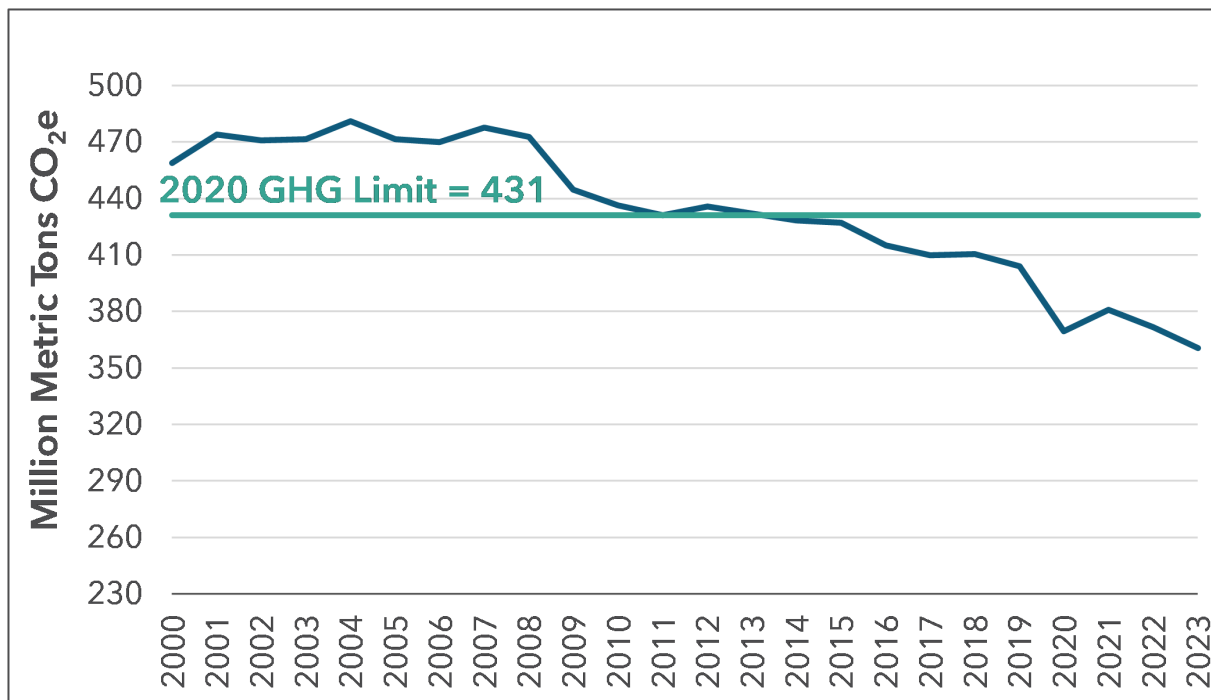


1.1 Greenhouse Gas Emissions

Global greenhouse gas (GHG) emissions are increasing, reaching a new peak in 2022. In contrast, California's GHG emissions peaked in 2004 and have since declined, while the economy has grown. Emissions have remained below California's 2020 GHG emissions reduction target since 2014. California's statutory targets require statewide GHG emissions to be reduced to at least 85% below 1990 levels and for the state to achieve economywide carbon neutrality by 2045.

Figure 1.1.1. Annual Statewide GHG Emissions.



The graph shows statewide GHG emissions in California. Emissions of GHGs other than carbon dioxide (CO₂) are converted to carbon dioxide equivalents, or CO₂e, based on their global warming potential (GWP)*. The 2020 GHG emissions limit of 431 million metric tons of CO₂e is shown as well.

*GWP represents the warming influence of different GHGs relative to CO₂ over a given time period and allows the calculation of a single consistent emission unit, CO₂e. Current international practice, as defined by the Intergovernmental Panel on Climate Change (IPCC) Guidelines, uses 100 years as the GWP timeframe for GHG Inventories. GWPs are updated periodically to reflect the latest science. This report uses GWPs from the IPCC's Fourth Assessment Report (IPCC, 2006) unless otherwise noted.

