California's 2000-2023 AB 32 Greenhouse Gas Emissions Inventory (2025 Edition)

Inventory Updates for the 2025 Edition

Supplement to the Technical Support Document

CALIFORNIA AIR RESOURCES BOARD

Industrial Strategies Division

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A. Introduction

Assembly Bill (AB) 1803 gave the California Air Resources Board (CARB) the responsibility to prepare and update California's Assembly Bill 32 Greenhouse Gas (GHG) Emissions Inventory (Inventory) to track the State's progress in reducing GHG emissions. The Inventory is one piece, in addition to data from various California Global Warming Solutions Act (AB 32) programs, in demonstrating the State's progress in achieving the statewide GHG targets established by AB 32 (reduce emissions to the 1990 levels by 2020), Senate Bill 32 (reduce emissions to at least 40% below the 1990 levels by 2030), and AB 1279 (achieve net zero GHG emissions as soon as possible, but no later than 2045). The 2025 edition of the Inventory covers emissions for 2000 through 2023 and includes inventory improvements and accounting method updates.

The Inventory was developed according to the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories ("IPCC Guidelines") [IPCC 2006], which is the internationally recognized standard for developing national GHG inventories. For the 2025 edition of the Inventory (2000-2023 emissions), staff have made improvements to emissions estimation methods and incorporated new data sources. This document describes those improvements.

The IPCC Guidelines state it is good practice to recalculate historic emissions when methods are changed or refined, when new source categories are included, or when errors in the estimates are identified and corrected. Consistent with the IPCC Guidelines, recalculations are made to incorporate new methods or the reflect changes in data for all years from 2000 to 2023, to maintain a consistent time-series of estimates within the Inventory.[1] Therefore, emissions estimates for a given calendar year may be different between editions.

In the sections to follow, background information and a method update description are presented for each emissions source category whose methodology was revised, or whose underlying data changed significantly, for the 2025 edition of the Inventory. Inventory methods described in this document refer to those used for the 2025 edition, or changes between the 2024 and 2025 editions, unless explicitly noted otherwise. The sections of this document are presented in numerical order of inventory category codes as defined by the IPCC. The inventory category code associated with the hierarchical structure of IPCC inventory categorization is shown in the sub-heading title of each section.

[1] In addition, when other government agencies and programs update their data for historical years (e.g., 2000-2022 activity data in the 2025 edition of the Inventory, where 2023 is the most current year), their updated historical data are incorporated into the latest edition of the Inventory. This type of update is routine and not a change in methodology, data source, or assumption. Such updates are not explicitly enumerated in this document.

B. Description of Inventory Updates

B.1 Fossil Gas Combustion Data Sources and Allocation Methods

IPCC Categories: 1A1cii, 1A2, 1A2c, 1A2d, 1A2e, 1A2f, 1A2g, 1A2h, 1A2i, 1A2j, 1A2k, 1A2l, 1A2m, 1A3b, 1A4a, 1A4b, 1A4c

B.1.a Background

Fossil gas (also known as natural gas) is combusted across all sectors of the Inventory and accounts for nearly 30% of California's GHG emissions.

For 2000-2011, fossil gas consumption data is compiled for each sector from the best available data source, and the Inventory fossil gas total simply reflects the sum of each sector.

For 2012 and later years, the Inventory fossil gas consumption total is set according to fossil gas data reported by fuel suppliers under Section 95122 of the Regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR) [CARB MRR 2019]. The MRR fossil gas supplier data captures the total heat content of fossil gas supplied to California customers by local distribution companies (LDC), intrastate pipeline operators, interstate pipeline operators, and liquefied natural gas (LNG) suppliers (as defined in the MRR regulation). Total fossil gas heat content reported by fossil gas suppliers under Section 95122 of MRR represents an aggregated statewide sum and does not provide the amount of fuel used by each end use sector. Therefore, aligning the GHG Inventory to match the MRR total fossil gas quantity requires reconciling the fossil gas consumption total with the sum of sector-specific data from various data sources.

