver of this reduction was the **decommissioning of the County's fuel cell** at the end of 2020. At the fuel cell, natural gas consumption decreased 62% from 2017 to 2019 and 99.6% from 2019 to 2021. The fuel cell was non-operational for part of 2019 due to a mechanical failure, decommissioned at the end of 2020 and shut down completely in early 2021.

Figure 18. Natural gas emissions across inventory years from all sources and the County's fuel cell.



Other Fuels

Scope 1

Other fuels—such as propane, fuel oil and liquified petroleum gas—also release emissions through the process of stationary combustion and are a Scope 1 emission source. County Regional Parks and other County departments use propane to run hot water heaters and heaters in remote facilities that fall outside of gas service areas. Emissions from propane were responsible for 2,067 $MTCO_2e$ in 2017, 883 $MTCO_2e$ in 2019 and 64 $MTCO_2e$ in 2021. This accounted for **4%, 2% and 0.2% of total County emissions in 2017, 2019 and 2021, respectively**.

Trend Analysis

Propane use and emissions decreased 57% between 2017 and 2019 and 93% between 2019 and 2021, resulting in a **total decrease of 97% in the 2017–2021** period.

Transportation

Mobile combustion from County vehicles used for transportation is a Scope 1 emission source and was responsible for **20%, 22% and 26% of total County emissions in 2017, 2019 and 2021, respectively**.

Electricity consumption by electric vehicles is a Scope 2 emission source. While the County does own electric vehicles, emissions from electricity consumption by these vehicles are included in the *Electricity* section above, due to insufficient data granularity to be able to quantify electricity use by these vehicles. Therefore, a small proportion of energy emissions could be attributed to transportation (see estimates below).

The County has a relatively high degree of control over its transportation emissions, so this should be a high priority focus area for the County to address through its climate action planning process.

Fleet Vehicles and Equipment

Scopes 1 2

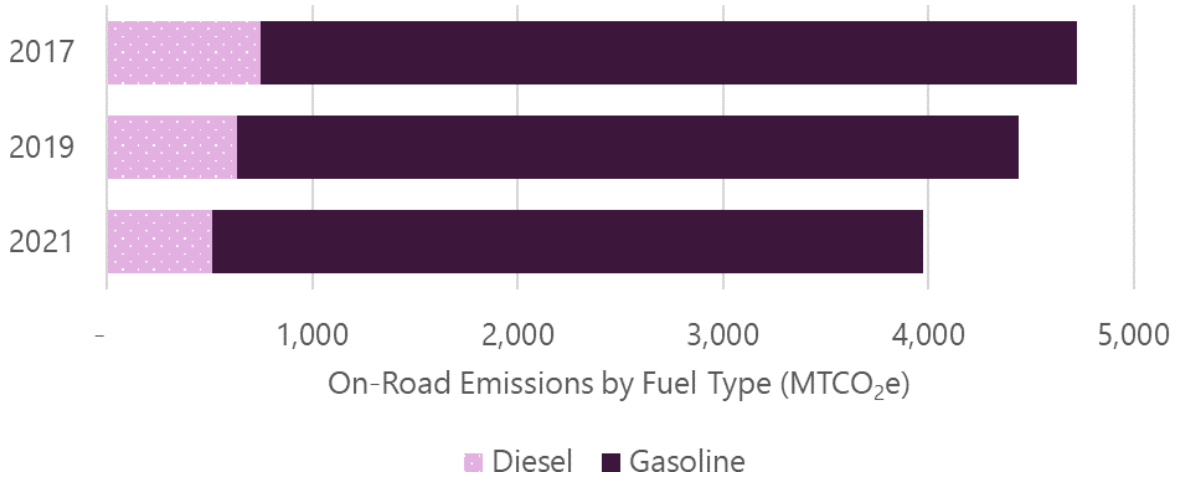
Fleet emissions consist of both on- and off-road vehicles and equipment that run on gas, diesel or electricity. County vehicles and equipment are shared or operated across all County departments, but management of the fleet is carried out by the Sonoma County Public Infrastructure Department, previously known as the General Services Department.

On-Road Vehicles

Emissions from on-road vehicles include emissions from **heavy-duty vehicles, light-duty trucks and passenger cars**. On-road vehicles were responsible for **9% of total County emissions in 2017, 10% in 2019 and 13% in 2021**. On-road vehicles emitted 4,724 $MTCO_2e$ in 2017, 4,443 $MTCO_2e$ in 2019 and 3,974 $MTCO_2e$ in 2021.

- **Gasoline** vehicles accounted for 84% of total on-road emissions in 2017, 86% in 2019 and 87% in 2021, shown below in Figure 19.
- **Diesel** vehicle emissions accounted for 16% of on-road vehicle emissions in 2017, 14% in 2019 and 13% in 2021, shown below in Figure 19.
- Total energy usage for **electric fleet vehicles** was estimated to be 268 kWh in 2017, 5,166 kWh in 2019 and 7,544 kWh in 2021. Emissions from these vehicles were included in energy totals and omitted from transportation totals to prevent double counting but are estimated to emit less than 1 $MTCO_2e$ total.

Figure 19. Emissions from on-road fleet vehicles by fuel type ($MTCO_2e$).



Off-Road Vehicles and Equipment

Aviation

Worldwide, aviation is responsible for 12% of all transportation emissions and 2.1% of total global emissions.[18] Although it is essential to reduce aviation emissions globally and locally, the scope of these inventories focuses on sources within the County of Sonoma's operational control. Per the Local Government Operations Protocol, jurisdictions should not include emissions from tenant-owned equipment (such as planes) because they do not have operational control over this emission source. County of Sonoma owns Sonoma County Airport (STS) and the **emissions associated with operating the facilities at the airport are included in these inventories**, but emissions from planes, which are not County-owned, are excluded. The associated emissions from air travel are considered Scope 1 emissions for aviation companies and should thus be accounted for by those entities.

The County owns one helicopter, which was included in the *Off-Road Vehicles and Equipment* category below.

Off-Road Vehicles and Equipment

Off-road equipment accounted for a much smaller proportion of emissions when compared to on-road vehicles. Emissions from off-road vehicle use were estimated to be 659 $MTCO_2e$ in 2017, 701 $MTCO_2e$ in 2019 and 522 $MTCO_2e$ in 2021, which accounted for **1–2% of total County emissions across inventory years**. This category includes fuel consumption emissions from the County's helicopter and other off-road vehicles and equipment, such as all-terrain vehicles (ATVs), flat bottom boats and mowers.

Trend Analysis

Emissions from fleet vehicles and equipment **decreased between 2017 and 2021**, with a steeper reduction occurring in 2019–2021 compared to 2017–2019.

- **On-road** vehicle emissions decreased 6% between 2017 and 2019 and 11% between 2019 and 2021.
- **Off-road** vehicle emissions increased 6% between 2017 and 2019 and decreased 26% between 2019 and 2021.

[18] Facts & Figures | atag.org

As discussed in the electricity *Trend Analysis* section above, as the County electrifies its fleet and transit vehicles, emissions from mobile combustion will likely continue to decrease, while emissions from electricity consumption will increase.

Transit Vehicles and Equipment

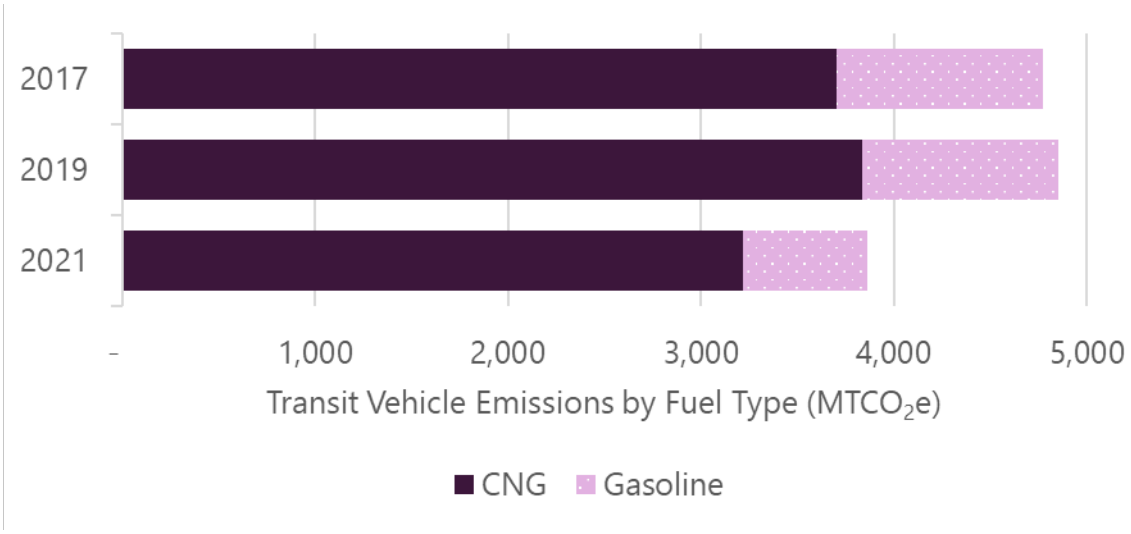
Scopes 1 2

Sonoma County Transit was responsible for 4,774, 4,850 and 3,862 $MTCO_2e$ in 2017, 2019 and 2021, respectively. This accounted for **9% of total County emissions in 2017, 11% in 2019 and 12% in 2021**. Total emissions from transit vehicles, broken out by fuel type, are shown in Figure 20.

Transit fleet vehicles are made up of fixed-route transit buses, paratransit cutaway buses and vans. **Compressed natural gas was responsible for 78% of total transit emissions in 2017, 79% in 2019 and 83% in 2021**. All paratransit buses and a few fixed-route buses ran on gasoline, which accounted for 22% of transit emissions in 2017, 21% in 2019 and 17% in 2021, shown below in Figure 20.

Figure 20. Emissions from transit vehicles by fuel type ($MTCO_2e$).

CNG = Compressed Natural Gas



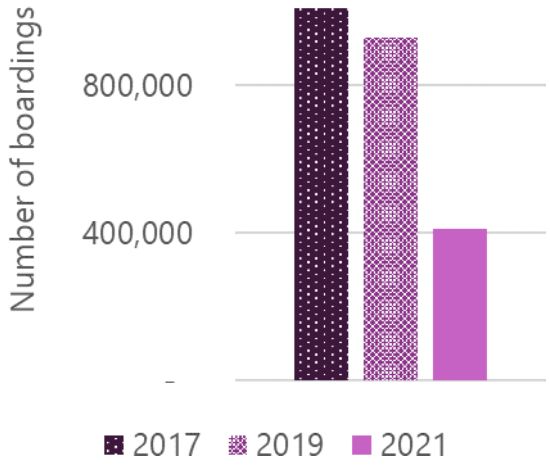
While most transit emissions came from the combustion of compressed natural gas and gasoline, there were a few electric buses in the fleet, which fall under Scope 2 emissions. In 2019, an electric fixed-route bus was introduced to the fleet, and two more were in operation in 2021. Total energy usage for electric buses was 7,985 kWh in 2019 and 59,805 kWh in 2021. Emissions from these vehicles were included in the energy totals to prevent double counting but are estimated to emit between 1 and 2 $MTCO_2e$ total.

Trend Analysis

Emissions from transit vehicles and equipment decreased between 2017 and 2021, with a steeper reduction occurring in 2019–2021 compared to 2017–2019.

- Transit vehicle emissions **increased 2% between 2017 and 2019** and **decreased 20% between 2019 and 2021**.
- In 2021, the **number of passenger boardings** for all of Sonoma County saw a **59% decrease** when compared to 2017 levels, as shown in Figure 21. The decrease in ridership was primarily due to the COVID-19 pandemic, as many commuters avoided public transportation or now had the ability to telework.

Figure 21. Number of Sonoma Transit passenger boardings.



- The County of Sonoma recognizes that increasing public transportation services and ridership is key to achieving communitywide GHG emissions reduction goals. This will likely mean that emissions associated with this emissions inventory source will increase, potentially even as the fleet becomes more electrified.

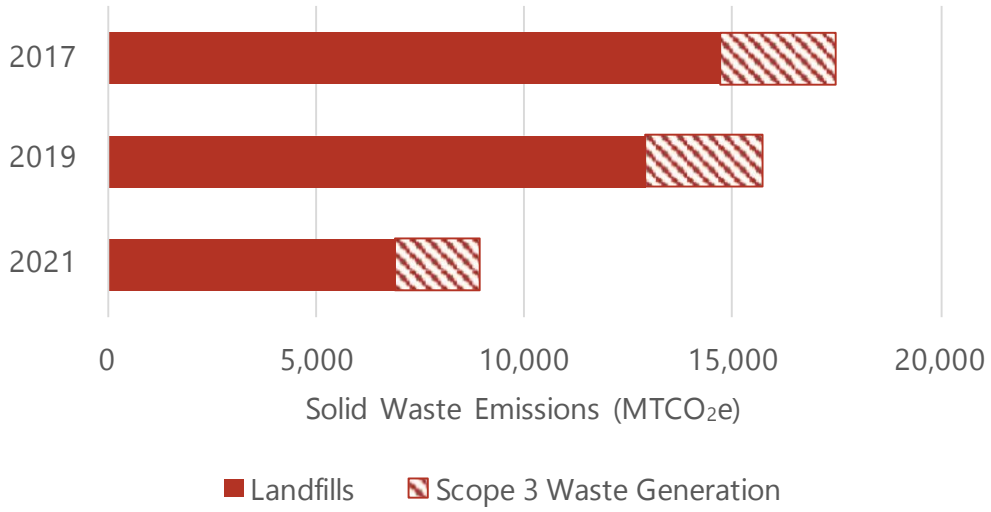
Solid Waste

Solid waste emissions include those from the landfilling and composting of solid waste. Emissions occur from the transport of waste in addition to methane released as waste decomposes in landfills. Landfills are typically an anaerobic (lack of oxygen) environment, which results in methane being released when organic waste is broken down. It is possible for landfills to capture methane via a landfill gas collection system, though some methane leakage will still occur. Additionally, landfills continue to release emissions into the atmosphere following closure. Composting also releases GHGs as organic material decomposes.