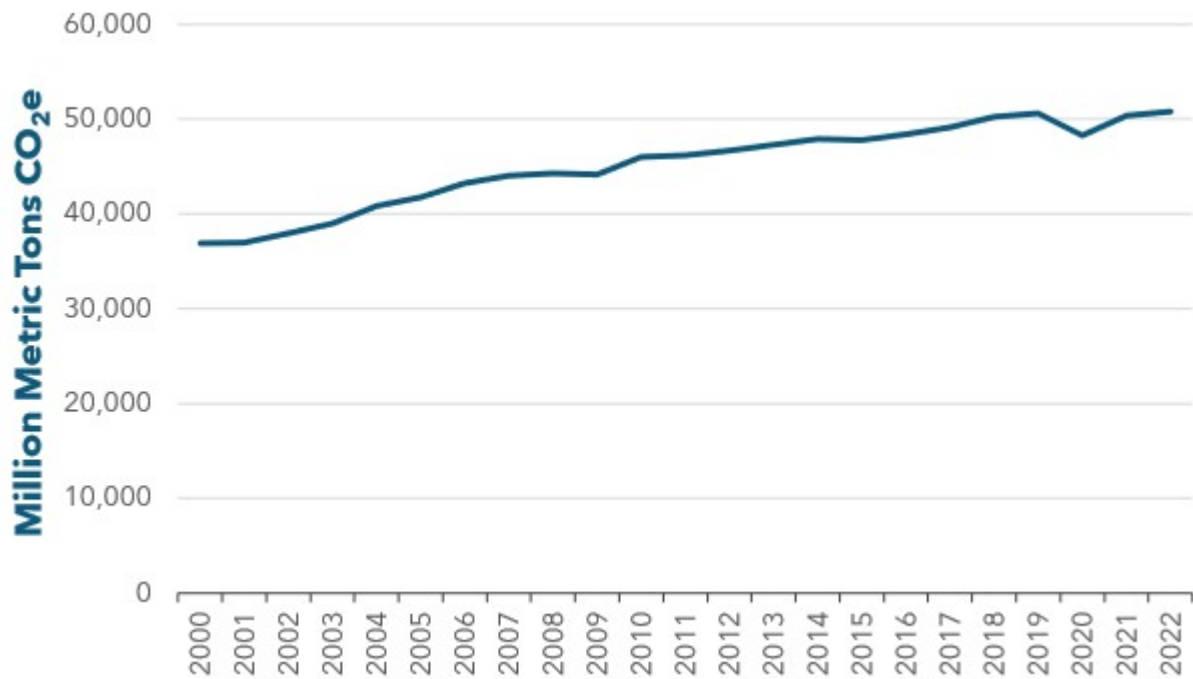
Source: California Air Resources Board (2025)



What does the indicator show?

Statewide GHG emissions in California are trending downwards ([Figure 1.1.1](#)). However, worldwide GHG emissions continue to trend upwards ([Figure 1.1.2](#); WRI, 2025).

Figure 1.1.2. Global GHG Emissions: 2000-2022.