For 2012 and later years, the process for estimating sector-level fossil gas heat content is as follows:

1. Obtain total fossil gas heat content reported by fuel suppliers under Section 95122 of MRR.
2. Obtain sector-specific fossil gas heat content data from MRR, the California Energy Commission (CEC), and the U.S. Energy Information Administration (EIA) (see Table 1 for data source by sector).
3. Perform scaling adjustment calculation for scaled sectors (see Table 1 for identification of scaled and non-scaled sectors).

$$\textbf{Scaling Factor} = (H_{Total} - \sum H_{non\text{-}scaled\ sector}) / \sum H_{scaled\text{-}sector,\ initial}$$

And,

$$H_{scaled\text{-}sector,\ final} = \textbf{Scaling Factor} * H_{scaled\text{-}sector,\ initial}$$

Where,

Scaling Factor = the factor applied to scaled sectors such that the sum of sector-specific fossil gas heat content sums to the total fossil gas heat content reported by fossil gas suppliers under Section 95122 of MRR.

H_{Total} = total fossil gas heat content reported by fossil gas suppliers under Section 95122 of MRR.

$H_{non\text{-}scaled\ sector}$ = fossil gas heat content for a given non-scaled sector.

$H_{scaled\text{-}sector,\ initial}$ = initial fossil gas heat content for a given scaled sector.

$H_{scaled\text{-}sector,\ final}$ = final fossil gas heat content for a given scaled sector.

Table 1 lists the fossil gas combustion categories that are within the scope of MRR Section 95122 reporting and whether each category is subject to the scaling adjustment. This table was originally published in the 2022 Edition Inventory Updates Document [CARB 2022a]. It has been updated to reflect the method updates described in section B.1.b, and the changes are indicated with table notes.

Table 1. Fossil Gas Combustion Categories Within Scoping of MRR Section 95122 Reporting and Whether They Are Subject to Scaling

Sector-Specific Inventory Category	Sector Level Fuel Data Source	Subject to Scaling?
On Road Transportation	EIA [EIA 2025a]	Yes
Electricity Generation (In-State)	MRR Sections 95112 and 95115 [CARB MRR 2025] and Form EIA-923 [EIA 2025b]	No
Cement Manufacturing	MRR Section 95115 [CARB MRR 2025]	No
Liquid Fuels Refining and Hydrogen Production	MRR Sections 95113 and 95115 [CARB MRR 2025]	No
Oil and Gas: Production and Processing[1]	MRR Section 95115 and Subarticle 5 [CARB MRR 2025]	No
Cogeneration Thermal Energy Allocated to Industrial Use	MRR Sections 95112 and 95115 [CARB MRR 2025] and Form EIA-923 [EIA 2025b]	No

Sector-Specific Inventory Category	Sector Level Fuel Data Source	Subject to Scaling?
Cogeneration Thermal Energy Allocated to Commercial Use	MRR Sections 95112 and 95115 [CARB MRR 2025] and Form EIA-923 [EIA 2025b]	No
Natural Gas Pipeline Compressor Stations	EIA [EIA 2025a]	Yes
Other Industrial Categories Not Yet Mentioned Above	CEC [CEC QFER 2025][3]	Yes
Commercial (Except Cogeneration Thermal Energy)	CEC [CEC QFER 2025]	Yes
Residential	CEC [CEC QFER 2025]	No[2]
Agriculture Sector Natural Gas Combustion	CEC [CEC QFER 2025][3]	Yes

1. The data source for oil and gas sector fossil gas combustion is now MRR facility-level data (see section B.1.b.iii). Data sourced from MRR is not scaled, whereas data sourced from CEC and EIA is scaled, so this update also changed the oil and gas sector from a scaled to a non-scaled sector (see section B.1.b.iv).
2. The residential sector changed from a scaled to a non-scaled sector (see section B.1.b.iv).
3. The data source for interstate pipeline deliveries of fossil gas directly to end users changed from EIA [EIA 2024] to CEC [CEC QFER 2025] (see section B.1.b.i).

