

## Appendix A: Emissions Inventory Supporting Documentation

The Bay Area Air Quality Management District (Air District) has prepared this Priority Climate Action Plan (Plan) for the San Francisco-Oakland-Berkeley Metropolitan Statistical Area (MSA). An important element of this Plan is an updated regional greenhouse gas (GHG) emissions inventory that will serve as the foundation for the development and implementation of reduction measures to reduce emissions of GHGs throughout the region, and especially in the frontline communities. This section provides a deeper understanding of:

- the scope of the regional GHG inventory,
- the inventory development methodology,
- the quality assurance process that is being applied to maintain data quality, and
- insights into emissions data and trends.

### Scope

This section provides details about the scope of the GHG emissions inventory, both in terms of minimum requirements instituted by U.S. Environmental Protection Agency (EPA) as part of the Climate Pollution Reduction Program (CPRG) program, as well as specifics on how the emissions inventory is further classified into economic activity-based sectors and sub-sectors.

#### *Geographical*

The Bay Area region's GHG emissions inventory includes emissions for eight counties in the San Francisco-Oakland-Berkeley Metropolitan Statistical Area (MSA) that are represented in the PCAP. These include Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and parts of Solano and Sonoma counties. The Air District's complete GHG inventory includes a ninth county - Santa Clara, which is within the jurisdiction of the Air District, but it is part of the San Jose-Sunnyvale-Santa Clara MSA's CPRG planning process.

#### *Pollutants*

The PCAP GHG inventory includes emissions of the following GHG pollutants:

- Carbon Dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)
- Nitrous Oxide (N<sub>2</sub>O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur Hexafluoride (SF<sub>6</sub>)
- Nitrogen Trifluoride (NF<sub>3</sub>)

For the purposes of classification of chemically similar pollutants and ease of visualization, emissions of HFCs and PFCs are reported as one family of pollutants in this PCAP report.

## *Timespan*

The year 2022 has been chosen as the base year for this inventory as it is the latest year for which complete, published, and verified datasets are available for most source categories within all sectors and sub-sectors. Additionally, the year 2022 is treated as representative of "business-as-usual" as it is considered a post-pandemic year. The Comprehensive Climate Action Plan (CCAP) will include a regional GHG inventory that accounts for emissions over a multi-decadal time frame. For the CCAP, further work will be done to refine the year 2022 emissions and to estimate emissions for future years, up through year 2050.

## *Sectors*

For the Bay Area region's GHG emissions inventory, six major sectors have been identified based on an economic classification. These sectors include:

- Transportation,
- Industrial,
- Commercial and Residential,
- Electricity Generation,
- Waste Management, and
- Agriculture.

The sectors are further divided into sub-sectors (see *Figure 1* and *Table 1*). The definition and source composition of the economic sectors generally align with the USEPA's classification of GHG emissions sources<sup>1</sup> with some exceptions and deviations to account for differences at the regional level. Definitions for each sector are provided below:

### *Transportation*

The emissions in this sector are comprised of direct and indirect combustion, non-combustion, and process emissions, occurring from complex machines including cars, trucks, aircrafts, railroads, ships, off-road equipment etc., whose primary objective is to transport people and goods from one place to another. The emission sources in this sector include, but are not limited to, the following:

- Emission from passenger cars, light duty vehicles, medium duty vehicles, and heavy-duty vehicles,
- Emissions from aircraft, marine vessels, and locomotives,
- On-road and off-road emissions sources which act as a residence / home are also included in the transportation sector (e.g., motorhomes, houseboats, RVs),
- Emissions from the use of lubricants to perform maintenance on on-road and off-road mobile equipment, and
- Emissions of high-GWP gases resulting from the use of air conditioners in vehicles and refrigerated transport.

Emission sources not included in this sector are:

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<sup>1</sup> Sources of Greenhouse Gas Emissions, <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

- On-road and off-road emissions sources with wheels and/or ability to move if the primary objective is to provide a service, e.g., lawn mowing and garden equipment (included in Commercial & Residential sector) or tractors (included in Agriculture),
- Emissions from transportation of natural gas via pipelines and water through water distribution network (this is considered a service to the general population for commercial, residential, and industrial use and both combustion and non-combustion emissions are excluded from this sector),
- Emissions from off-road equipment that pertains to agricultural activities, and from construction, mining, and industrial activities (considered under Agriculture and Industrial sectors, respectively), and
- Fugitive emissions from all kinds of fueling activities of primary sources included in the Transportation sector as well as combustion emissions from support equipment for the fueling (and other support) infrastructure. These emissions are accounted for under Commercial and Residential sectors (e.g., gasoline dispensing facilities, aircraft ground support equipment, etc.).