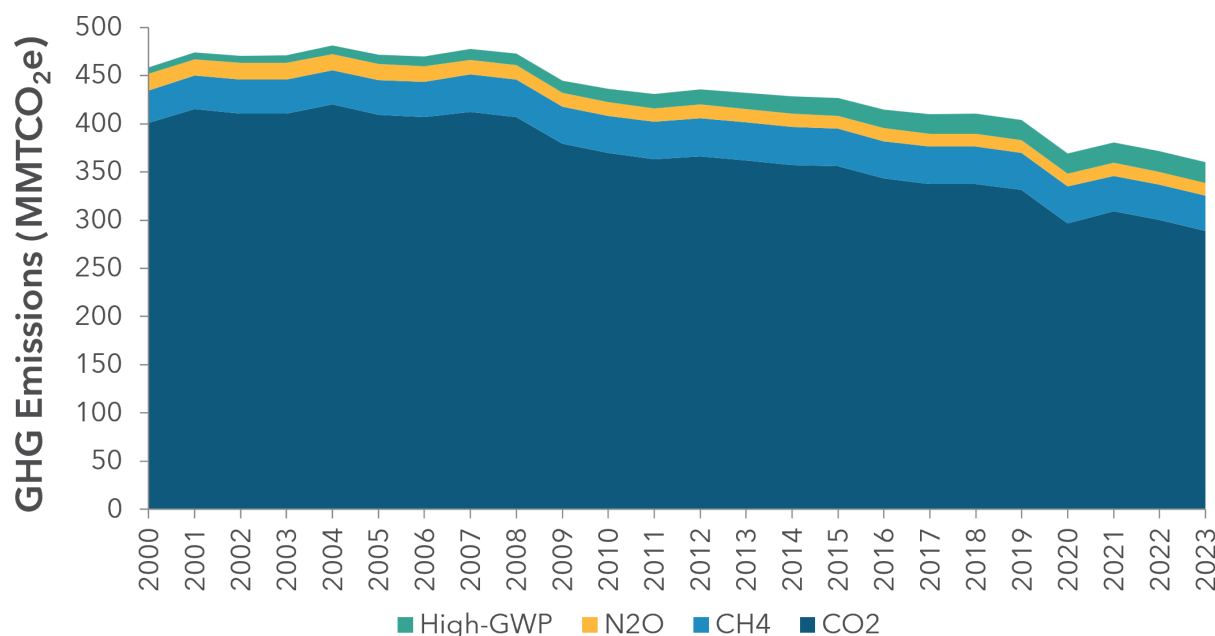


The graph shows global GHG emissions in million metric tons CO₂e based on their 100-year global warming potential (GWP) values. Source: WRI (2025)

[Figure 1.1.3](#) shows California's combined emissions of GHG carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and others with a high global warming potential (high-GWP) (CARB, 2025).



Figure 1.1.3. GHG Emissions in California, 2000-2023, Disaggregated by Pollutant.



Source: CARB (2025)

CO₂ accounted for the largest proportion of GHG emissions, making up 80% of the total in 2023. In comparison, CH₄ and N₂O accounted for 10% and 4% of total GHG emissions, respectively. The remaining 6% of GHG emissions consisted of high-GWP gases including hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF₆), and nitrogen trifluoride (NF₃).