For these inventories, the **solid waste sector includes Scope 1 emissions** from five out of seven **closed landfills that are owned and operated by the County** and **served residents and businesses countywide**. Data were not available for two of the closed landfills; more details can be found in the *County Landfill Emissions* and *Appendix A: Inventory Methodology* sections below. The inventories also include **Scope 3 emissions from the solid waste generated at County facilities** (i.e., what gets thrown away or composted at County buildings).

Solid waste activities accounted for **35%, 35% and 28% of total County emissions in 2017, 2019 and 2021, respectively**. Most of these emissions came from closed landfills, as shown in Figure 22.

Figure 22. Emissions from solid waste by source ($MTCO_2e$).



County Landfill Emissions

Scope 1

The County has historically owned and operated seven landfills (Airport, Annapolis, Guerneville, Healdsburg, Occidental, Roblar and Sonoma), all of which have closed. Despite being closed, the landfills still generate emissions from the historical waste decomposing at those sites (referred to as "waste-in-place"). Currently, solid waste in Sonoma County is sent to the Central Landfill on Mecham Road. While this landfill is owned by the County, it is currently operated by Republic Services and not within the scope of these inventories (see the call-out box below for more details). As such, the only landfill emissions included in these inventories are from **closed landfills**.

Context about Central Landfill on Mecham Road.

Why is the Central Landfill on Mecham Rd. excluded from this analysis?

The Central Landfill on Mecham Rd. is owned by the County of Sonoma but operated by Republic Services, a solid waste collection company. Because the site is not being actively operated by the County, it was determined to be out of scope because contracted services are not required under the Local Government Operations Protocol and the scope of these inventories is based on operational control, as described earlier in the *Inventory Scope* section.

The Central Disposal Site's emissions are publicly available online through the U.S. Environmental Protection Agency. For informational purposes, the facility produced 68,774 $MTCO_2e$ in 2017, 59,165 $MTCO_2e$ in 2019 and 53,547 $MTCO_2e$ in 2021, showing a decline in emissions over time.

Emissions from closed County-owned landfills are a Scope 1 emission source. As the manager of these landfills, the County has a relatively high degree of control over this emission source. However, because the landfills are closed and the amount of gas emitted from the landfills has declined significantly over time, it has become **infeasible to reduce these emissions** by increasing gas collection. Therefore, this should not be a high priority focus area for the County to address through its climate action planning process.

Emissions from **closed County landfills accounted for 77–84% of total solid waste emissions** across inventory years. These **landfill emissions made up 22–29% of total County emissions** across inventory years.

- Of the seven landfills, **Healdsburg** is the only landfill that still collects landfill gas through gas flaring and has a partial collection system.[19] The Healdsburg landfill is responsible for 11,243, 9,718 and 3,929 $MTCO_2e$ for the inventory years 2017, 2019 and 2021. Emissions from the landfill have been decreasing steadily because landfill gas decreases in closed landfills over time. Landfill gas rates in 2017 and 2021 were reported directly from the County Waste Operations Division based on the department's internal readings of landfill gas collected at the Healdsburg landfill. Over this period, the amount of gas collected decreased 71%. Gas rates were not available for 2019, so these emissions were estimated based on a linear change

[19] Currently, the landfill is collecting the maximum amount of gas possible.

between 2017 and 2021. More details can be found in *Appendix A: Inventory Methodology*.

- The Healdsburg landfill is also responsible for a small number of biogenic emissions (see the *Biogenic Emissions* section below).
- Waste-in-place data were not available from the County Waste Operations Division for the Airport and Sonoma landfills, which closed in 1971 and 1985, respectively. The age and composition of these landfills does not make it possible to accurately estimate the waste-in-place tonnage; therefore, these landfills were excluded from the emissions analysis.
- Annapolis, Guernville, Occidental and Roblar collectively generated 3,445, 3,193 and 2,959 $MTCO_2e$ for the inventory years 2017, 2019 and 2021, respectively. Of these four landfills, Roblar generated the most emissions (4,678 $MTCO_2e$ across all three years) and Occidental generated the least emissions (1,024 $MTCO_2e$ across all three years).

Additional context about closed landfill emissions.

Why do closed landfills generate emissions?

Once a landfill has been closed for approximately 30 years, it typically is no longer viable to collect landfill gas, so the remaining gas is released into the atmosphere as GHG emissions. The Healdsburg landfill has been closed for 28 years and has a large amount of waste-in-place relative to the other landfills (65% of the total tons of waste decomposing across the five closed landfills are at the Healdsburg landfill). To date, the landfill has produced enough gas to flare and collect. However, according to the County Waste Operations Division, the landfill will stop flaring in the coming months due to declining gas production.

What can the County do about these emissions?

This decline in gas collection is normal for closed facilities. The only way that the County could increase the gas collected at landfills is to re-open closed facilities and add more organic material to produce more gas to be collected.

Trend Analysis

Landfill emissions have **decreased 53%** since 2017 with the greatest reduction coming from the Healdsburg landfill, where emissions decreased 65%.

As discussed above, it is typical for gas production to decline over time in closed landfills. As such, it is expected that most closed County landfills will continue producing fewer emissions in the years ahead. As an exception to this, the Healdsburg landfill is expected to stop collecting landfill gas in 2023 and transition to a Granular Activated Carbon system because of its age (it becomes infeasible to continue collecting landfill gas over time as landfills age). When it stops collecting landfill gas, emissions from this landfill are expected to increase temporarily as gas escapes. These emissions are then expected to decline, following a landfill's typical decline in gas production over time.

Scope 3 Solid Waste Generation

The County also produced solid waste emissions from the **landfilled solid waste** (i.e., trash sent to landfills) and **compost** generated by County facilities. All waste was collected by Recology; landfilled waste was disposed at the Central Disposal Site and compost was transferred by Zero Waste Sonoma from County transfer stations to one of the three composting facilities (WM Redwood, Napa Recycling and Cold Creek Compost).

Landfilled waste and compost included in this analysis included both waste generated as part of the County's typical operations (weekly waste pick-ups) as well as waste generated as part of on-call (not typical) contracts, including waste generated as part of County emergency response efforts.

Although some inventories include Scope 3 emissions associated with recycling or composting, these emissions are considered optional to report by LGOP. Unlike landfills and composting facilities where materials are buried or contained, recycled materials are often re-processed into materials that prevent extraction of raw materials. Because this inventory is not intended to incorporate lifecycle emissions, emissions from recycled materials have not been included in these inventories.

Emissions from waste generation are a Scope 3 emission source; however, because these emissions are tied directly to the amount of waste generated by County facilities, the County has a high degree of control over this emission source, so it should be a priority for the County to address through its climate action planning process.

- Scope 3 emissions from solid waste generation accounted for **6% of total County emissions in 2017, 2019 and 2021**.
- The County disposed of 15,999 tons of landfilled solid waste across all three inventory years (5,987, 5,695 and 4,317 tons in 2017,[20] 2019 and 2021, respectively.

[20] 2017 solid waste rates were not available, so emissions were calculated using 2018 data. See *Appendix A: Inventory Methodology* for more details.

This waste generated 2,754, 2,619 and 1,986 $MTCO_2e$ in 2017, 2019 and 2021, respectively.

- The County generated 1,743 tons of compost across all three inventory years (203, 1,300 and 240 tons in 2017, 2019[21] and 2021, respectively. This compost generated 32, 206 and 38 $MTCO_2e$ in 2017, 2019 and 2021, respectively.
  - Although compost generates emissions, it also avoids emissions that would have come from the material decomposing in landfills. However, in alignment with inventory protocol, these emissions reductions are not accounted for in these inventories.

Trend Analysis

Emissions from solid waste generation **decreased 27% between 2017 and 2021**. Emissions remained relatively constant between 2017 and 2019, increasing 1%, but decreased 28% between 2019 and 2021. This decrease was driven primarily by a 28% reduction in the tons of waste sent to landfills. This reduction in landfilled waste was likely tied to an increase in County recycling rates; during the same period, tons of recycling generated by the County increased 83%.

Other Emission Sources

Wastewater

Emissions associated with the treatment of the wastewater generated by the County are estimated to be 29, 29 and 28 $MTCO_2e$ in 2017, 2019 and 2021, respectively, making up **less than 1% of total County emissions** each inventory year.

These emissions were scaled from Sonoma County Regional Climate Protection Authority (RCPA)'s 2018 and 2020 GHG inventories, based on factors of service population, County employee count and working hours. Across each inventory year, the service population included in RCPA's inventories stayed relatively consistent, fluctuating less than 3%. Due to this consistency in service population, emissions per inventory year varied only slightly.

Because the County does not have full operational control over wastewater treatment processes in Sonoma County, these emissions are considered a Scope 3 source. Because of this minimal operational control and the relatively low emissions this source

[21] Compost rates were disproportionately higher in 2019 due to an on-call contract with high compost rates during that year.

generates, this should not be a high priority focus area for the County to address through its climate action planning process.

Water Delivery

Scope 2 Emissions from electricity usage associated with potable water delivery are **included in *Electricity*** (Figure 13). Because the County has minimal operational control over this source and water delivery generates a relatively small quantity of emissions, this should not be a high priority focus area for the County to address through its climate action planning process.

Refrigerants

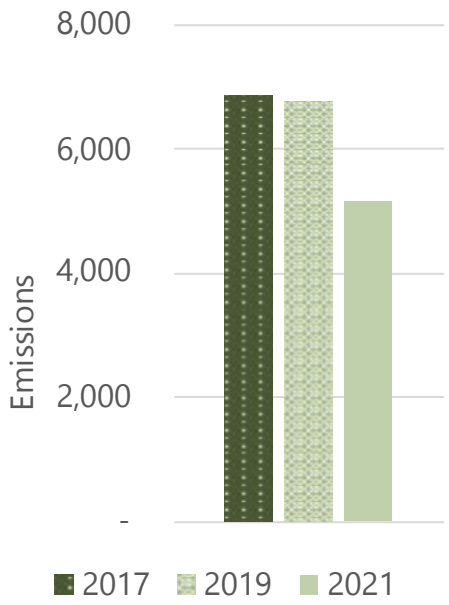
Scope 1 Refrigerant usage **data were unavailable** for the inventory years, so emissions could not be calculated. Refrigerants are a Scope 1 emission source over which the County has a relatively high degree of control, so the County should consider prioritizing this area through its climate action planning process, beginning with implementing a system to track refrigerant consumption in future years. See the *Recommendations* section for more information.

Employee Commute

Scope 3 Emissions from employees commuting to and from work in personal vehicles are categorized as Scope 3. While local governments generally have limited control over these emissions, the County can work to reduce these emissions through carpool programs, telecommute options and flexible schedules.

- **Employee commute** emissions accounted for **14%, 15% and 16% of total County emissions in 2017, 2019 and 2021, respectively.**
- Employee commutes produced 6,845 $MTCO_2e$ in 2017, 6,773 $MTCO_2e$ in 2019 and 5,159 $MTCO_2e$ in 2021, as shown in Figure 23.

Figure 23. Employee commute emissions in 2017, 2019 and 2021 ($MTCO_2e$).



Trend Analysis

In March 2020, the County adopted a temporary telework policy to allow eligible employees to work remotely in response to the COVID-19 pandemic. Some staff continued operations in-person, although a large proportion of the County's workforce shifted to remote work. Remote work remained at its highest rates from

March 2020–May 2021, at which point some departments began requesting in-office worktime. From May 2021–May 2022, in-office worktime slowly increased overall as some staff returned to office as part of a hybrid telework-office schedule. **In May 2022, the Board of Supervisors adopted a formal telework policy**. This policy allows for individual departments and supervisors to set baseline expectations for their staff's hybrid schedules. Since May 2022, telework rates have remained relatively consistent.

Emissions from employee commutes remained relatively constant between 2017 and 2019 and **decreased 24% between 2019 and 2021**, likely due primarily to the **increase in telework** described above.

Employee Business Travel

Employee business travel **data were unavailable** for these inventory years, so emissions could not be calculated. While local governments generally have limited control over these emissions, the County can work to reduce these emissions through encouraging online attendance of conferences and events where possible. See the *Recommendations* section for more information.

Biogenic Emissions

GHG emissions are categorized as either biogenic or anthropogenic emissions and should be reported separately. Emissions of biogenic origin are those that release carbon that was recently contained in living matter, while anthropogenic emissions release carbon from fossil fuels that have been trapped in geologic formations for millennia, like the combustion of fossil fuels.

Activities that produce biogenic CO_2 include the burning of biofuels—fuels that utilize living matter as a source of energy—such as wood or biodiesel, as well as certain wastewater treatment processes, solid waste incineration, emissions from livestock and forestry/land use change.

The LGOP states, "*because of the distinction between biogenic and anthropogenic emissions, local governments should track the biogenic CO_2 emissions from biomass combustion separately from Scope 1 direct emissions.*"[22]

Because naturally decomposing organic matter only produces CO_2, the CO_2 from these emission sources is considered to be biogenic, but the methane (CH_4) and nitrous oxide (N_2O) emissions from the combustion of biomass are still considered to be

[22] Local Government Operation Protocol

anthropogenic emissions, and thus should be reported with the rest of the County's emissions.