### *Industrial*

This sector consists of emissions related to the production of goods and raw materials. This sector includes:

- Direct GHG process emissions that originate at the facility, primarily from combustion processes,
- Emissions resulting from chemical reactions in metal, cement, and mineral production, and
- Leaks from industrial processes, equipment, natural gas, and petroleum systems, including that of high-GWP gases.

Exceptions not included in this sector are:

- Indirect emissions that occur off-site but are associated with the facility's use of electricity (these are included in Electricity Generation), and
- Emissions from food processing of agricultural products, for example, ethanol emissions from wineries and emissions from food processing industries, etc. (considered under Agriculture sector).

### *Commercial + Residential*

This sector includes the following direct emissions from homes, commercial businesses, office spaces, places of business, worship, and congregation, entertainment venues, etc. (excluding those classified as agricultural and industrial activities:

- Direct emissions resulting from fossil fuel combustion for heating, cooling, and cooking needs, for transport and management of waste and wastewater, and leaks of refrigerants from equipment.
- Direct emissions from all maintenance and service equipment, e.g., lawn mowing equipment, leaf blowers, floor cleaning and polishing, etc.
- Direct emissions from use of personal products and consumer goods within commercial and residential facilities.

Emissions sources that are not reported in this sector include:

- Indirect emissions produced by burning fossil fuel at a power plant to generate electricity (that occurs offsite) which is meant for consumption in residential and commercial facilities, such as lighting and for appliances (these emissions are included in Electricity Generation),
- Landfill waste emissions (like CH<sub>4</sub>) that are generated from organic waste that originated at commercial and residential facilities (these emissions are included in Waste Management),
- On-site wastewater treatment plant emissions of CH<sub>4</sub> and N<sub>2</sub>O, or emissions from sewer network (these emissions are included in Waste Management),
- Energy required to produce and transport clean water consumed at commercial and residential facilities (these emissions are included in Electricity Generation),
- Anaerobic digestion and composting emissions of CH<sub>4</sub> at biogas facilities that supply energy/product to commercial and residential buildings and venues (these emissions are included in Waste Management),
- Emissions/sinks from production of construction materials, for example, upstream emissions from production of cement, emissions and sinks from land use changes, etc. (these emissions are included in Industrial), and
- Direct emissions from onsite energy combustion and electricity production for energy-intensive warehouses and factories are typically included in the Industrial sector.

### *Electricity Generation*

This sector includes emissions from activities and processes involved in the generation, transmission, and distribution of electricity within the Bay Area region. These emissions are direct and involve combustion of fossil fuels, such as coal, oil, and natural gas, etc., in a centralized power generation plant to produce electricity, or fugitive/leak-related emissions. This inclusion is independent of whether the electricity is consumed within the Bay Area or imported. Other sources include:

- Emissions from cogeneration facilities producing both heat and power are included in this sector, even if this heat and power is being consumed within the Industrial sector,
- Emissions of sulfur hexafluoride (SF<sub>6</sub>), which is an insulating chemical used in electricity transmission and distribution equipment, and
- Onsite emissions from non-fossil fuel source generation facilities, including nuclear, and renewable energy sources like hydroelectricity, biomass, and wind.

A source that is not included in this sector is:

- Direct emissions caused due to production of electricity outside of the Bay Area, but which is imported and used in the Bay Area. These emissions are not accounted for in the GHG emissions inventory.

### *Waste Management*

This sector includes direct and fugitive emissions from centralized waste management activities that focus on solid waste, wastewater, industrial, and non-hazardous waste. These activities usually occur at municipal solid waste (MSW) landfills, industrial waste landfills, industrial wastewater treatment, publicly owned wastewater treatment plants (POTWs), composting operations, anaerobic digesters, biogas facilities, and can also include processes like manure spreading / application, waste incineration, etc. Other direct emissions included are as follows:

- Direct emissions from combustion activities occurring at waste management facilities to provide heat and power,
- Fugitive emissions from the urban collection network of sewers, waste pipes, manholes, etc., and,
- Emissions from standalone septic systems.

Sources not included in this sector are:

- Waste management emissions occurring outside of the Bay Area region from management of waste originating within the region,
- Direct emissions from on-site waste treatment at commercial and residential facilities (included in the Commercial and Residential sector),
- Direct emissions from manure management at animal and dairy farms (included in the Agriculture sector), and
- CO<sub>2</sub> emissions from the combustion of biomass since it is considered biogenic.