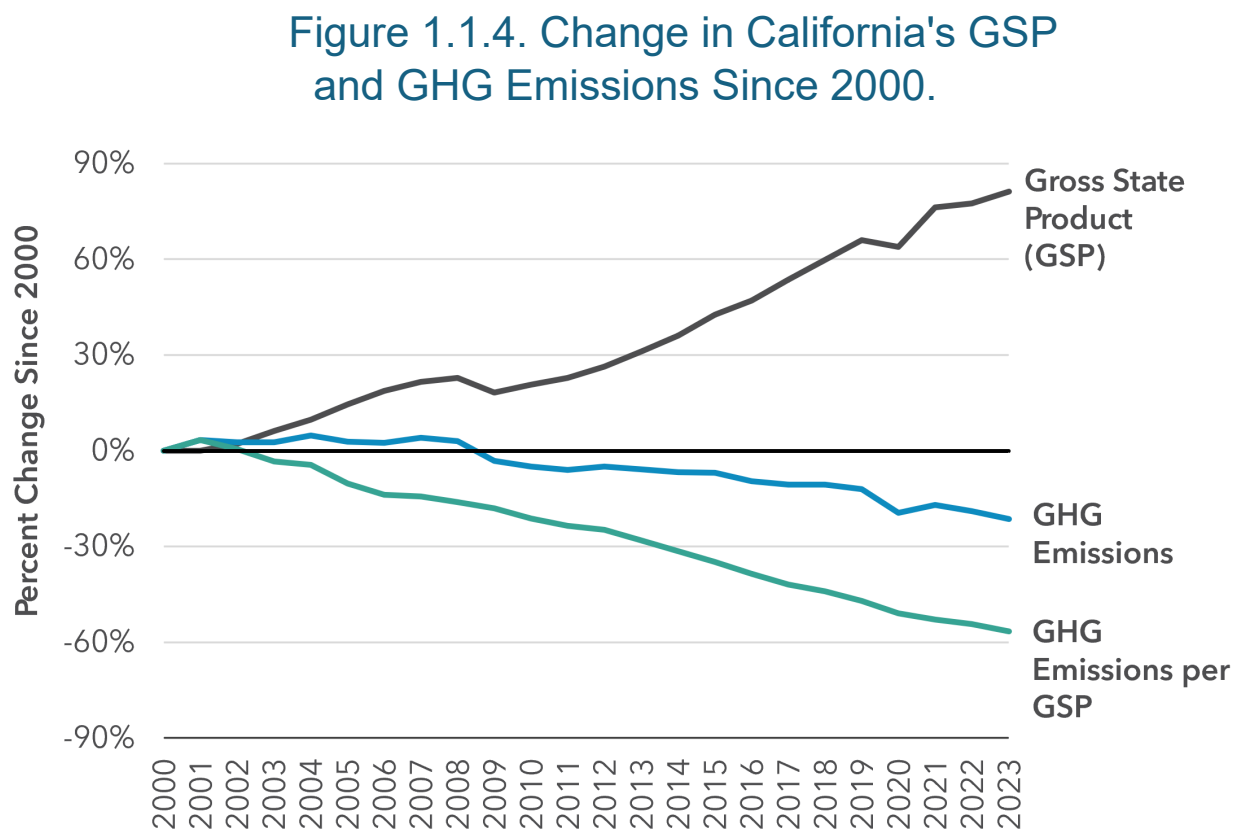
Methane and a subset of HFCs¹ are also considered [short-lived climate pollutants](#) (SLCPs), which are powerful climate forcers that remain in the atmosphere for a much shorter time period than longer-lived climate pollutants such as CO₂. Black carbon, a class of particulate matter, is also considered a SLCP. Black carbon causes warming, not because it's a GHG that traps infrared radiation, but because it absorbs sunlight and converts it to heat, directly warming the atmosphere. Unlike long-lived gases like CO₂,

¹ These include HFC-152a, HFC-32, HFC-245fa, HFC-365mfc, HFC-134a, HFC-43-10mee, HFC-125, HFC-227ea, and HFC-143a.



its warming effect is immediate, making it a key target for fast-acting climate solutions (see the *Atmospheric Black Carbon Concentrations* chapter).

Figure 1.1.4 shows that California's GHG emissions per dollar of gross state product (GSP, a measure of the state's economic output) declined between 2000 and 2023. California's 2023 GHG emissions were over 20% lower than in 2000, and emissions per dollar of GSP (carbon intensity) have declined by almost 60%. A combination of factors contributed to this decrease in carbon intensity of the California economy. These factors include growth in renewable energy sources, carbon pricing from the Cap-and-Invest and Low Carbon Fuel Standard Programs, a reduced vehicle emissions rate, incrementally higher energy efficiency standards, and other regulations, programs, and initiatives.



Sources: CARB (2025); DOF (2025)