The LGOP also specifies that since emissions from forestry and land use change are biogenic, they are outside the scope of the LGOP, which focuses mainly on anthropogenic sources of GHG emissions. These inventories did include a land use analysis (see *Land Use* below) as an information-only analysis.

Biogenic Landfill Emissions

The Healdsburg landfill, the closed County-owned and -operated landfill that still collects landfill gas, generates biogenic CO_2 emissions from its combustion of landfill gas (a biomass-based fuel). These emissions should be tracked separately from the LGOP scopes. The landfill generated 0.0000000428, 0.0000000370 and 0.0000000150 $MTCO_2e$ in 2017, 2019 and 2021, respectively.

Land Use

Emissions from land use are not included in the LGOP guidance but are included in this report for informational purposes. This analysis also estimated the carbon removals from tree planting (afforestation) and sequestration by existing forests.

Forests and vegetation typically act as a **carbon sink**, storing carbon in tree trunks, roots, leaves, branches and soil. However, management of forests and vegetation can also be an **emission source**; when tree cover or vegetation is lost or converted to another land type, stored carbon is released into the atmosphere. Tree cover loss can be driven by development, wood harvests, insects, fire and other disturbances.

Emissions and removals from land use were calculated based on land use changes on County-owned and -operated land that occurred between 2016 and 2019. Emissions from land use are typically calculated based on a range in time because permanent land use change occurs over multiple years. **This analysis is based on the 2016–2019 period**, so emissions and removals are not attributed to specific years.

- Land use changes produced 60,365 $MTCO_2e$ per year.[23]
  - Most emissions (59,419 $MTCO_2e$) were generated from the conversion of 767 hectares of forest to grassland.

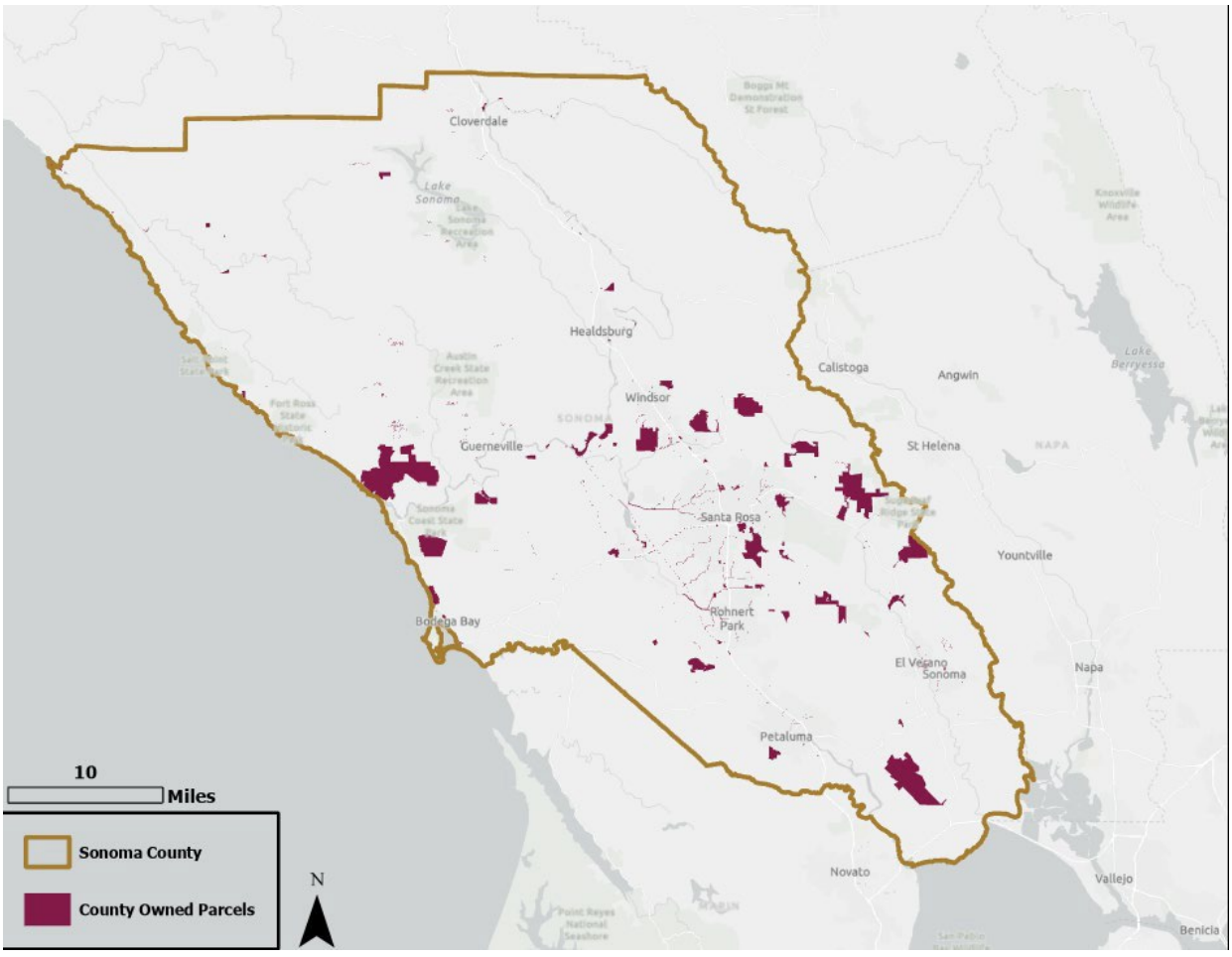
[23] Because emissions represent an average across the year range, emissions and removals were consistent across inventory years.

  - The remaining emissions came from the conversion of forest to settlements/development and forest loss from fire and harvesting.

- County forests and vegetation removed or sequestered 31,070 $MTCO_2e$ per year.[23]
  - Most carbon removals (25,655 $MTCO_2e$) were tied to undisturbed forest land.
  - Carbon was also removed from 18 hectares of re-forestated forest land and an increase of 334 hectares of tree canopy in other non-forested County land.

- While the tool used to calculate land use emissions did not provide details on the exact type of land use change that occurred, it is notable that this time period includes the 2017 Sonoma Complex Fires and 2019 Kincade Fire. The analysis also indicated that the land experienced insect disturbances and harvests. More details about this tool and its data sources and limitations can be found in the *Land Use* section of *Appendix A: Inventory Methodology*.

Figure 24. County-owned parcels included in the land use analysis.



Carbon Offsets and Renewable Energy Certificates

Renewable Energy Certificates are credits purchased by an entity that represent the climate benefits of purchasing renewable energy generation. The purchase of credits and other offsets by local jurisdictions should be noted as supplemental information, if reporting to a third party in accordance with the LGOP, but should not be deducted from the jurisdiction's emissions.

The County of Sonoma did not purchase Renewable Energy Certificates or other carbon offsets in 2017, 2019 or 2021. If the County makes these purchases in the future, it will follow the LGOP's guidance for reporting that information.

Assumptions and Limitations

The table below summarizes notable limitations of the inventory approach, mostly related to data availability and specificity.

Assumptions and Limitations	Rationale
Emission Source & Sub-source – Energy: Electricity	
Year-specific emission factors were not available for City of Healdsburg and 3 Phases Renewables, so the inventory held these emission factors constant across inventory years. Due to data availability limitations, the inventory also used PG&E's 2020 emission factor for 2021.	The inventories use utility-specific emission factors. In the absence of published emission factors for each inventory year, the closest available year was used as a proxy (e.g., 2020 for 3 Phases and 2021 for City of Healdsburg). Electricity is 1–4% of total emissions across years, so the impact of this limitation on the inventories is minimal.
When utility-specific emission factors were reported in CO_2 only, regional CH_4 and N_2O values from the Emissions & Generation Resource Integrated Database (eGRID) were used.	The LGOP advises using default eGRID CH_4 and N_2O values for electricity emission factors.
Some emission factors were reported in CO_2e only.	Because CO_2e refers to carbon dioxide equivalent and is generally used when multiple gas types are accounted for in the value, it was assumed that CH_4 and N_2O were already captured in the CO_2e value.
2017 electricity consumption data were not available; 2018 data were used as a proxy.	2018 is considered an appropriate proxy year given its proximity in time to 2017 and the lack of any known anomalies in either year.
Emission Source & Sub-source – Energy: Stationary Combustion	
2017 natural gas consumption data were not available; 2018 data were used as a proxy.	2018 is considered an appropriate proxy year given its proximity in time to 2017 and the lack of any known anomalies in either year.

Emission Source & Sub-source – Transportation: Fleet and Transit Vehicles	
Electric vehicle electricity consumption is included within the "Energy" sector as electricity data could not be disaggregated at that level of granularity. As a result, electric vehicles were assigned emission factors of 0 to avoid double counting emissions.	The kWh consumed for transportation were included in electricity emissions; therefore, there is no impact on overall emissions.
Fleet management only keeps records of diesel and gasoline, so the on-road fleet inventories only account for consumption of these two fuels.	Less than 1% of vehicles in the Sonoma County fleet were labeled as running on miscellaneous fuels other than diesel and gasoline. Because these comprise a small proportion of the overall fleet, differences in emissions are minimal.
Emission Source & Sub-source – Transportation: Off-Road Vehicles/Equipment	
Fleet management only keeps records of diesel, gasoline, and jet fuel, so the off-road vehicles/equipment inventories only account for consumption of these fuel types.	See note above.
Emission Source & Sub-source – Landfills	
2019 landfill gas recovery data were not available for the Healdsburg landfill; calculated by assuming a linear change between 2017 and 2021.	Because the landfill is closed, it is expected that the landfill gas would decrease at a steady rate, so scaling data linearly provides a reasonable estimate.

Waste-in-place data were not available for the Airport and Sonoma landfills, so these were omitted from the analysis.	Data were not available from the County Waste Operations Division. According to County representatives, the age and composition of these landfills does not make it possible to accurately estimate the waste-in-place tonnage. While the exact emissions from these sites are unknown, both landfills have been closed for more than 30 years, meaning gas production has decreased substantially and will continue to decrease in the years ahead.
Emission Source & Sub-source – Solid Waste: Scope 3 Solid Waste Generation*	
The Ratto Group was the County's waste hauler for most of 2017, and Recology became the County's waste hauler in December of 2017. Waste data for 2017 were unavailable, so 2018 Recology data were used as a proxy.	Waste generation is not affected by waste hauler, so Recology data was an appropriate proxy; it was determined that 2018 was an appropriate proxy year given its proximity in time to 2017 and the lack of any known anomalies in either year.
Recology was not able to provide measured waste tonnage; instead, they provided total cubic yards for each waste container they pick up weekly. Recology provided a conversion factor to convert cubic yards per week into pounds per week.[24]	Exact tonnage rates are often unavailable for solid waste because service charges are based on scheduled pickups (not the weight of waste collected). Therefore, it is common to estimate tons based on typical trash service.
The waste data from Recology could not be disaggregated by material type. The composition of the County's waste stream was estimated using the *Zero Waste Sonoma 2022 County Waste Characterization Study*. [25]	This study was recent and location-specific; therefore, it was assumed to be an accurate enough data source for these inventory years, until a County-specific waste characterization study is available.

[24] The conversion factor was based on a study of Recology's actual waste weights per cubic yard in Q4 of 2020.
[25] Waste Characterization Study 2022 Final Report

Emission Source & Sub-source – Other Sources: Wastewater*	
2017, 2019 and 2021 wastewater data were not available at the County or organizational level. RCPA's regional 2018 wastewater calculations were used as a proxy for 2017 and 2019 and 2020 calculations were used as a proxy for 2021. RCPA emissions were scaled based on a combination of service population, employee count, and work hours/day to estimate emissions attributed to the County.	According to the LGOP, if a jurisdiction does not have operational control over wastewater treatment facilities, the jurisdiction should not report the fugitive emissions from those facilities as Scope 1 emissions. Because the County does not have operational control over Sonoma Water or the other wastewater agencies in the unincorporated area of the county, reporting estimated wastewater emissions from County operations as a Scope 3 source is considered optional and could be excluded from these inventories.
Emission Source & Sub-source – Other Sources: Refrigerants	
Refrigerant data was not available for 2017, 2019 and 2021.	Emissions from refrigerants made up <3% of emissions in the United States in 2017, 2019, and 2021,[26] so it is likely that refrigerants are a minor source of the County's emissions.
Emission Source & Sub-source – Other Sources: Employee Commute*	
Personal vehicle data was not available, so it was assumed that all commuting was done in gasoline passenger vehicles.	Nationally, most on-road vehicles are gasoline passenger vehicles. As such, it was deemed a reasonable assumption for commuting County employees.[27]
Telework percentage data was not available before early 2020, so it was assumed that 100% of employees commuted in 2017 and 2019, while actual telework percentage data was used for 2021 calculations.	Telework percentages were not recorded before 2020, but because 2017 and 2019 were before the COVID-19 pandemic, it can be assumed that very few employees were teleworking; if any employees were teleworking, it would minimally reduce the emissions reported in these inventories.

[26] Inventory of U.S. Greenhouse Gas Emissions and Sinks | US EPA
[27] National Default Vehicle Fuel Efficiency & Emissions Factors

An average commuting distance was used in emissions calculations due to a lack of more specific data.	Because exact fuel/milage-based employee commute data was not available, an average-data method was used. It was assumed that the average commuting distance from a previous survey would allow for accurate total emissions to be estimated.
Emission Source & Sub-source – Other Sources: Business Travel*	
Employee business travel data were not available for 2017, 2019 and 2021.	Business travel metrics have historically not been tracked by the County. Without knowledge of how expansive the County's business travel is, it is unknown how significant the impact of business travel emissions would be on the County's overall GHG emissions. As a scope 3 emission source, including these emissions is optional.
Emission Source & Sub-source – Land Use†	
The ICLEI – Local Governments for Sustainability Land Emissions and Removals Navigator (LEARN) tool uses time periods for land use change.	Data from the most recent time period (2016–2019) were used for this analysis. Land use emissions and removals are reported separately from total emissions in accordance with the LGOP.