Section B.1.b discusses changes to data sources and methods that affect the allocation of fossil gas among sectors. Section B.1.c discusses the emissions impacts of these updates.

B.1.b Data and Method

Method updates were implemented primarily for 2012 and later years to improve the allocation of total fossil gas among sectors, as described in the following five subsections. For select sectors, 2000-2011 data were also adjusted.

B.1.b.i Data Source for Interstate Pipeline Deliveries to End Users

Some fossil gas is delivered directly to end users via interstate pipelines, rather than via LDC. These deliveries are mostly made to oil and gas sector facilities, and to a lesser extent to mining facilities and agriculture operations.

Prior to the 2025 edition Inventory, the data source for sector-specific fossil gas delivered via interstate pipelines was [EIA 2024]. For the 2025 edition Inventory, the data source was changed to CEC [CEC QFER 2025]. CEC has sector-specific interstate pipeline delivery data for 2008 and later years. The Inventory uses the data for 2012 and later years directly. The data for 2008-2011 is used in backcasting calculations applied to 2000-2011 data for the oil and gas sector, as described in section B.1.b.iii.

B.1.b.ii Method for Reconciling Gas Combusted by Electricity Generation and Cogeneration Units

CEC data for sector-specific fossil gas heat content includes fossil gas combusted by electricity generation and cogeneration units; however, the Inventory categorizes emissions from these units as electricity generation and cogeneration sector emissions and sources this data from MRR. Therefore, the heat content data associated with combustion by electricity generation and cogeneration units must be identified and excluded from the CEC data to avoid double-counting with MRR data compiled for these sectors. This potential overlap most commonly exists when there are cogeneration units at liquid fuels refineries, oil and gas production facilities, hospitals, and universities.

The fossil gas data provided by CEC is an aggregation of gas deliveries data provided to CEC by each LDC. A "rate code" field in the CEC data was used in the 2024 edition Inventory to identify gas that was assumed to be combusted by electricity generation and cogeneration units so it could be excluded from the industrial and commercial sectors.

The "rate code" field is not used for 2012 and later years within the 2025 edition Inventory. All gas deliveries recorded in the CEC data are compiled to obtain sector-specific totals inclusive of electricity generation and cogeneration gas. Separately, the MRR facility-level data used to compile fossil gas combustion data for the electricity generation and cogeneration sectors is mapped to industrial and commercial sectors using North American Industrial Classification System (NAICS) codes reported pursuant to MRR. For each sector, the fossil gas heat content is then calculated as the CEC sector-specific total (inclusive of gas to electricity generation and cogeneration units) minus the MRR electricity generation and cogeneration heat content mapped to that sector. The resulting heat content becomes the $H_{\text{scaled sector, initial}}$ value used in the scaling calculation described in section B.1.a.