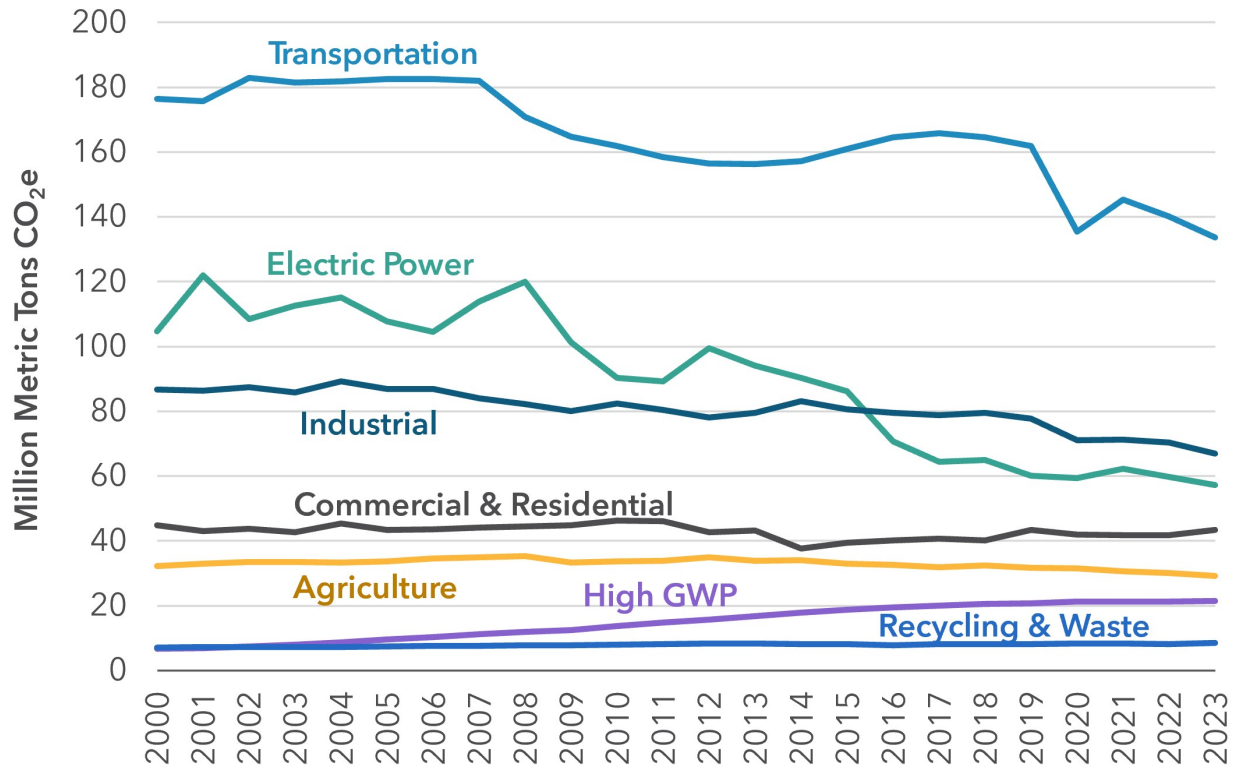
Figure 1.1.5 shows GHG emissions from 2000 to 2023, organized by sector as defined in the California Air Resources Board's (CARB) 2022 Scoping Plan for Achieving Carbon Neutrality (*2022 Scoping Plan*) (CARB, 2022). The transportation and electric power sectors are the primary drivers of year-to-year changes in statewide emissions. Some of the factors affecting emissions from these sectors are discussed below. A detailed discussion of factors affecting emissions trends in all sectors can be found in CARB's annual report titled "[California GHG Emissions: Trends of Emissions and Other Indicators](#)" (CARB, 2025).

Transportation sector emissions have generally decreased since their peak in 2002 but have experienced periods of both emissions growth and decline. Several factors can influence transportation sector emissions. These include vehicle miles traveled, vehicle GHG emissions rates, the number of zero-emission vehicles on the road, and the amount of fuel derived from non-fossil resources. Year-to-year changes in economic conditions can also impact the amount of transportation fuel used across the state.

Emissions from the electric power sector include both emissions from in-state generation and imported electricity. Electricity sector emissions are primarily driven by fossil gas combustion such that years with low hydropower availability typically lead to increased emissions, as more fossil gas is required to fulfill the remaining demand. The increased production of zero-GHG resources, such as solar and wind, in California, along with imports from other western states, has also reduced demand for fossil gas generation over time.



Figure 1.1.5. Trends in California GHG Emissions Disaggregated by Scoping Plan Sector.



Note: High-GWP gases do not represent an “economic sector,” but are grouped into a single Scoping Plan sector for purposes of organizing and tracking emissions, sources, and emissions reduction strategies.