* These sub-sources are considered optional to include under the LGOP (Scope 3).

† This source is included as an additional analysis for informational purposes and is not included in the LGOP.

Additional Analyses

In addition to completing GHG inventories for 2017, 2019 and 2021, a **trend analysis** was completed to summarize trends across inventory years and identify the causes of significant variations in emissions. A **wedge model** was also completed to forecast the County's future greenhouse gas emissions through 2030. A **non-GHG emissions analysis** was completed to evaluate air quality impacts of County operations.

Trend Analysis Summary

Some emissions trends were consistent across inventory years 2017, 2019 and 2021, while others were driven by annual fluctuations in activity data, County context or external factors. A trend analysis **summarizes year-over-year trends and identifies common factors across years that contributed to the change in emissions over time**. The *Inventory Results by Emission Source* section above contains trend analyses for different sub-sources of emissions. Key trends include:

- From 2017 to 2021, **emissions decreased 37%**.
- From 2019 to 2021, total emissions decreased 29%, over two times the rate of reduction that occurred between 2017 and 2019 (12%).
- Emissions were impacted by both internal factors, such as changes in operations, and external factors, such as the **COVID-19** pandemic.
- Emissions decreased or remained relatively constant across all sources except **electricity**, where **emissions increased 61%** between 2017 and 2021.
    - This increase was likely due in large part to the **decommissioning of the Sonoma County Fuel Cell** at the end of 2020, which previously supplied some County facilities with electricity.
    - As the County electrifies its buildings and vehicles (i.e., switching to electric vehicles and completing building retrofits to move away from natural gas use), **electricity consumption will likely continue to increase**. However, these emissions will be lower than the avoided emissions from stationary and mobile combustion, so **electrification should reduce the County's total emissions**, especially when renewable electricity is generated on site at County facilities.

County and Community Context

From 2017 to 2021, the County's fiscal budget increased by 28%. The number of full-time equivalent County employees remained relatively constant with a <1% change over the inventory period.[28]

In addition to changes to County employee count and fiscal budget, Sonoma County also experienced meaningful **changes in regional weather patterns** from climate change between 2017 and 2021. In particular, Sonoma County experienced a 5.5% decrease in heating degree days—days in which the average temperature might require heating—and a 34.6% increase in cooling degree days, which are days that might require cooling.[29] These changes likely caused County employees to adjust their use of heating or cooling equipment, which impacted overall energy use and the related emissions.

Changes in emissions were observed worldwide in 2020 from a reduction in high-emitting activities, such as air and ground travel, as a result of the **COVID-19 pandemic**.[30] Emissions from County operations were affected by the pandemic in a variety of ways, most notably in the shift by many County employees from in-person to remote work and the reduced use of transit vehicles such as buses and vans.

Wedge Analysis

A wedge analysis is a tool used to **forecast GHG emissions into future years under a variety of scenarios** using actual emissions data in combination with growth and change projections for a variety of different indicators.

The purpose of this wedge analysis was to **understand where the County should focus its future climate action work**. The wedge forecasted the County's emissions from 2022 through 2030 in a "no action future" and with the impact of multiple federal and state policies and regulations. This wedge also assumed that the County implements multiple actions across sectors to reduce emissions by 2030. Results of this analysis can be found in *Wedge Analysis Results.*

[28] Budget Reports | ca.gov
[29] Cooling Degree Days and Heating Degree Days | cal-adapt.org
[30] Emission Reductions from Pandemic Had Unexpected Effects on Atmosphere | nasa.gov

Business-as-usual Forecast

The emission forecasts use the projected demographic changes shown in Table 2 to approximate growth in activity with associated GHG emissions over time.

Table 2. Projected changes in Sonoma County's demographics.

Growth Factor	2021 Baseline	2030 Projections	% change
Population	485,110[31]	521,303[32]	+ 7%
County Employee Count	3,859[33]	3,936	+ 2%

Adjusted business-as-usual Forecast

The "adjusted business-as-usual" (ABAU) forecast adjusts the "business-as-usual" forecast to account for the impacts of adopted federal and state policies (but assuming that the County does not implement emission reduction actions). Table 3 summarizes the key policies reflected in the ABAU forecast.

Table 3. Key federal and state policies reflected in adjusted business-as-usual forecast.

Policy	Level	Key Assumptions in Forecast
SB 100 (California Renewables Portfolio Standard)	State	• California's renewable portfolio standard establishes that eligible renewable energy resources and zero-carbon resources supply 100% of retail sales of electricity to California end-use customers by 2045.
Corporate Average Fuel Economy (CAFE) standards	Federal	• Corporate Average Fuel Economy (CAFE) standards are regulated by the Department of Transportation and supported by the U.S. Environmental Protection Agency. These standards require average fuel economy levels (miles per gallon/MPG) for manufacturers and related GHG standards.
Low Carbon Fuel Standard	State	• The Low Carbon Fuel Standard requires a 20% reduction of the carbon intensity of transportation

[31] Estimates | Department of Finance (ca.gov)
[32] Projections | Department of Finance | ca.gov
[33] Employee count data was collected from County adopted budget position allocations. 2030 employee counts were forecasted based on the observed increase in County employees from 2017-2021 and does not represent of any future County budgetary projections.

Policy	Level	Key Assumptions in Forecast
		fuels by 2030 through low-carbon and renewable alternatives. CA was required to achieve 10% reduction by 2020.
Innovative Clean Transit (ICT)	State	• The Innovative Clean Transit regulation sets a goal of full transition to zero-emission buses by 2040. This policy sets requirements for the purchases of zero-emission buses. • According to Sonoma County Transit's ICT rollout plan, the transit agency plans to have the following numbers of electric buses in its fleet by each milestone year. ▪ 9 EV buses by 2023. ▪ 19 EV buses by 2024. ▪ 32 EV buses by 2026. ▪ 53 EV buses by 2031. • This ICT rollout plan also plans to remove all compressed natural gas buses from the transit fleet by 2035.
SB1383 (Short-Lived Climate Pollutants)	State	• SB 1383 regulations went into effect on January 1, 2022. The regulations aim to divert 50% of organic waste from landfills below 2014 levels by 2020 and 75% by 2025.

Potential County Actions

The County will need to implement additional strategies to address this gap between expected emissions and its net zero goal. These wedge models include the following County actions that will strategically target the County's largest emission sources.

- **Increase energy efficiency in County facilities:** This mitigation pathway reduces emissions from energy consumption through a reduction in MMBTU/square foot, achieved by implementing energy efficiency actions in County facilities. This wedge models a **25% reduction** in MMBTU/square foot at County facilities by 2030.
- **Transition from natural gas:** This mitigation pathway reduces emissions from energy consumption by transitioning the County's buildings and facilities away from

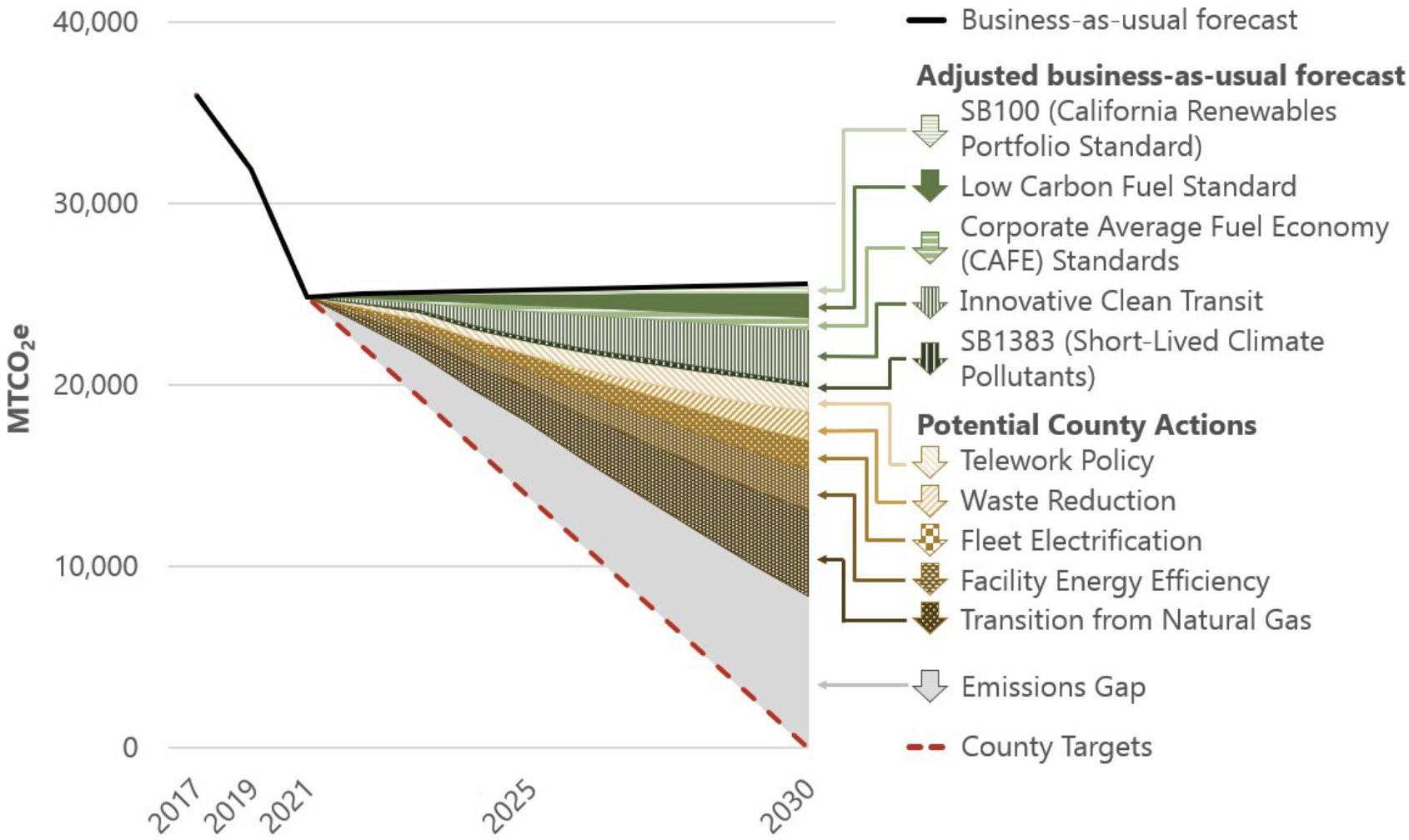
natural gas by replacing it with electricity. This scenario assumes that the County will **fully** transition away from natural gas by 2030.

- **Electrify the County fleet:** This mitigation pathway reduces emissions from fuel consumption by on-road, off-road, and transit vehicles and equipment. This pathway assumes an increasing percentage of total vehicle miles traveled are in electric vehicles. This action will result in a decrease in gasoline and diesel consumption and an increase in the County's electricity consumption. The County's goal is to, "where feasible, phase out County (owned or leased) gasoline powered light-duty cars, vans, and pickups to **achieve a 30% zero-emission vehicle light-duty fleet by 2026.**" This wedge also models an additional "above and beyond" scenario in which the County achieves the following by 2030:
  - **50%** electrification of gasoline passenger and light-duty vehicles,
  - **10%** electrification of gasoline heavy-duty vehicles,
  - **10%** electrification of diesel vehicles,
  - **50%** electrification of gasoline and diesel off-road vehicles and equipment,
  - **10%** electrification of gasoline fixed route and paratransit buses and support vehicles operated by Sonoma County Transit.
- **Zero Waste by 2030:** This mitigation pathway aims to achieve zero waste generated by the County by 2030. In this pathway, "zero waste" is defined as "diverting 90% of all material from landfills by 2030". This model assumes that 100% of compostable and recyclable materials currently being landfilled are diverted to compost and recycle. Four material types are classified as non-recyclable and non-compostable, so this tonnage is not diverted from landfills in this model. This analysis excludes emissions from recycling in alignment with the County's 2017, 2019 and 2021 inventory years. This exclusion was made due to the lifecycle implications of calculating emissions from recycled materials.
- **Telework Policy:** This mitigation pathway reduces emissions from employee commuting by increasing the total percentage of full-time employee equivalents that telework rather than commuting to job sites. This pathway includes three scenarios:
  - Scenario 1) Assumes that telework trends stay constant from 2021 through 2030.
  - Scenario 2) Assumes that the County achieves 40% telework for all staff by 2030.
  - Scenario 3) Assumes that the County achieves 50% telework for all staff by 2030. **The wedge models this scenario.**

Wedge Analysis Results

The analysis demonstrates two different emission baselines: one that includes emissions from closed landfills and one that excludes landfill emissions. Both show the impact of the same federal and state policies and high-level mitigation strategies. Because these landfills are closed and landfill gas collection is no longer possible as an emissions reduction option, landfill emissions reduction strategies are not a high priority focus area for the County. The analysis that excludes landfill emissions can help the County focus on emissions reduction opportunities it has the most control over. Figure 25 below represents the County's forecasted emissions when excluding emissions from closed landfills.

Figure 25. Forecasted County GHG emissions through 2030, excluding landfill emissions.



If no climate action is taken at the federal or state level, the County's emissions are projected to increase **3%** by 2030. When considering the impacts of high-impact federal and state policies and regulations, the County's GHG emissions are expected to decrease **20%** by 2030.