### *Agriculture*

This sector includes direct emissions from all agricultural and farming activities related to crop and livestock production including land and soil management activities, such as application of synthetic and organic fertilizers, the growth of nitrogen-fixing crops, the drainage of organic soils, irrigation practices, livestock enteric fermentation, manure management and storage, liming and urea application, burning of crop residues, and rice cultivation. All on-site combustion-related activities supplying energy to agricultural equipment (like diesel generators and pumps), and for farm-related activities are included. All emissions sources with wheels and/or ability to move are included if the primary objective is to provide a service to the agricultural industry (e.g., airplane fertilizer application, mechanical cotton picker, etc.). Sources not included in this sector include:

- Accidental wildfires over natural lands and forests

### *Organization of sources of high GWP fluorinated gases*

The group of emission sources termed fluorinated gases or high-GWP compounds is emitted almost entirely from human-related activities. Their primary sources include:

1. Use of substitutes for ozone-depleting substances (referred to as ODSS compounds) - Hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) are ODSS that are considered replacements for chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) because they do not deplete the stratospheric ozone layer. ODSS are high-GWP gases and contribute to the greenhouse gas effect (CFCs and HCFCs are also high-GWP gases). Example applications include refrigerants, aerosol propellants, foam blowing agents, solvents, and fire retardants.
2. Industrial processes such as aluminum and semiconductor manufacturing - PFCs are produced as a byproduct of aluminum production and are used in the manufacturing of semiconductors. Sulfur hexafluoride (SF<sub>6</sub>) is used in magnesium processing and semiconductor manufacturing. Nitrogen trifluoride (NF<sub>3</sub>) is used in semiconductor manufacturing. HFC-23 is produced as a byproduct of HCFC-22 production and is used in semiconductor manufacturing.
3. Transmission and distribution of electricity - SF<sub>6</sub> is used as an insulating gas in electrical transmission equipment, including circuit breakers.

The GHG emissions from this group of sources and source categories are not considered as a separate sector, as has been done in the past in the Bay Area region’s inventory and in the current statewide California GHG inventory. This is because the prevailing logic for sector-level classification of GHG emissions sources is an economic activity driven classification, rather than a chemical family / pollutant-type based classification. Thus, all source categories associated with this group of emissions are assigned to different sectors based on the following logic:

- ODSS are assigned to Commercial and Residential, Transportation, and Industrial sectors based on category hierarchy and end-use information.
- Emissions of PFCs, NF<sub>3</sub>, SF<sub>6</sub> and any other F-gas that is used for product manufacturing or metal production are assigned to the Industrial sector.
- Emissions from SF<sub>6</sub> from electrical transmission equipment are assigned to the Electricity Generation sector.

## Inventory Methodology

The Air District takes a ‘production-based’ approach to develop the regional GHG emissions inventory, which focuses on estimating emissions from sources that directly produce emissions in the region, as compared to attributing emissions produced elsewhere to Bay Area consumers (and end-users) of goods and services (consumption-based approach). The Air District inventory methodology involves a combination of –

- a bottom-up approach that combines activity data and/or throughputs (e.g., fuel used, vehicle miles traveled, etc.) with GHG emissions factors (e.g., kg of CO<sub>2</sub> produced per unit mass of fuel burned, grams of CO<sub>2</sub>-equivalent released per vehicle mile traveled, etc.) and local/regional controls to generate emissions,
- a top-down approach where emissions are derived by scaling down from an existing (e.g., national and/or state) emissions inventory using a proxy or surrogate, and
- self-reported emissions verified and approved through the Air District’s permitting program.

### *Bottom-up Approach*

A bottom-up GHG emission inventory involves estimating emissions using (1) emission factors (mass of pollutant emitted per unit of activity); (2) local activity or throughput information of the emission processes (e.g., number of events, duration of activity, duty cycle, and quantity of gallons consumed); and (3) estimated emissions reduction or control efficiency if an abatement device is installed or a relevant regulation is implemented. For permitted sources, the Air District uses source-specific information submitted by the facility (and accepted/approved by the agency) to calculate emissions. Detailed activity data and emission factors are also available for some mobile source categories and non-permitted source categories, the statewide EMFAC inventory (for on-road and off-road mobile sources) being an example.

The following equation illustrates a general formula for estimating emissions following the bottom-up method:

$$E_i = A \cdot (1 - ER_i) \cdot EF_i$$

where

$E_i$	=	emissions of pollutant $i$
$A$	=	activity rate or throughput
$ER_i$	=	emission reduction efficiency of pollutant $i$
$EF_i$	=	emission factor of pollutant $i$

Emission factor (EF) is a value that reflects the quantity of pollutant emitted per activity or time/distance/unit increment (e.g., grams per hour, grams per gallon of fuel consumed). EFs can be general or source specific. General EFs from published literature represent averages of similar operations, while specific EFs are derived from source-specific emission testing, mass balance, or chemical analysis. Specific EFs are typically more representative and can be self-reported by the facility/operator or compiled by the regulating agency.