Source: CARB (2025)

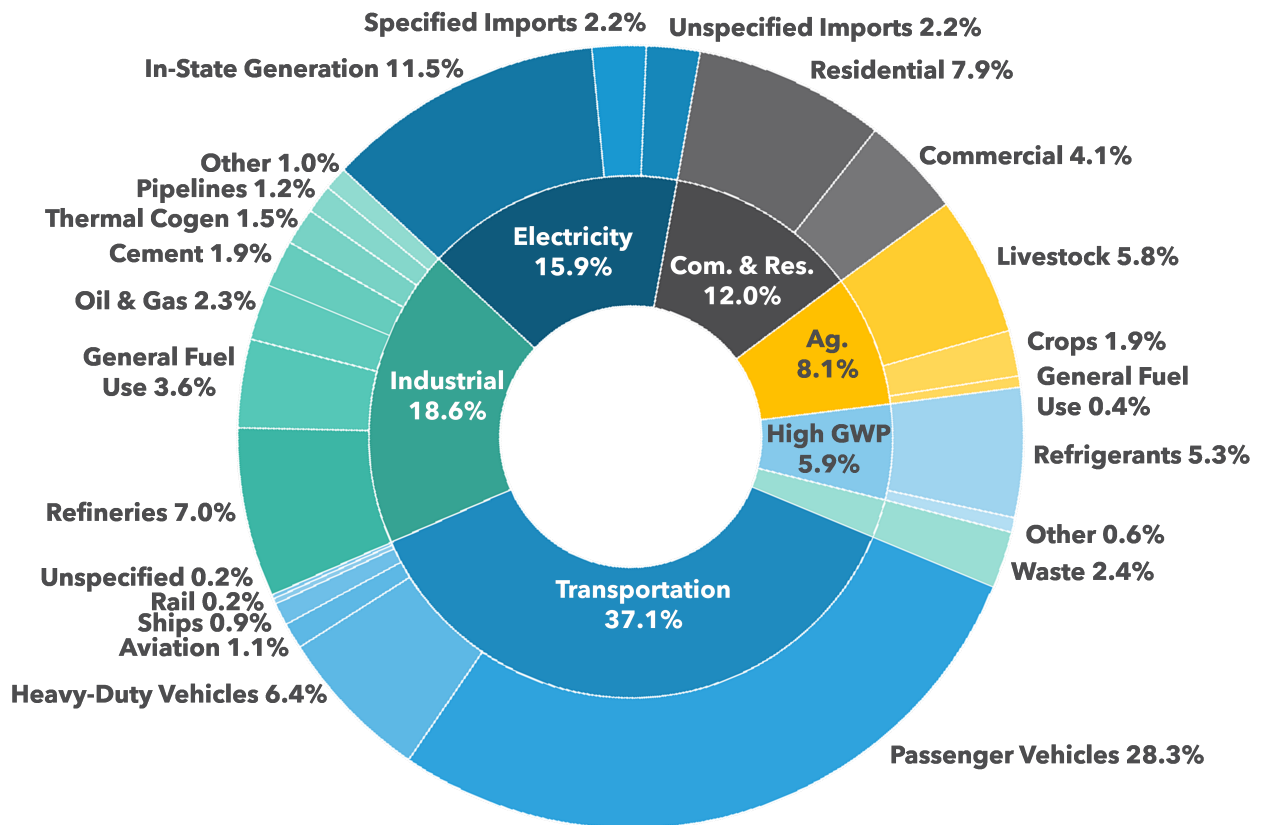
Figure 1.1.6 shows 2023 GHG emissions by *Scoping Plan* sector and sub-sector.

Transportation was the largest emitting sector, accounting for 37.1% of the total emissions. Cars, light duty trucks, and sport utility vehicles are the highest contributor to transportation emissions. Industrial activities accounted for 18.6% of emissions and include fossil fuel combustion and fugitive emissions from a wide variety of sources such as petroleum and alternative fuels refineries, oil and gas production and processing, and cement plants. The electricity sector (in-state generation and electricity imports) accounted for 15.9% of emissions. Commercial and residential sources collectively accounted for 12.0% of emissions. Emissions from the agricultural sector,



which are mainly from livestock, contributed 8.1%. High-GWP gases, which are primarily used in refrigeration and air conditioning, comprised 5.9% of emissions. Finally, recycling and waste contributed 2.4% with most of this sector's emissions coming from landfills.