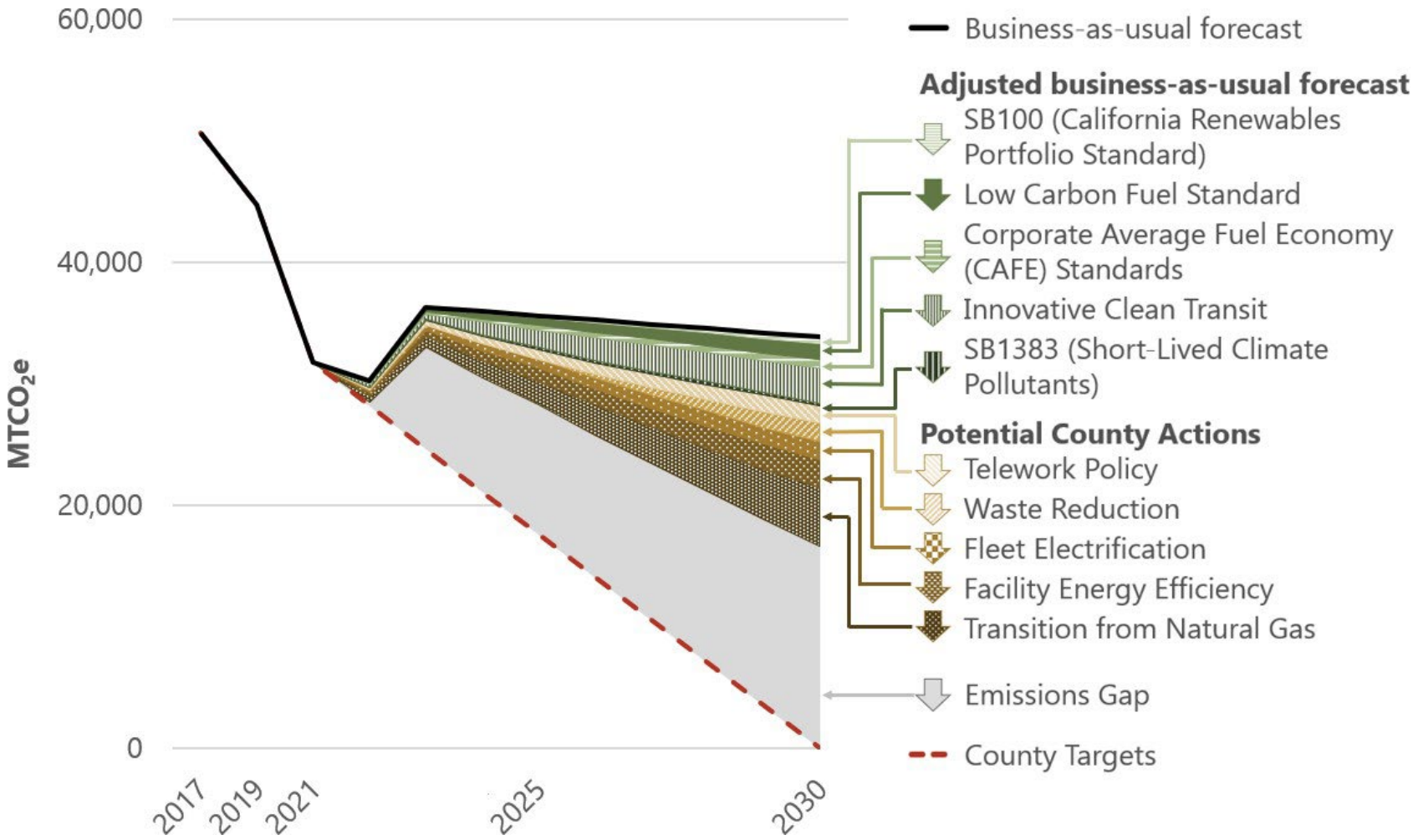
When including the impact of a suite of potential County actions, emissions are expected to decrease **66%** by 2030. Based on the results of this analysis, after implementing these actions, the County's remaining emissions in 2030 will mostly come from employee commute (**35%**), electricity (**25%**), and the County's on-road vehicle fleet (**23%**).

Table 4. Summary of emissions forecast estimates (in $MTCO_2e$), excluding landfills.

Description	2021	2030
Business-as-usual (BAU) emissions – emissions forecast based on the County's 2021 GHG emissions profile, assuming no climate action (programs, policies, standards) at the local, state or federal level.	24,824	25,534
Difference between business-as-usual and adjusted business-as-usual emissions	*N/A*	*5,662*
Adjusted business-as-usual (ABAU) emissions – adjusted business-as-usual forecast to account for the impacts of adopted federal and state policies and regulations (still assuming no climate action at the County operations level).	N/A	19,872
Difference between adjusted business-as-usual and County action emissions.	*N/A*	*11,529*
County action emissions – expanded scenario that accounts for the impacts of strategic pathways for local emissions reduction, in addition to adopted federal and state policies and regulations and existing action emissions reductions.	N/A	8,343

In comparison, Figure 26 represents the County's forecasted emissions when including emissions produced by closed landfills.

Figure 26. Forecasted County GHG emissions through 2030, including landfill emissions.



If no climate action is taken at the federal or state level, the County's emissions are projected to increase **7%** by 2030. When considering the impacts of high-impact federal and state policies, the County's GHG emissions are expected to decrease **11%** by 2030. By implementing the same key high-level emission reduction strategies described above, the County's emissions are expected to decrease **48%** by 2030. Based on the results of this analysis, the County's remaining emissions in 2030 will largely come from landfills (**50%**), employee commute (**18%**) and electricity (**13%**).

Table 5. Summary of emissions forecast estimates (in $MTCO_2e$), including landfills.

Description	2021	2030
Business-as-usual (BAU) emissions – emissions forecast based on the County's 2021 GHG emissions profile, assuming no climate action (programs, policies, standards) at the local, state or federal level.	31,713	33,834
Difference between business-as-usual and adjusted business-as-usual emissions	N/A	*5,662*
Adjusted business-as-usual (ABAU) emissions – adjusted business-as-usual forecast to account for the impacts of adopted federal and state policies and regulations (still assuming no climate action at the County operations level).	N/A	28,172
Difference between adjusted business-as-usual and County action emissions.	N/A	*11,529*
County action emissions – expanded scenario that accounts for the impacts of strategic pathways for local emissions reduction, in addition to adopted federal and state policies and existing action emissions reductions.	N/A	16,643

Non-GHG Emissions

In addition to the GHG inventory, a separate non-GHG analysis was conducted to examine the **air quality impacts of the County's operations** on vulnerable populations. This analysis relied on available spatial datasets described below.

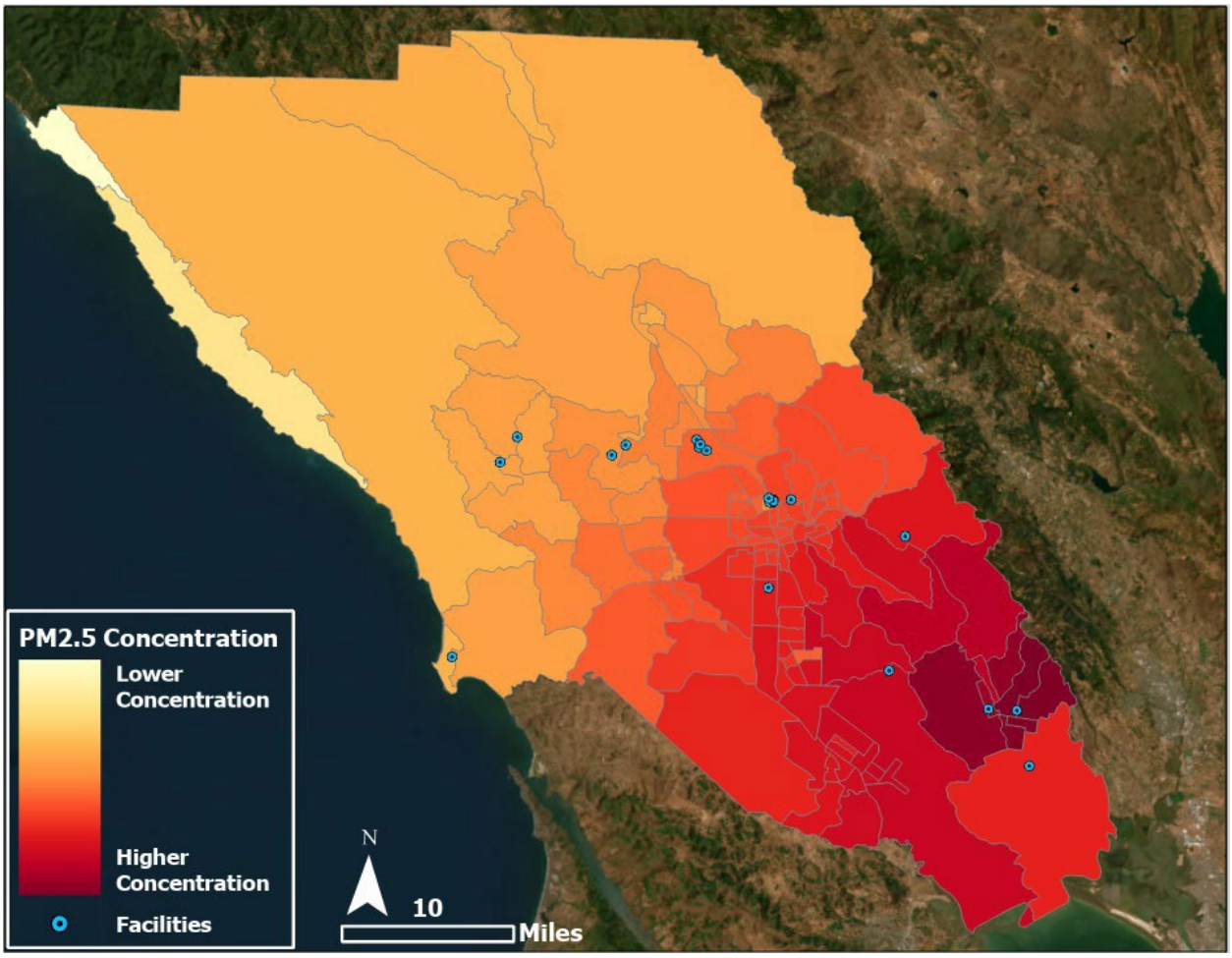
To identify areas of air quality concern, Sonoma County's census tract-level data from the U.S. Environmental Protection Agency's National Air Toxics Assessment (NATA) was mapped using ArcGIS mapping software. Average Particulate Matter 2.5 ($PM_{2.5}$) concentration ($\mu g/M^3$) for each census tract was indexed into percentiles across the County (Figure 27). In addition, County facility locations with fuel tanks, provided by the County and the Bay Area Air Quality Management District, were overlayed on the index, as combustion of these fuels leads to local $PM_{2.5}$ emissions that can impact surrounding communities. County facilities with fuel tanks are labeled on the figures below as "facilities."

Particulate Matter 2.5 consists of fine solid particles and liquid droplets suspended in the air that have diameters less than 2.5 micrometers.[34] This analysis used $PM_{2.5}$ as an indicator of overall air quality because $PM_{2.5}$ contains common air criteria pollutants such as nitrogen oxides (NO_x) and sulfur oxides (SO_x).[35]

$PM_{2.5}$ emissions are prevalent across communities, as they result from combustion of fossil fuels such as gasoline and diesel. Long-term exposure to $PM_{2.5}$ has been linked to **adverse health effects such as heart disease, lung cancer, chronic obstructive pulmonary disease, and lower-respiratory infections**.[36]

[34] Particulate Matter (PM) Basics | US EPA
[35] How NOx and SO2 Harm Health | Citizens' Climate Lobby (citizensclimatelobby.org)
[36] Health Impacts of PM2.5 | State of Global Air

Figure 27. Sonoma County PM2.5 concentration index.