Activity rate or throughput (A) data refers to the frequency and amount of pollution activities based on the operation of the source or facility. General activity data may be used for categories where minimal information is available, such as some area sources; for point source categories, activity data are based on reported source-specific information provided by the permitted facility.

Emissions reduction efficiency or control factors (ER) indicate the percent reduction in pollutant emissions if an abatement device is installed or specific regulations are applicable for the source. For example, if a baghouse on a cement silo serves as an abatement device that could reduce particulate emissions by 95%, then a control factor of 0.95 can be used for emissions estimation.

### *Top-down Approach*

The top-down emissions estimation approach is typically used for those sources or categories with limited source-specific information. A top-down emissions inventory can be developed from a larger-scale (e.g., state or county) emissions inventory using spatial surrogates, activity proxies, socioeconomic trend indicators, etc., to disaggregate total emissions and apportion to finer spatiotemporal scales. A top-down emissions inventory is developed for the Bay Area region's non-permitted stationary source categories, where equipment-level identification and information are not available, often using county-level emissions and activity data obtained from California's State Implementation Plan Inventory<sup>2</sup>. Also, frequently used for top-down estimation of the Bay Area region emissions are the statewide greenhouse gas inventory<sup>3</sup>. Surrogate activity data, such as fuel throughput, population growth, employment by job sector, and land use, etc., are used to scale available statewide data to derive source-category specific GHG emissions estimates for the region. For example, county-specific cattle head count data are used to assign California GHG emissions total for animal manure management across the Bay Area region.

### *Air District permit data*

For most permitted stationary sources (including facilities, processes, equipment, etc.), GHG emissions are calculated from data that has been submitted by operators and owners, responsible and liable for

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<sup>2</sup> California Emissions Projection Analysis Model (CEPAM 2018), <https://ww2.arb.ca.gov/applications/cepam2019v103-standard-emission-tool>

<sup>3</sup> California 2000-2021 GHG Inventory (2023 Edition), <https://ww2.arb.ca.gov/ghg-inventory-data>

those sources, as part of the annual Air District permit renewal process. These data submissions are verified for accuracy, consistency, change in permit and operating conditions, etc., by Air District staff before being approved for issuance of permit. These data are then utilized to generate emissions using the bottom-up approach (described above). For some select facilities and Bay Area region refineries, there are adopted regulations (e.g., Regulation 12 Rule 15) which impose a mandatory emissions reporting requirement on the facilities subject to these regulations. These regulations, thus, serve as a robust tool for the Air District to generate a GHG emissions inventory for some of the larger and more polluting sources in the region.

## Quality Assurance Project Plan (QAPP)

The primary objectives for this PCAP are to develop reliable inventories for each of the GHG-emitting sectors in the Bay Area region, and to identify options for reducing emissions from those sectors. As per the USEPA's CPRG guidelines, the PCAP (and eventually the CCAP) require the development and implementation of a quality assurance program that promotes confidence in the developed emissions inventory and all subsequent policy initiatives and regulatory programs based on the inventory estimates.

Accordingly, all quality objectives and criteria are aligned with the overall PCAP objectives and laid out in a Quality Assurance Project Plan<sup>4</sup> (QAPP). The GHG emissions inventory is subject to a data review and quality control process that is described in the QAPP. All activities under this project will conform to the QAPP. The quality system used for this project is the joint responsibility of the Air District Project Manager (PM), Task Leaders (TLs), Technical Reviewers (TRs), and an organizationally independent Quality Assurance (QA) Manager.

A detailed quality assessment is applied to each of the six major sectors during the GHG inventory development process with a seven-step planned quality assessment and control activity (for each sector). This seven-step approach includes:

1. Determining quality of existing Air District inventory for the Bay Area region
2. Identifying, researching, and collecting other published data
3. Characterizing the data
4. Assessing data for accuracy and applicability
5. Deriving emissions estimates
6. Verification of quality
7. Quantification of reduction measure options

## GHG Emissions Summary

*Figure 1* presents a sunburst pie chart that shows the distribution of GHG emissions (in CO<sub>2</sub>-equivalent terms) across sub-sectors within the major sectors. The sub-sectors are more specific classification of emissions sources within a sector and are often based on characteristics like emission-type (e.g., combustion), source type (e.g., ships), process (e.g., petroleum refining), pollutant class (e.g., high-GWP gases), etc. The inner ring in the sunburst chart is broken down into the six major GHG sectors, while the

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<sup>4</sup> Quality Assurance Project Plan for The Bay Area Climate Action Planning Initiative, Grant No.: 98T73201; *submitted on*: 12-27-2023; *approved on*: 01-04-2024; available on request.



outer ring splits those major sector contributions further into several sub-sectors. For a detailed distribution of emissions across sub-sectors within the six major sectors, refer to *Table 1* in *Appendix A*.