**Figure 1.1.6. 2023 GHG Emissions
by Scoping Plan Sector and Sub-Sector.**



Source: CARB (2025)

Together, these trends indicate that while global GHG emissions continue to rise, California has made measurable progress toward its statutory climate targets. This progress is guided by the *2022 Scoping Plan*, which lays out a path to achieve targets



for carbon neutrality and reduce statewide anthropogenic GHG emissions by 85% below 1990 levels no later than 2045, as directed by Assembly Bill 1279.

Why is this indicator important?

Atmospheric concentrations of GHGs have increased since the Industrial Revolution, enhancing the heat-trapping capacity of the Earth's atmosphere. Global temperatures are directly linked to GHG levels in the atmosphere. Atmospheric GHG concentrations are determined by the balance between GHG emissions and removals on a global scale. The most recent data from the National Oceanic and Atmospheric Administration indicate that global CO₂ concentrations are over 50% higher than pre-industrial levels, with June 2025 measurements reaching approximately 426 parts per million (ppm), compared to the pre-industrial average of around 280 ppm. Accurately tracking GHG emissions trends, both globally and in California, provides critical information to policymakers as they assess climate change mitigation options and track the progress of GHG emissions reduction programs.

GHG emissions reduction targets are intended to prevent atmospheric concentrations from reaching levels at which catastrophic and irreversible impacts occur. Fossil fuels are the largest contributor to global climate change, accounting for around 68% of global GHG emissions and nearly 90% of CO₂ emissions (UN, 2025). The 2015 Paris Agreement aims to limit warming to below 3.6°F (2°C) above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 2.7°F (1.5°C) (UNFCCC, 2016). These efforts would significantly reduce the risks and impacts of climate change (Xu and Ramanathan, 2017). However, if global emissions continue to increase at the current rate, global warming is likely to reach 2.7°F (1.5°C) by the 2030s, and no later than 2040 (IPCC, 2023).

While California is responsible for a relatively small percentage of global GHG emissions, the state must do its part to reduce them. California plays an important role in exporting both political will and technical solutions to address the climate crisis globally and many of our environmental policies have served as models for other localities. California's pioneering efforts in the adoption and implementation of policies are reducing our GHG emissions.



In 2023, nearly three-quarters of California's GHG emissions came from the combustion of fossil fuels. Globally, the combustion of these fuels is a primary contributor to climate change. The combustion of fossil fuels emits not only GHGs, but also harmful localized air pollutants such as particulate matter (PM) 2.5, volatile organic compounds including air toxics, and nitrogen oxides, which pose known risks to public health and can combine in the atmosphere to form other pollutants. Health hazards from air pollution include increased risk of asthma and other respiratory illnesses, hospitalizations and emergency department visits, cardiovascular disease, and premature death. Low-income communities and communities of color are often located adjacent to major roadways and large stationary sources of emissions; thus, these communities are disproportionately exposed to the effects of these localized pollutants. Overburdened communities may also be exposed to multiple pollution sources and factors such as less access to health care. Therefore, eliminating our dependence on fossil fuels through actions like moving to zero-emission cars and trucks and decarbonizing local industries and the electricity sector will advance our climate goals and deliver health benefits to the most impacted communities. The *2022 Scoping Plan* lays out a sector-by-sector roadmap for California to achieve carbon neutrality by 2045 or earlier. CARB conducted a health analysis of the proposed actions in the *2022 Scoping Plan* roadmap to estimate statewide health benefits by 2045 of implementing those actions. CARB estimated \$200 billion in health benefits by 2045 including avoided early deaths, illnesses, hospitalizations, and other positive health outcomes. In addition, CARB also developed a Public Health Appendix (Appendix G) in the *2022 Scoping Plan* to evaluate co-benefits of proposed climate actions and discuss ways to reduce vulnerability in communities. The co-benefits evaluated included reduced traffic pollution, increased access to urban green spaces, reduced exposure to wildfire smoke, increased mobility and physical activity through active transportation, and reduced heat related illnesses. CARB found that climate actions and related co-benefits could provide large public health benefits and increase community resilience to climate effects.