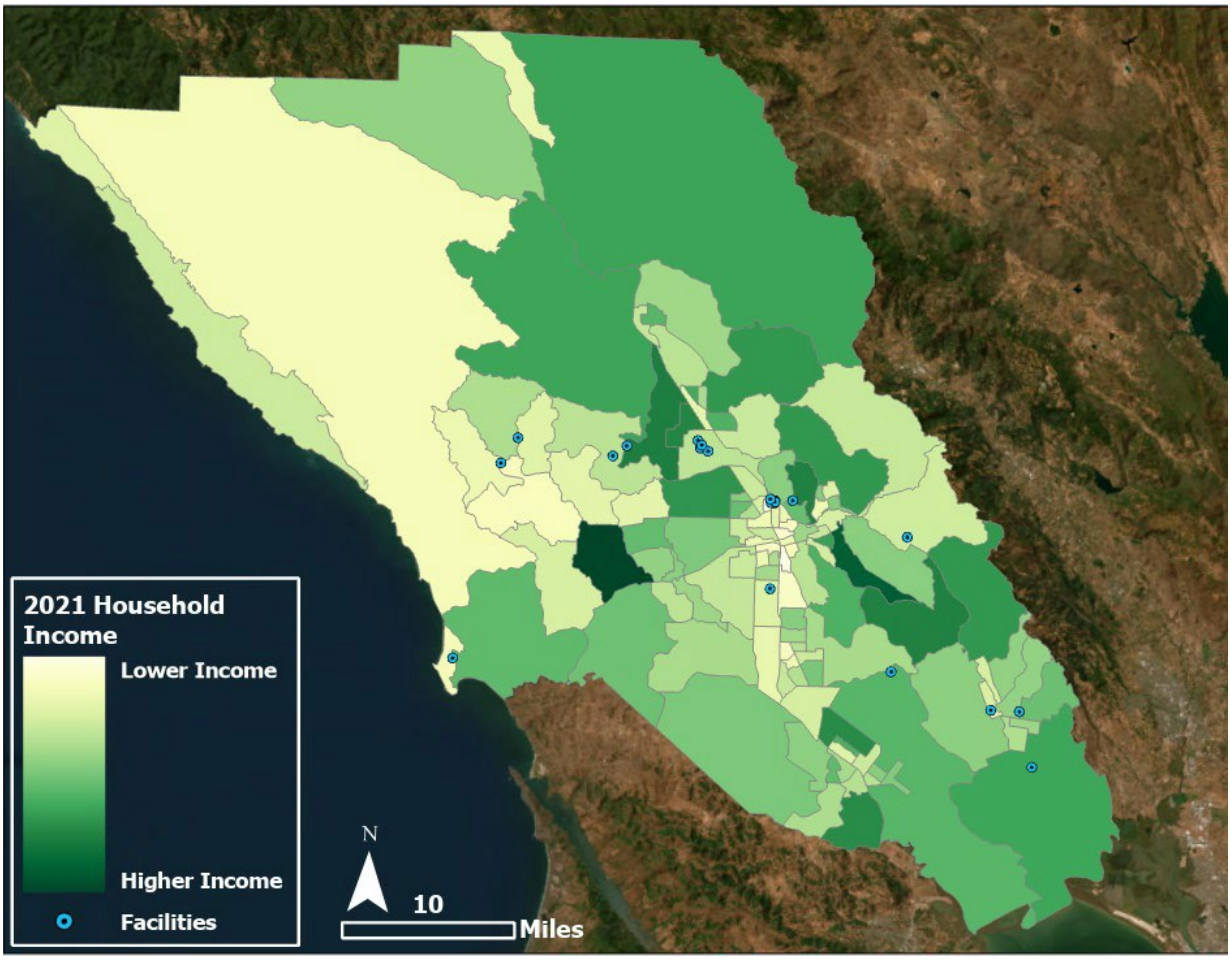


To understand which communities may be particularly vulnerable to these air pollutants, Figure 28 shows median household income data by census tract.[37] Lower-income populations are often disproportionately impacted by poor air quality as there is often a lack of environmental regulations and higher rates of proximity to pollutant sources in poorer communities.[38] Household income data for each census tract in Sonoma County were indexed into percentiles (Figure 28).

[37] Sonoma County | measureofamerica.carto

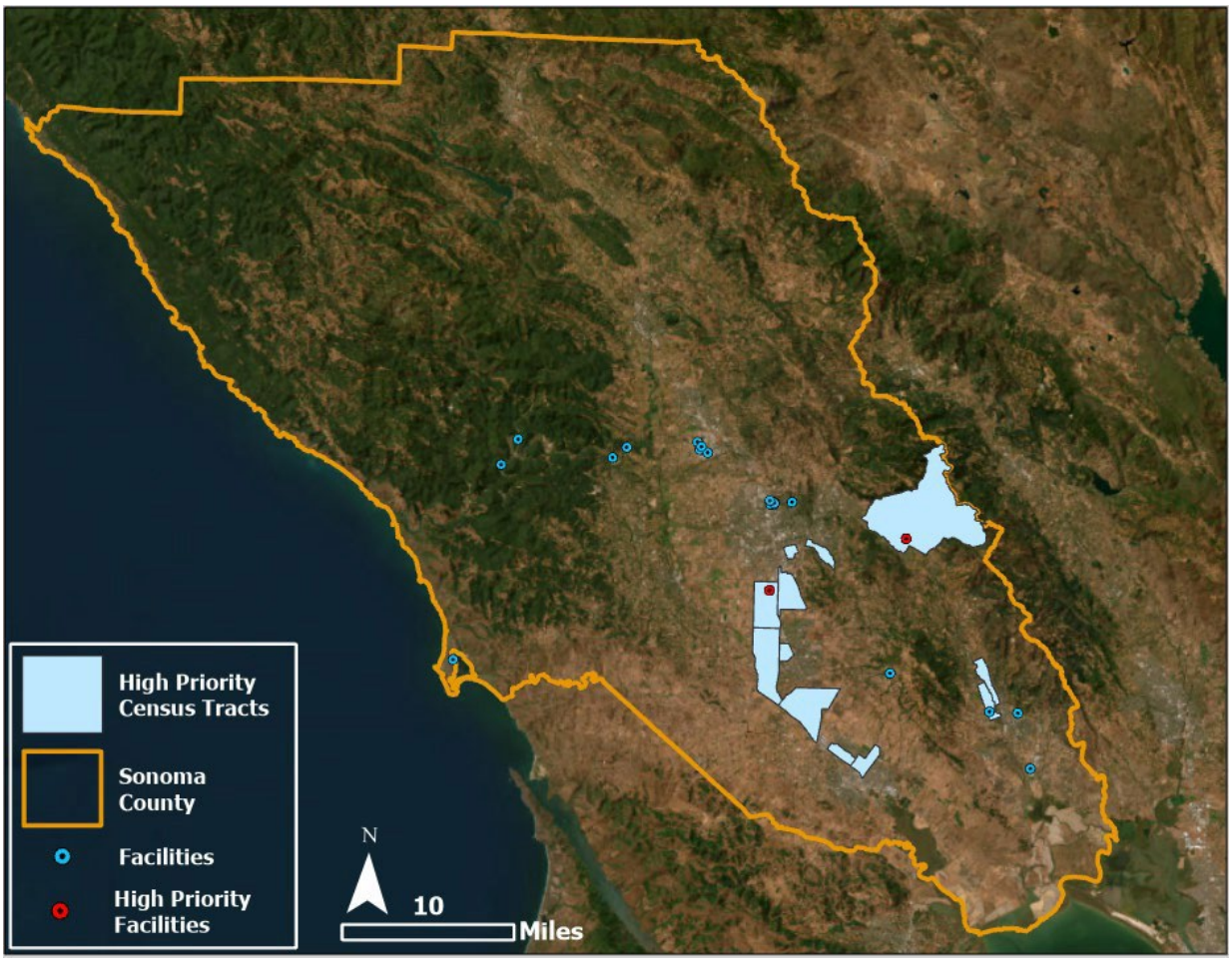
[38] Disproportionate Exposure to Air Pollution for Low-Income Communities in the United States - Ballard Brief | byu.edu

Figure 28. Sonoma County average household income.



Both indexes (air quality and household income) were mapped together to **identify priority census tracts** that are in the **lower 30th percentile in median household income** and the **top 30th percentile in $PM_{2.5}$ concentrations**. These census tracts are likely disproportionately impacted by non-GHG air pollution and could be priority areas for the County to reduce its impact on air quality. Of the 121 census tracts within Sonoma County, 12 were identified as priority areas for the County to reduce activity that results in $PM_{2.5}$ emissions (Figure 29).

Figure 29. Priority census tracts.



Facilities with fuel tanks that are located within high priority census tracts—such as the County's transit yard and juvenile corrections facility (displayed as red in Figure 29)—should be evaluated for strategies to reduce air-polluting activities.

Key Performance Indicators and Metrics

The County will **monitor** inventory activity data and other metrics to **ensure that the County is on track to reach its net zero goals**.

These key performance indicators (KPIs) and metrics have been developed alongside the County's inventories and wedge analysis to ensure that these source-specific indicators are relevant and feasible for the County to monitor. The KPIs include data that the County can track using existing data sources and data that could be gathered and tracked in the future.

Source	Key Performance Indicator
Energy	• Total energy consumption (electricity and natural gas) by government operations (kWh/therms or MMBtu). • Energy consumption (electricity and natural gas) per building square foot. • Percentage of County accounts on Sonoma Clean Power's Evergreen product.
Transportation	• Number of on-road, off-road and transit vehicles in County fleet. • Total mileage, fuel consumption and kWh consumption by vehicles and equipment. • Percentage of fleet that is electric. • Average vehicle mileage of County fleet by fuel type. • Number of annual transit passengers or passenger boardings.
Solid Waste	• Tons of solid waste, recyclable material and compost produced at County facilities. • Percentage of landfill gas captured at each closed County landfill.
Other Sources: Wastewater & Water Delivery	• Indoor water consumption at County facilities.
Other Sources: Refrigerants	• Pounds of refrigerants used (by refrigerant type) at County facilities.

Source	Key Performance Indicator
Other Sources: Employee Commute	• Miles commuted by County employees. • Percentage of full-time employee equivalents teleworking. • Percentage of employee commuting using non-single-occupancy vehicle travel modes.
Other Sources: Business Travel	• Annual miles traveled by vehicle type.

These KPIs are incorporated into the Power BI inventory framework so that the County can easily track and update metrics over time and create dynamic dashboards that can be tailored for internal or external audiences.

Recommendations

Based on the inventory results, analyses, and KPIs, the following recommendations are intended to **guide the County's emissions reduction efforts**. Additionally, to facilitate straightforward, accurate and useful GHG inventory updates in the future, this section includes recommendations related to **conducting future inventories**, including preferred data sources, data collection efficiencies and increased data granularity.

Emissions Reductions

The following table recommends **high-level strategies** that should be prioritized for emissions reductions. Prioritization within this list can be determined based on the percentage contribution of the source and sub-source and other relevant factors (e.g., co-benefits, degree of County control).

The County should also consider emissions reduction strategies beyond the scope of these inventories; for example, the County could consider climate strategies related to sustainable procurement, which would not impact local government operations emissions as calculated in these inventories but would result in "upstream" emissions reductions.

Emission Source & Sub-Source	% of Total Emissions	High-level Strategies	Notes
Energy: Electricity	1–4%	Shift County accounts to Sonoma Clean Power's Evergreen program, as feasible. Implement on-site solar where feasible. Complete energy efficiency upgrades and retrofits.	Medium-priority focus area due to small proportion of past emissions (electricity: 1–4%) but should be a higher priority in future years as electricity consumption becomes a larger percent of emissions; high degree of County control.
Energy: Natural Gas & Other Fuels	25–30%	Electrify County buildings (ideally using on-site solar or Sonoma Clean Power's Evergreen program).	High-priority focus area due to large proportion of emissions and high

Emission Source & Sub-Source	% of Total Emissions	High-level Strategies	Notes
		Complete energy efficiency upgrades and retrofits.	degree of County control. Co-benefits: indoor air quality improvements.
Transportation: On-road	9–13%	Electrify County fleet (on-road, transit and off-road vehicles and equipment).	High-priority focus area due to large proportion of emissions and high degree of County control. Co-benefits: air quality improvements; cost savings on fuel.
Transportation: Off-road	1–2%		
Transportation: Transit	9–12%		
Solid Waste: Landfills	22–29%	Continue to collect landfill gas as feasible at the Healdsburg landfill and from there transition to a granular activated carbon system that reduces the environmental impact from landfill gas by purifying gas before it is discharged.	Medium-priority focus area due to relatively low degree of County control and complex implementation feasibility.
Solid Waste: Scope 3 Solid Waste Generation	6%	Conduct waste audit and characterization study of the County's waste to better understand waste generation. Promote sustainable procurement, consumption and waste reduction in County facilities. Increase diversion of waste from landfills through education and improved waste receptacles.	Low/medium-priority focus area due to small proportion of emissions; relatively high degree of County control.

Emission Source & Sub-Source	% of Total Emissions	High-level Strategies	Notes
Other Sources: Wastewater & Water Delivery	<1%	Implement water conservation efforts at County buildings and facilities.	Low-priority focus area due to minimal emissions; relatively high degree of County control. Co-benefits: enhanced resiliency during droughts.
Other Sources: Refrigerants	N/A	Regularly maintain equipment using refrigerants to prevent leaks. Phase out hydrofluorocarbons in accordance with the U.S. EPA's Phasedown program.[39]	Medium-priority focus area (unknown emissions); high degree of County control.
Other Sources: Employee Commute	14–16%	Maintain flexible work schedules and increase telework where feasible. Encourage or incentivize carpool and non-single-occupancy vehicle modes of commute such as transit, biking or walking.	High-priority focus area due to large proportion of emissions; moderate degree of County control.
Other Sources: Business Travel	N/A	Reduce County business travel (especially air travel) where virtual attendance options exist.	Low-priority focus area; unknown emissions; medium/high degree of County control.
Land Use	N/A (reported separately	Maintain and expand existing forest cover and green spaces on County land.	Medium/high-priority focus area; high emissions; medium/low

[39] Protecting Our Climate by Reducing Use of HFCs | US EPA

Emission Source & Sub-Source	% of Total Emissions	High-level Strategies	Notes
	from total emissions)		degree of County control. Co-benefits: natural habitat, carbon sequestration, public health and wellbeing.

Future Inventories

The County plans to complete additional GHG inventories to track progress toward its goal of achieving net zero emissions from government operations. To improve the **accuracy, comprehensiveness and efficiency of future inventories**, the County can consider the following:

- **Fleet vehicles**: At this time, the County's fleet management only maintains records of gasoline and diesel consumption. To better estimate emissions associated with the County's on- and off-road vehicle fleet, the records should also be maintained for any vehicles that run on other fuels, such as liquified petroleum gas, compressed natural gas or biodiesel.
- **Electric vehicles**: To better understand the emissions impact of electric vehicle electricity consumption, kWh consumption and the associated electric utility should be recorded and incorporated into GHG inventories for all County-owned electric vehicles. For additional granularity, record and incorporate EV charging facilities/locations.
- **Scope 3 solid waste generation:** The 2017, 2019 and 2021 inventories calculated emissions related to solid waste generation based on the Zero Waste Sonoma 2022 County Waste Characterization Study.[25] To better estimate the composition of solid waste generated at County facilities, the County could consider completing a waste characterization study to understand the breakdown of materials disposed of at County facilities, rather than within the full community, to ensure that emissions estimates are tailored to the County.
- **Temporary/emergency waste**: The 2017, 2019 and 2021 inventories include "temporary waste collection," which includes waste from emergency response paid for by the County for fires, floods and the COVID-19 pandemic. In future inventories,

it may be helpful to document the amount and source (facility, department, etc.) of this waste to better understand total waste emissions.