*Table 1* provides insight into the sub-sectors within major sectors and the relative share of the total GHG emissions between these sub-sectors. From the pie chart, it can be observed that passenger vehicles (~11% of total regional GHG emissions) within the Transportation sector has the largest share of GHG emissions, along with combustion of natural gas in industrial operations (~11%) and fuel combustion processes at refineries (~11%) within the Industrial sector. Other major GHG emissions sources include residential natural gas combustion (~7%) in Commercial and Residential sector, light-duty (~7%) and heavy-duty (~7%) trucks in the Transportation sector, cogeneration facilities (~7%) and power plants (~5%) in the Electricity Generation sector, and petroleum refining processes (~7%) in the Industrial sector. Emissions from landfills (~3% of total regional GHG emissions) constitute the largest share of GHG emissions within the Waste Management sector although recent measurement-based estimates in the Bay Area region indicate that CH<sub>4</sub> emissions from this sub-sector (along with those in the refinery sub-sector) are being underestimated and need revision<sup>5</sup>.

### *Direct vs Indirect emissions from Electricity Generation*

As has been stated in the *Scope* sub-chapter in *Chapter 2*, the Air District's GHG emissions inventory represents a production-based accounting approach with GHG pollutant emissions attributed to sources (categorized within sectors and sub-sectors) and accounted at point of origin (ascribed to county). This is also true for the Electricity Generation sector, where, in addition and in parallel, the Air District has also developed a regional emissions inventory for Electricity Use based on a consumption-style approach using independent data sources (see *GHG Emissions*).

A production based GHG emissions inventory for Electricity Generation sector is often broken down into two components:

#### *Direct Emissions*

These are GHG emissions emitted from power plants and cogeneration facilities, that are located within the Bay Area region, during the process of electricity production. These emissions are typically 'directly' emitted into the Bay Area's atmosphere with 'direct' local pollution and health impacts, independent of whether this generated electricity is consumed within the region or exported.

#### *Indirect Emissions*

These are GHG emissions emitted from power plants and cogeneration facilities that are located outside the Bay Area region, during the process of electricity production, where some of this generated electricity is being imported and used by consumers located within the Bay Area. In this case, the emissions can be referred to be 'indirectly' emitted within the Bay Area.

The Air District does not include 'indirect emissions' from electricity generation in the Bay Area regional emissions total for the following reasons:

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<sup>5</sup> Assessment of Regional Methane Emission Inventories through Airborne Quantification in the San Francisco Bay Area, <https://pubs.acs.org/doi/abs/10.1021/acs.est.0c01212>