Because the impacts of climate change will be highly unequal across California's communities, the *2022 Scoping Plan* also introduced a Climate Vulnerability Metric (CVM). CVM aggregates the impacts of climate change across nine components (e.g.,



human mortality, flood-related property damage). The impacts can be quantified at the census tract level to show how human welfare in communities will be affected by a warming climate. The impacts on human welfare through 2050 are shown as a percentage of census tract-specific incomes. The CVM metric can be used by policymakers to identify vulnerable communities and direct funding.

What factors influence this indicator?

Statewide GHG emissions reflect activities across all major economic sectors, which are influenced by a variety of factors, including population growth, vehicle miles traveled, economic conditions, consumer behavior, technological changes, drought and heat events, regulations, and other factors.

GHGs are emitted from a variety of sources, but most notably from the combustion of fossil fuels used in the electric power, industrial, commercial, residential, and transportation sectors. GHG emissions also occur from the use of high-GWP gases and non-combustion activities in the recycling and waste and agriculture sectors. A detailed discussion of emissions trends by *Scoping Plan* sector is provided on CARB's [GHG Emission Inventory Data webpage](#) (CARB, 2025).

Technical considerations

Data characteristics

A GHG inventory is an estimate of GHG emissions over a specified area and time period from known sources or categories of sources. Emission inventories generally use a combination of two basic approaches to estimate emissions. The “top-down” approach utilizes nationwide or statewide data from various federal and state government agencies to estimate emissions. The “bottom-up” approach utilizes facility-level activity data to compute facility-level emissions that are then aggregated to the state level for a particular source category. In either approach, calculation assumptions are made to estimate statewide GHG emissions from different levels of activity data. California’s GHG Inventory uses California-specific data and methods to the extent possible. When not possible, the methods used typically reference either the 2006 IPCC Guidelines for



National GHG Inventories (IPCC, 2006) or the U.S. Environmental Protection Agency's Inventory of U.S. GHG Emissions and Sinks (US EPA, 2024).

Atmospheric measurements and modeling can also be used to estimate total emissions across a broad area. This approach can serve as an independent check on inventory estimates, helping to identify opportunities for improvement.

Strengths and limitations of the data

The methods used to develop the California GHG Inventory are consistent with international and national inventory guidelines to the greatest extent possible. Emission calculation methods are continually evaluated and refined over time, incorporating the latest scientific research and monitoring activities. Much of the data used for the California GHG Inventory – including statewide fuel consumption totals for major fuels and facility-level data for the largest emitting industrial sectors – is reported and verified pursuant to the Regulation for the Mandatory Reporting of GHG Emissions (CARB, 2019).

The California GHG Inventory includes emissions from anthropogenic sources located within California's boundaries. Pursuant to the California Global Warming Solutions Act of 2006 (Nuñez, Chapter 488, Statutes of 2006), also known as Assembly Bill 32, California's GHG Inventory also includes emissions from the generation of imported electricity. In accordance with international practice, California's GHG Inventory excludes emissions that occur outside the state during the manufacture and transportation of products and services consumed within the state (except for electricity). While those emissions are not included, it should be noted that California is a net exporter of multiple products, especially agricultural commodities, and California's GHG Inventory includes the in-state GHG emissions associated with these products. In addition, California's GHG Inventory does not reflect reductions outside California's boundaries achieved as part of international and sub-national collaboration efforts, or as a natural result of implementation of state programs.



OEHHA acknowledges the expert contribution of the following to this report:



Industrial Strategies Division
California Air Resources Board
ghginventory@arb.ca.gov

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