- **Refrigerants**: Data related to refrigerant consumption should be collected at the start and end of each calendar year and monitored throughout the year. For each piece of equipment or vehicle that uses refrigerants, the refrigerant type should be noted as well as that equipment's refrigerant capacity. As the year progresses and equipment is used, refrigerants may be consumed through normal usage, or damage may occur, causing leakage of these coolants. By monitoring equipment that uses these refrigerants, the County can more accurately understand how much of each type of refrigerant is being consumed through its operations.
- **Employee commute:** More accurate data to calculate employee commute emissions can be obtained by conducting more thorough annual employee surveys and continuing to encourage employee responses to these surveys. Survey questions that gather more detail on an employee's commute—such as the type of vehicle they drive and the length of their commute in miles—should be included.
- **Business travel:** While emissions from business travel are not required under the LGOP, including these Scope 3 emissions is recommended. In future inventories, the County should record business trips by mode of travel (rail, aviation, personal vehicle, watercraft, etc.) and total mileage. With this information, the County can estimate the impact from business travel and better understand how to reduce its emissions. More information on how to calculate business travel emissions can be found in chapter 6 of the GHG Protocol Technical Guidance for Calculating Scope 3 Emissions.
- **Granularity in analyses**: If additional granularity in GHG inventory analyses is desired, categorize all activity data by departments and facilities. This would allow for a greater understanding of County emissions (i.e., which departments and facilities produce the most emissions). Using more organized account- or meter-level data could be especially useful for energy emissions, so that the County can better understand where to focus its energy efficiency and electrification efforts.

Appendix A: Inventory Methodology

This appendix provides a detailed description of the methodology used to complete these inventories, including the protocols used, inventory platform, data collection process, regional synergies, data sources, emissions calculation methods and quality control practices.

Inventory Protocol

The **Local Government Operations Protocol (LGOP) was selected as the calculation methodology for these inventories** for the following reasons:

- The LGOP focuses on emission sources that a jurisdiction may have within its operational control.
- The State of California's Air Resource Board played a key role in developing this protocol.40
- The LGOP allows for the County's emissions calculations to align with other jurisdictions to improve comparability between local municipalities.

The **Local Government Operations Protocol** was developed in partnership with the California Air Resources Board (CARB), the California Climate Action Registry (CCAR) and ICLEI – Local Governments for Sustainability and the Climate Registry. This protocol was developed as an emissions measurement tool for the implementation of California's Assembly Bill 32—the Global Warming Solutions Act of 2006—a state law that requires reducing greenhouse gas emissions down to 1990 levels by 2020.[41] This protocol provides the structure needed for **relevant, complete, consistent, transparent and accurate** emissions reporting that can be plausibly **compared across local governments**. In addition, by adhering to the LGOP's accounting and reporting principles and maintaining detailed inventory records, the County can get inventories **verified by an independent third-party in the future**, if desired.

The LGOP provides step-by-step guidance for emissions quantification for each emission source. Due to a universal challenge of a lack of granular data or resources needed for many emissions calculations, this **protocol includes multiple calculation methods for each emission source, based on the data available**. These "recommended" and "alternative" approaches account for varying availability of activity data and emission factors. In many situations, "alternative" approaches may be

[40] Local Government Operations Protocol for Greenhouse Gas Assessments | California Air Resources Board
[41] AB 32 Global Warming Solutions Act of 2006 | California Air Resources Board

considered appropriate for emissions calculation methods but are not acceptable for third party verification, so using "recommended" approaches is preferable where possible. By providing recommended and alternative calculation methods, the LGOP reduces variation between inventories completed by different jurisdictions when the preferred data for an emission source may not be available. This allows for more confidence in **comparing local government operations inventories completed by different jurisdictions**.

The LGOP was selected as the best option for these County operations inventories; however, it is important to note that **this does not invalidate other emission calculation protocols.** Different protocols include different emission sources or take different approaches, such as a geographic or consumption-based approach (see Figure 6 in *Inventory Scope* for an overview of different inventory approaches). **Different inventory methodologies provide different insights into an organization's emissions**; for example, a consumption-based emissions inventory includes upstream and downstream emissions (i.e., emissions that occur before and after a product is consumed). Examples of upstream and downstream emissions include emissions generated from the transportation of an item to a consumer and to a disposal site after the item has been used or when electricity is lost during transmission and distribution of electricity to a consumer (T&D losses).

The LGOP includes minimal guidance related to calculating supply chain upstream and downstream emissions, noting that the data needed to calculate these emissions is often difficult to gather. For example, a consumption-based inventory is likely to have more robust data collection needs, may rely more heavily on modeling based on assumptions and may identify emissions reduction opportunities related to County procurement. The exclusion of emissions associated with consumption through County operations is related to the protocol selected for these inventories and is an accepted omission through the LGOP. The completion of additional complementary analyses, such as a consumption-based emissions inventory or a life-cycle analysis, may be beneficial to fully understand the scope of the County's emissions. The purpose of these inventories was to allow the County to understand its local government operations emissions, identify areas of opportunity to reduce these emissions and track progress toward achieving its carbon neutrality target as it implements climate action initiatives.

According to the LGOP, "*biogenic emissions related to forestry and land management should not be quantified under this Protocol as the Protocol is designed to account primarily for the anthropogenic sources of GHG emissions and is not designed to assess the carbon stocks of government-owned lands*." However, the **County opted to quantify emissions and removals from land use management** to better understand the impact of activities under the County's operational control and inform more

comprehensive climate action planning efforts. These emissions were reported separately from the emission sources calculated using the LGOP.

In the absence of guidance from the LGOP, emissions from land use were calculated using ICLEI's Land Emissions and Removals Navigator (LEARN) tool. The specific land parcels included in the analysis were based on shapefiles—a geospatial data format—of County-owned and -operated lands, excluding land under the jurisdiction of Sonoma County Agricultural Preservation and Open Space District (Ag + Open Space), which includes conservation easements. Ag + Open Space is a separate legal entity from the County.

Additional analyses may be beneficial for the County to understand other opportunities for emissions reduction from sources not quantified in the 2017, 2019 and 2021 GHG operations inventories.

Data Collection

Data collected for these inventories can be categorized as:

- **Activity data**: Data that is used to quantify the amount of GHG emissions produced based on levels of activity. Examples of activity data include miles driven by fleet vehicles, average employee commute length in a single occupancy vehicle or kilowatt hours of electricity consumed.
- **Emission factors**: Specific factors that are used to determine an amount of a GHG emitted per unit of activity data. Examples of emission factors include $MTCO_2e$ produced per kWh of electricity used or $MTCO_2e$ per gallon of gasoline.
- **Indicators**: Relevant pieces of information about the County's operations, used to provide additional context, estimate emissions and develop KPIs. Examples of indicators include number of County employees, County population and the total area within the County's jurisdictional boundaries.

The data used to calculate emissions for each inventory year was collected through an iterative process that included input from County employees, consultant expertise and a review of regional GHG efforts. Data collection was tracked via a cross-cutting data collection checklist workbook that includes the following:

- A "checklist" tab, summarizing all data needs and key contacts.
- Detailed data collection template tabs for each emission source to facilitate streamlined data collection in the desired format.

Inventory activity data and emission factors were organized into the following workbooks:

- **Energy:**
  - Activity Data Workbooks.
    - PG&E Data (includes electricity and natural gas data from PG&E, Sonoma Clean Power, 3 Phases Renewables and SPURR).
    - Healdsburg Data (includes electricity data from City of Healdsburg).
    - Other Fuels Data (included propane use data).
  - Emission Factors Workbook.
    - Energy-related emission factors for all electricity utilities and fuels.
- **Transportation:**
  - Vehicle Fleet Activity Data Workbooks.
    - Fuel Data (annual fuel totals by vehicle).
    - Mileage Data (annual mileage totals by vehicle).
    - Vehicle Make and Model (mapping table that assigns vehicle category and vehicle type to each fleet vehicle).
    - Helicopter Data (annual fuel totals for Sonoma County Sheriff's Office's helicopter).
  - Transit Fleet Activity Data Workbook.
    - Sonoma County Transit Data (annual fuel and mileage totals by bus type).
  - Emission Factors Workbook.
    - Transportation-related emission factors for all vehicle and fuel types.
- **Solid Waste:**
  - Generated Waste Activity Data Workbook.
    - Total County generated landfilled and composted tonnage by waste material type.
  - Landfill Emissions Workbook.
    - Details on landfill gas collection, methane fraction, uncollected areas, collection efficiency, etc. needed to calculate total methane produced annually by each landfill.
  - Emission Factors Workbook.
    - Solid waste-related emission factors for all waste material types as well as derived emission factors for landfills.

- **Other Emission Sources:**
  - Wastewater Workbook.
    - Countywide wastewater emissions data, downscaled for County operations using population and employee counts. Includes derived emission factors.
  - Employee Commute Workbook.
    - Estimates of annual personal vehicle miles traveled (VMT) and fuel use by department using employee commute data, telework data, employee counts and informed assumptions.
- **Land Use:**
  - Land Use Change Workbook.
    - Land use change outputs from ICLEI LEARN tool including hectares and total emissions as well as derived emission factors.

Each workbook contains the following tabs:

- **Read Me tab** providing an overview of the workbook, the data inputs, any assumptions or data limitations, data sources/key contacts and a table of contents explaining what is in each workbook tab.
- **LGOP Reference tab** with screenshots of the specific protocol reference used to calculate emissions.
- **Calculations tab** for any data transformation/preliminary calculations needed to get the data into the format required for the inventory.
- **Power BI Activity Table tab** (if applicable) data formatted for import into Power BI.
- **Power BI EmFac Table tab** data formatted for input into Power BI.

This workbook provides as much transparency and detail as possible to facilitate an easily re-performable inventory in future years. Supporting documentation for data is saved in "References" folders to provide transparency into raw data inputs.

Inventory Platform

Microsoft Power BI was used to calculate emissions and generate an informational inventory dashboard. For each emission source, activity data inputs and emission factors were imported into Power BI in a database format. Note that some emission sources required manual calculations or data transformation in Microsoft Excel prior to importing into Power BI.

The Power BI database tables include all emission sources across all inventory years, allowing users to easily track emissions and trends over time. The Power BI inventory outputs allow for flexible reporting:

- Data can be **summarized** or "rolled up" to mirror the LGOP standard reporting categorizations as well as a custom rollup structure tailored to the County's emissions categorization preferences.
- Data is available as **granular** as possible (tracked by GHG, by department, by facility, by source, by scope, etc.).
- Data can be **disaggregated** into activity and emission factors to track progress over time and analyze how changes in each dataset impact overall emissions.

Coordination with Other Inventories

The regional GHG inventories in the table below informed the County's operational inventories.

Inventory	Inventory Year(s)	Protocol(s)	Notes
Sonoma County Regional Climate Protection Authority (RCPA), Sonoma County Community GHG Inventory	2018 and 2020	U.S. Community Protocol (ICLEI)	RCPA's wastewater calculations were used as a proxy for these inventories due to lack of County-specific data.
Sonoma County Regional Parks, GHG Emissions Inventory Baseline Assessment	2019	LGOP	This inventory was reviewed to understand opportunities for consistency between inventories.
Sonoma Water, GHG Inventories	2017, 2019 and 2021	LGOP The Climate Registry's General Reporting Protocol	These inventories were reviewed for information only.

Quality Control

The data and calculations used in these inventories underwent quality assurance/quality control steps at multiple stages. The following elements were reviewed for each emission source:

- The data source aligns with the Data Outline.
- Sources and key contacts are well-documented.
- Data appears complete, accurate and in the correct format.
- Any calculations performed to transform data are complete and accurate.
- Any assumptions or projections are based in sound logic and well-documented.

Upon completion of inventory calculations in Power BI, results were reviewed for the following:

- Results appear appropriately proportionate by emission source.
- Results contain no surprising outliers.
- Trends in emissions over time appear reasonable based on known circumstances (e.g., decommissioning of Sonoma County Fuel Cell, increased telework).
- Trends in emissions over time appear reasonable compared to trends of other regional inventories (e.g., RCPA).

Approach & Data Sources

The approach and data sources for each emission source are detailed by emission source below.

Energy

Energy Consumption

This emission source category includes emissions from stationary combustion and electricity consumption for all owned/leased and operated facilities.

Stationary Combustion

Stationary combustion refers to the combustion of fuels, such as natural gas or propane, to produce electricity, heat, or motive power using equipment in a fixed location. Stationary combustion is a Scope 1 emission source. The County purchased natural gas from Pacific Gas & Electric (PG&E) and SPURR. The County's Regional Parks department

also uses propane to run hot water heaters and heaters in remote facilities that fall outside of gas service areas.

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Stationary Combustion	Natural gas consumption (therms)	Pacific Gas & Electric (PG&E) (activity data includes SPURR)	Default greenhouse gas emissions intensity (MT GHG/therm)	U.S. EPA[42]
	Propane consumption (gallons)	Regional Parks propane consumption data	Default greenhouse gas emissions intensity (MT GHG/gallon)	

In accordance with the LGOP, stationary combustion was grouped into the following categories, where relevant and feasible:

1. Water delivery facilities;
2. Power generation facilities;
3. Solid waste facilities;
4. Airport facilities; and
5. All other buildings and facilities not included above.