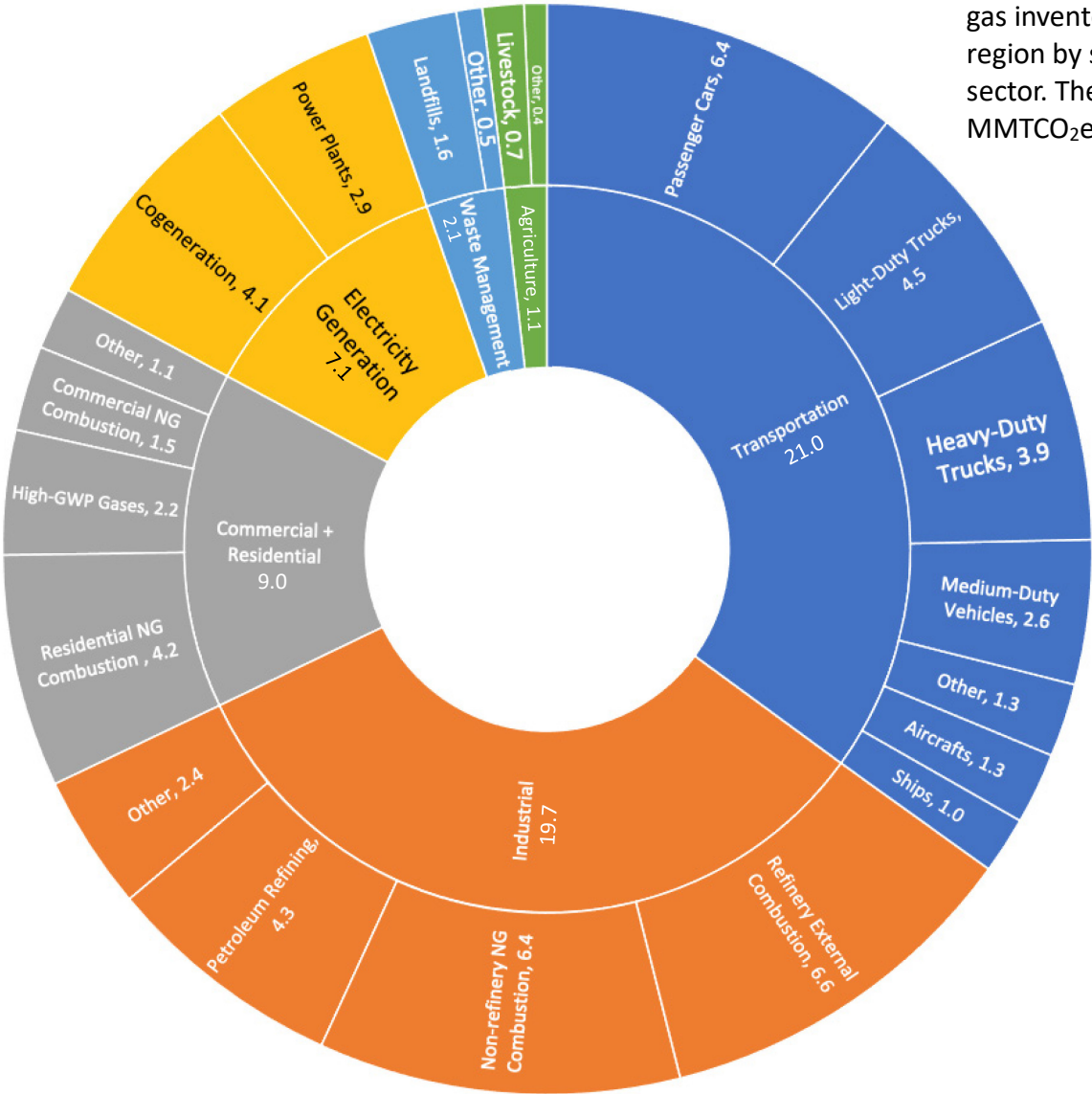
- 1) The Air District's 'direct' GHG emissions from the power plant sub-sector within the Electricity Generation sector are ~3 MMTCO<sub>2</sub>-e for the Bay Area region, while the consumption-based emissions inventory from retail electricity usage is 2.1 MMTCO<sub>2</sub>-e. This indicates that a large chunk of electricity produced in the Bay Area region is exported outside the region and not consumed by Bay Area users. Despite this consumption pattern, these emissions are accounted for and included as 'direct' emissions in the regional inventory. This is consistent with the Air District's production-based inventory accounting approach and independent of whether another MSA or regional entity is reporting and including these as 'indirect' emissions in their inventories. This ensures that the Bay Area region's emissions inventory accounting methods remain conservative and are all-encompassing, independent of another MSA's choice of scope of their inventory.
- 2) The Air District is unaware whether another MSA or region (where some of Bay Area's imported fossil-fuel based electricity may be produced) is including or excluding the Bay Area's 'indirect' emissions as part of their 'direct' emissions accounting. In the absence of this information, the Air District's practice helps avoid double-counting of GHG emissions at the state or federal level.
- 3) Availability of activity data for generated electricity going in and out of the Bay Area is not readily available as electricity trading is a continuous process and managed in a wholesale energy market<sup>6</sup>, and this greatly hinders calculation of net emissions resulting from use and generation.

In this regard, the Air District encourages all PCAP participants and grantees to report the full scope of their 'direct' emissions without discounting any 'indirect' emissions of other regions.

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<sup>6</sup> California Independent System Operator (ISO), <https://www.caiso.com/Pages/default.aspx>

**Figure 1.** 2022 greenhouse gas inventory for the Bay Area region by sector and sub-sector. The total is 59.88 MMTCO<sub>2</sub>e.