Due to data disaggregation limitations, some of the "All other buildings and facilities" category likely includes stationary combustion from other categories.

Electricity

The County purchased electricity from four providers: Sonoma Clean Power, Pacific Gas & Electric (PG&E), 3 Phases Renewables and City of Healdsburg. To calculate Scope 2 emissions from electricity consumption in accordance with LGOP 6.2.1, electricity usage is multiplied by the corresponding utility-specific emission factor.

[42] GHG Emission Factors Hub | epa.gov

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Electricity Consumption	Electricity consumption (kWh)	Pacific Gas & Electric (PG&E) (activity data includes Sonoma Clean Power and 3 Phases)	Utility-specific greenhouse gas emissions intensity (MT GHG/kWh)	The Climate Registry[43] eGRID[44] Sonoma Clean Power[45] California Energy Commission Power Content Labels[46]
		City of Healdsburg		Power Source Disclosure Reports[47]

In accordance with the LGOP, electricity consumption was grouped into the following categories, where relevant and feasible:

1. Streetlights and traffic signals;
2. Water delivery facilities;
3. Airport facilities;
4. Vehicle fleet;
5. Transit fleet;
6. Power generation facilities;
7. Solid waste facilities; and
8. All other buildings and facilities not included above.

Due to data disaggregation limitations, some of the "All other buildings and facilities" category likely includes electricity consumption from other categories.

[43] The Climate Registry | theclimateregistry.org
[44] Download eGRID Data | epa.gov
[45] Power Sources | sonomacleanpower.org
[46] Power Content Label | energy.ca.gov
[47] Power Source Disclosure | energy.ca.gov

Energy Generation

Stationary combustion that results in power generation is a Scope 1 emission source and includes emissions from a County-owned and -operated natural gas fuel cell (used to generate electricity), which was decommissioned at the end of 2020.

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Stationary Combustion (Energy Generation)	Natural gas consumption (therms)	Pacific Gas & Electric (PG&E)	Default greenhouse gas emissions intensity (MT GHG/therm)	U.S. EPA[48]

Transportation

Fleet Vehicles and Equipment

The County's vehicle fleet includes Scope 1 emissions from both on- and off-road vehicles.

On-Road Vehicles

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
On-Road Internal Combustion Engine Fleet	Fuel consumed (gallons)	Public Infrastructure Department	Emissions per gallon of fuel consumed (CO_2)	U.S. EPA[48]
	Vehicle miles traveled	Public Infrastructure Department	Emissions per VMT (CH_4, N_2O)	
On-Road Electric Vehicle Fleet	Electricity consumed	Public Infrastructure Department	MT GHG/kWh	See *Electricity* above

[48] GHG Emission Factors Hub | epa.gov

Off-Road Vehicles

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Off-Road Vehicles and Equipment	Fuel consumed (gallons)	Public Infrastructure Department	Emissions per gallon of fuel consumed (CO_2, CH_4, N_2O)	U.S. EPA[48]
Aircraft	Fuel consumed (gallons)	Sheriff's Office	Emissions per gallon of fuel consumed (CO_2, CH_4, N_2O)	U.S. EPA[48]

Transit Vehicles and Equipment

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Transit Fleet	Fuel consumed (gallons, scf)	Sonoma County Transit	Emissions per unit of fuel consumed (CO_2)	U.S. EPA[48]
	Vehicle miles traveled	Sonoma County Transit	Emissions per VMT (CH_4, N_2O)	
On-Road Electric Vehicle Fleet	Electricity consumed	Sonoma County Transit	MT GHG/kWh	See *Electricity* above

Solid Waste

County Landfill Emissions

Emissions from Annapolis, Guerneville, Occidental and Roblar—which no longer collect landfill gas—were calculated using the California Air Resources Board (CARB) Landfill Gas Tool,[49] which is based on the IPCC First Order Decay (FOD) Model[50] and estimates

[49] CARB's Landfill Gas Tool
[50] 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines

emissions based on the tons of waste-in-place in the landfill.[51] Emission factors were then derived from these emissions totals.

Emissions from the Healdsburg landfill were calculated using the LGOP Partial LFG (landfill gas) approach, which calculates emissions based on the amount of landfill gas collected and the fraction of methane contained within the landfill gas.[52] Emission factors were then derived from these emissions totals.

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Landfill – Partial LFG System	Annual landfill gas collected (MMSCF)	Public Infrastructure Department	N/A – emissions calculated using LGOP formula and emission factors derived from total	LGOP 9.2
	Fraction of CH_4 in LFG from source testing (%)	Public Infrastructure Department	N/A – emissions calculated using LGOP formula and emission factors derived from total	LGOP 9.2
Landfill – No LFG System (FOD Model)	Total waste-in-place (tons)	Public Infrastructure Department	N/A – emissions calculated using FOD model and emission factors derived from this total	CARB Landfill Gas Tool
Central Landfill (info only; operated by Republic)	Emissions reported to the U.S. Environmental Protection Agency (EPA)	EPA FLIGHT[53]	N/A – emissions reported to the EPA and shared publicly through the online FLIGHT database	EPA FLIGHT[53]

[51] Waste-in-place data were not available for the Airport and Sonoma landfills.

[52] Landfill gas data were not available for 2019; so 2019 gas was assumed based on a linear change in gas between 2017 and 2021.

[53] EPA FLIGHT

Scope 3 Solid Waste Generation

Emissions from County government generated waste were calculated using Recology data detailing annual tons of landfilled waste and compost collected at County facilities in each inventory year[54] and material type-specific emission factors from the U.S. EPA Emission Factor Hub.

Because the Recology data did not break down waste by material type, the composition of the waste was estimated using a Zero Waste Sonoma 2022 County Waste Characterization Study.[55] Emissions from the transportation of waste to landfills and fugitive CH_4 emissions were included in the final emissions total.

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Landfilled Solid Waste & Compost Generation	Annual tons of waste (landfilled solid waste and compost) collected by Recology from County facilities	Recology	MT CO_2e / short ton	U.S. EPA[48]

Other Emission Sources

Wastewater

This emission source category includes emissions related to the treatment of wastewater generated by County operations. Wastewater emissions attributed to the County were calculated by scaling emissions data from Sonoma County's Regional Climate Protection Agency's (RCPA) 2018 and 2020 GHG inventories using population and employee counts. This methodology was selected due to a lack of available data for County-specific wastewater generation.

The County's inventory does not include emissions from Sonoma Water as it is a special district and separate legal entity from the County.

[54] Recology data for 2017 were not available, so 2018 was used as a proxy.
[55] 2022 Waste Characterization Study 2022 Final Report

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Wastewater Treatment Process Emissions	Annual emissions ($MTCO_2e$)	Regional Climate Protection Authority	N/A – emissions scaled based on service population and County employee count	N/A

Water Delivery

Emissions from electricity usage associated with water delivery are included in *Energy Consumption*.

Refrigerants

The use of refrigerants—fluids commonly used in air conditioners, refrigerators, chillers and other cooling devices—produce Scope 1 GHG emissions though consumption in equipment and when leakage occurs. Many refrigerants consist of hydrofluorocarbons, which have high global warming potentials.

Data on stationary and mobile refrigerant usage were unavailable for selected inventory years. If the County wants to calculate these emissions in future years, the LGOP provides detailed guidance on how to collect refrigerant data (LGOP 6.6, LGOP 7.4).

Fugitive Emissions from Refrigerants & Fire Suppression Equipment

Activity data for the use of stationary refrigerants was not available for 2017, 2019 or 2021.

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Refrigerant consumption	Refrigerant consumption (pounds)	Data unavailable	N/A – emissions are stated in terms of kg of refrigerants consumed	N/A

Fugitive Emissions from Motor Vehicle Air Conditioning

Activity data for the use of mobile refrigerants was not available for 2017, 2019 or 2021.

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Refrigerant consumption	Refrigerant consumption (pounds)	Data unavailable	N/A – emissions are stated in terms of kg of refrigerants consumed	N/A

Employee Commute

Employee commute emissions were calculated by collecting data points such as full-time employee equivalent counts and telework percentages by department, commute mode data (passenger car, carpool, bus) from employee surveys and average commute distance for all employees. These averages and assumptions were combined to estimate yearly commuting emissions by department.

An internal commute survey was used to scale data on employees' commute distance and how they travel to work (passenger car, light duty truck, public transportation, walk, bike, etc.).

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Employee commute	Vehicle miles traveled	County Administrator's Office	Emissions per VMT (CO_2, CH_4, N_2O)	U.S. EPA[48]

Employee Business Travel

Data on personal vehicle and air travel for government business was not available for these inventories. In the future, the County could estimate emissions using total air and vehicle mileage with assumptions around vehicle and fuel types.

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Employee Personal	Fuel consumed (gallons)	County Administrator's Office	Emissions per gallon of fuel (CO_2)	U.S. EPA[48]

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Vehicle Travel	Vehicle miles traveled	County Administrator's Office	Emissions per VMT (CH_4, N_2O)	U.S. EPA[48]
Employee Air Travel	Total employee aviation passenger miles	County Administrator's Office	Emissions per passenger-mile (CO_2, CH_4, N_2O)	U.S. EPA[48]

Biogenic Emissions

The combustion of biomass and biomass-based fuels (such as wood, wood waste, landfill gas, ethanol, etc.) emit CO_2 emissions, but these CO_2 emissions are distinct from Scope 1 emissions generated by combusting fossil fuels. The CO_2 emissions from biomass combustion are tracked separately because the carbon in biomass is of a biogenic origin—meaning that it was recently contained in living organic matter—while the carbon in fossil fuels has been trapped in geologic formations for millennia.

Biogenic CO_2 emissions are generated from landfill gas recovery at the Healdsburg landfill (the only County-operated landfill that still collects and flare landfill gas). These biogenic emissions were calculated based on the annual landfill gas collected at the site and the LGOP's default biogenic emission factor for landfill gas combustion (adjusted to align with the proportion of CH_4 in the Healdsburg landfill gas).

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Landfill gas recovery	Annual landfill gas collected (MMSCF)	Public Infrastructure Department	MT GHG/MMSCF	LGOP 9.1 (Table G.2)

Land Use

The LGOP does not include guidance for tracking carbon emissions and removals from land use change. Instead, emissions were calculated using guidance from the U.S. Community Protocol.[56]

[56] U.S. Community Protocol (USCP) Appendix J: Forest Land and Trees

Emissions from land use change were calculated using the ICLEI LEARN tool (Land Emissions And Removals Navigator), which approximates the annual GHG emissions or removals generated from specific changes in land use over a given time period. LEARN combines emissions calculation methods outlined in the U.S. Community Protocol with land cover change data provided by the National Land Cover Database—the definitive Landsat-based, 30-meter resolution land cover database for the United States.[57]

Because permanent land use change occurs over multiple years, LEARN calculates annual emissions over a range of three or more years. At the time of analysis, the inventory period that most closely aligned with the inventory years was 2016–2019, so each inventory year was estimated using this time horizon.[58]

County shapefiles (excluding land under the jurisdiction of Ag + Open Space, which includes conservation easements) were uploaded into the LEARN tool to calculate GHG emissions and removals caused by specific changes in land use (measured in hectares) during the inventory period. ICLEI calculates emissions based on proximity to 11 broad forest regions (Sonoma falls within the Pacific Southwest forest region) and other characteristics about County forest land. For non-forest land, emissions are based on tree canopy coverage in representative urban areas in the U.S., the closest for Sonoma being San Francisco.

ICLEI details a number of limitations in its approach for calculating emissions that might lead to higher-than-expected emissions in this category. For example, the inventory assumes that a loss of forest or trees results in immediate emissions when, in some cases, emissions remain stored in the wood harvested from a tree or are delayed by trees decaying over time in a landfill. According to ICLEI, these limitations are typical for greenhouse gas inventories of forests using similar approaches (including the national GHG inventory led by the U.S. Environmental Protection Agency). In some cases, similar inventories have resulted in uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence).[59,60]

[57] ICLEI LEARN Tool methods
[58] Because each year was analyzed using the same inventory period, emissions were the same across all three inventory years.
[59] Inventory limitations are outlined in the detailed emissions report provided by the LEARN platform.
[60] ICLEI LEARN Tool

Source	Activity Data	Activity Data Source	Emission Factor	Emission Factor Source
Land Use / Biomass Burning	GIS shapefiles for land owned and managed by the County (hectares)	Agricultural Preservation and Open Space District	N/A – emissions calculated by ICLEI LEARN	ICLEI LEARN[60] (MT GHG/hectare)

Carbon Offsets and Renewable Energy Credits

Local governments should account for and report all carbon offsets which they purchase and retire or generate and sell. The County of Sonoma did not purchase Renewable Energy Certificates or other carbon offsets in 2017, 2019 or 2021. If the County makes these purchases in the future, it will follow the LGOP's guidance for reporting that information.

Appendix B: County Departments

County Departments

- Agricultural Commissioner-Sealer of Weights & Measures
- Auditor-Controller-Treasurer-Tax Collector
- Child Support Services
- Community Development Commission
- County Administrator/Board of Supervisors
- County Clerk-Recorder-Assessor-Registrar of Voters
- County Counsel
- District Attorney
- Economic Development Board
- Emergency Management
- General Services*
- Health Services
- Human Resources
- Human Services
- Independent Office - Law Enforcement Review/Outreach
- Information Systems
- Office of Equity
- Permit Sonoma
- Probation
- Public Defender
- Regional Parks
- Sheriff Coroner
- Transportation and Public Works*

* General Services and Transportation and Public Works were merged into one new department in 2022. Future inventories will reference these two departments as one, called Public Infrastructure.