**Table 1.** 2022 Bay Area Region Greenhouse Gas Inventory by Sector and Sub-sector

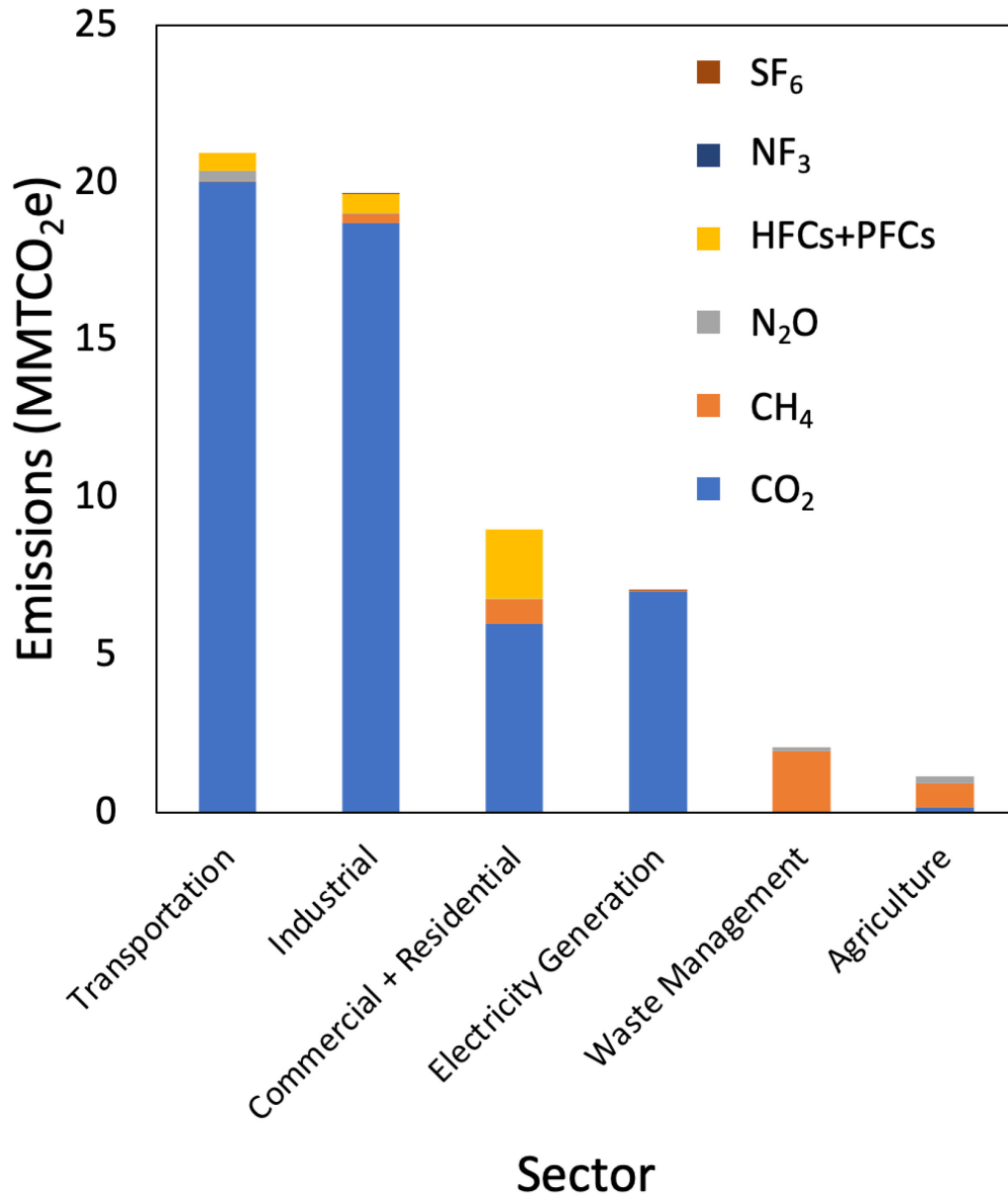
Sector	Sub-sector	Emissions (MMTCO <sub>2e</sub> )	Sector	Sub-sector	Emissions (MMTCO <sub>2e</sub> )	
<b>Transportation</b>	Passenger Cars	6.41	<b>Industrial</b>	Refineries External Combustion	6.64	
	Light-Duty Trucks	4.46		NG Combustion	6.44	
	Heavy-Duty Trucks	3.94		Petroleum Refining	4.27	
	Medium-Duty Vehicles	2.57		Fuel Combustion	0.83	
	Aircrafts	1.27		High-GWP Gases	0.59	
	Ships	1.01		Off-Road Equipment	0.54	
	High-GWP Gases	0.58		Manufacturing	0.19	
	Buses	0.29		NG Leakage	0.15	
	Other	0.12		Fugitive and Process Emissions	0.03	
	Locomotives	0.09		Other	0.0004	
	Heavy-Duty Vehicles	0.09		<i>Total</i>	<i>19.67</i>	
	Motorcycles	0.07		<b>Electricity Generation</b>	Cogeneration	4.08
	Motor Homes	0.06			Power Plants	2.95
	<i>Total</i>	<i>20.95</i>			Transmission/Distribution	0.03
<b>Commercial + Residential</b>	Residential Combustion - Natural Gas Only	4.15		<i>Total</i>	<i>7.06</i>	
	High-GWP Gases	2.21	<b>Waste Management</b>	Landfills	1.60	
	NG Combustion	1.49		Domestic Wastewater Treatment	0.37	
	Fuels Distribution	0.49		Industrial Wastewater Treatment	0.06	
	Natural Gas Leakage	0.28		Other	0.03	
	Residential Combustion - Other (non-Natural Gas)	0.15		Composting	0.01	
	Lawn and Garden Equipment	0.09		<i>Total</i>	<i>39.06</i>	
	Light Commercial Equipment	0.06	<b>Agriculture</b>	Livestock	0.73	
	Commercial Cooking	0.05		Other	0.26	
	Residential Wood Burning	0.01		Agricultural Equipment	0.15	
Off-Road Recreational Vehicles	0.002	Planned Fires		0.002		
<i>Total</i>	<i>8.98</i>	Food Processing		0.00004		
			<i>Total</i>	<i>42.27</i>		
<b>Grand Total</b>			<b>59.88</b>			

**Table 2. 2022 Bay Area Region Greenhouse Gas Inventory by County and Sector**

County	Sector	Emissions (MMTCO <sub>2</sub> e)	Emissions (% in county)	County	Sector	Emissions (MMTCO <sub>2</sub> e)	Emissions (% in county)
Alameda	Agriculture	0.11	0.95%	San Francisco	Agriculture	0.01	0.22%
	Commercial + Residential	2.39	21.05%		Commercial + Residential	1.64	36.45%
	Electricity Generation	0.55	4.81%		Electricity Generation	0.07	1.46%
	Industrial	0.97	8.55%		Industrial	0.79	17.60%
	Transportation	6.75	59.35%		Transportation	1.93	42.90%
	Waste Management	0.55	4.86%		Waste Management	0.06	1.37%
	<i>Total</i>	<i>11.32</i>			<i>Total</i>	<i>4.51</i>	
Contra Costa	Agriculture	0.21	0.79%	San Mateo	Agriculture	0.04	0.62%
	Commercial + Residential	1.79	6.71%		Commercial + Residential	1.39	24.20%
	Electricity Generation	6.14	23.02%		Electricity Generation	0.03	0.47%
	Industrial	14.11	52.91%		Industrial	0.47	8.12%
	Transportation	4.06	15.23%		Transportation	3.32	57.79%
	Waste Management	0.36	1.34%		Waste Management	0.51	8.80%
	<i>Total</i>	<i>26.67</i>			<i>Total</i>	<i>5.74</i>	
Marin	Agriculture	0.22	9.76%	Solano (BAAQMD portion only)	Agriculture	0.15	2.78%
	Commercial + Residential	0.51	22.80%		Commercial + Residential	0.42	7.76%
	Electricity Generation	0.01	0.30%		Electricity Generation	0.26	4.74%
	Industrial	0.07	3.15%		Industrial	2.98	54.64%
	Transportation	1.28	56.89%		Transportation	1.45	26.54%
	Waste Management	0.16	7.11%		Waste Management	0.19	3.54%
	<i>Total</i>	<i>2.25</i>			<i>Total</i>	<i>5.45</i>	
Napa	Agriculture	0.10	8.92%	Sonoma (BAAQMD portion only)	Agriculture	0.30	10.76%
	Commercial + Residential	0.24	20.32%		Commercial + Residential	0.60	21.52%
	Electricity Generation	0.01	1.26%		Electricity Generation	0.00	0.10%
	Industrial	0.11	9.57%		Industrial	0.17	6.05%
	Transportation	0.63	53.59%		Transportation	1.53	55.44%
	Waste Management	0.07	6.33%		Waste Management	0.17	6.12%
	<i>Total</i>	<i>1.17</i>			<i>Total</i>	<i>2.77</i>	
<b>Grand Total</b>				<b>59.88</b>			

*Table 2* provides a detailed breakdown of the distribution of GHG emissions by county across the Bay Area region. As stated in *Chapter 2*, most of the region's refineries (Industrial sector) and power plants (Electricity Generation sector) are located in Contra Costa county. This leads to a large share of the Bay Area's regional GHG emissions being attributed to this county. In addition, this also makes Contra Costa county one of the only counties in the Bay Area region where the Transportation sector does not account for a bulk of the GHG emissions. This is also true for the southwestern portion of Solano county (in Air District's jurisdiction) which is sparsely populated (and thus has a relatively small vehicular population) and is the location of one of the region's five refineries.

*Figure 2* presents an illustration of the information presented in *Table 2.1* in the form of a stacked bar chart that shows the relative distribution of GHG emissions across the six major source sectors by major climate pollutant type. This column chart shows that CO<sub>2</sub> is the predominant GHG pollutant emitted across three major sectors - Transportation, Electricity Generation, and Industrial (>95% relative share for each sector). HFCs and PFCs are important constituents of the Commercial & Residential sector (a combined 25% of sector emissions), although CO<sub>2</sub> (~67% of the sector emissions) remains the dominant pollutant for this sector. CH<sub>4</sub> is the predominant GHG pollutant emitted across the Waste Management and Agriculture sectors.



**Figure 2.** 2022 greenhouse gas inventory for the Bay Area region by sector and climate pollutant. The total is 59.88 MMT CO<sub>2</sub>e.