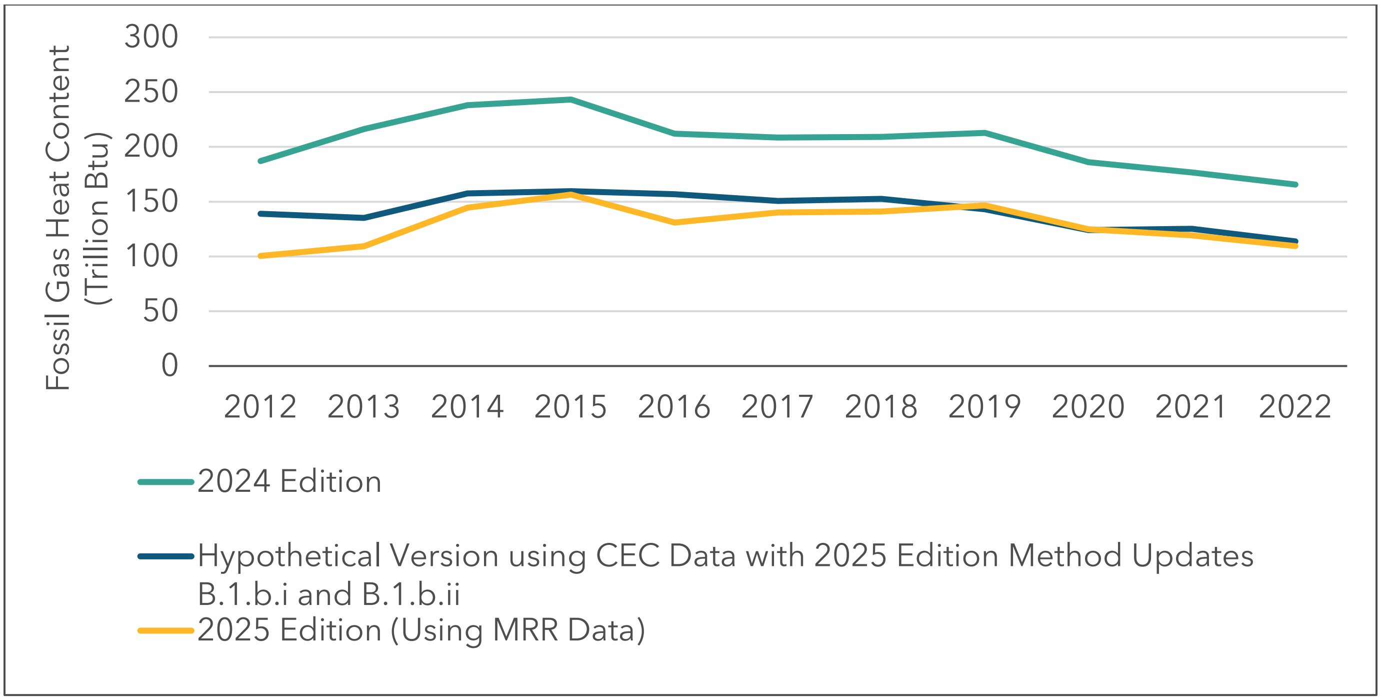
This method update resulted in a reallocation of fossil gas throughout the Inventory for 2012 and later years.

B.1.b.iii Data Source for Oil and Gas Sector Fossil Gas Combustion

The data source for oil and gas sector fossil gas heat content changed from CEC [CEC QFER 2025] (for deliveries via LDC) and EIA [EIA 2024] (for deliveries via interstate pipelines) to facility-level data reported pursuant to MRR Section 95115 and Subarticle 5 [CARB MRR 2025] for 2012 and later years in the 2025 edition Inventory. This method update resulted in a decrease in fossil gas heat content allocated to the oil and gas sector, as shown in Figure 1. Section B.2 discusses the change to MRR data for all other fuels combusted in the oil and gas sector.

Figure 1 also demonstrates that oil and gas sector fossil gas use would have decreased significantly due to the method updates described in sections B.1.b.i and B.1.b.ii, even without the data source change described above (i.e., MRR data used in lieu of CEC and EIA data). There is close agreement between the MRR data (yellow line in Figure 1) and the CEC LDC data plus CEC interstate pipeline data combined with the updated cogen reconciliation method (blue line in Figure 1). This agreement validates the significant reduction in oil and gas sector fossil gas heat content caused by using MRR data. Too much fossil gas was allocated to the oil and gas sector when using the prior data sources and methods (turquoise line in Figure 1). The overestimation was caused by the EIA interstate pipeline data overestimating gas deliveries to the sector and by not excluding any of the EIA interstate pipeline gas that was being delivered to cogeneration units.

Figure 1. Oil and Gas Sector Fossil Gas Heat Content Before and After 2025 Edition Method Update for 2012 and Later Years

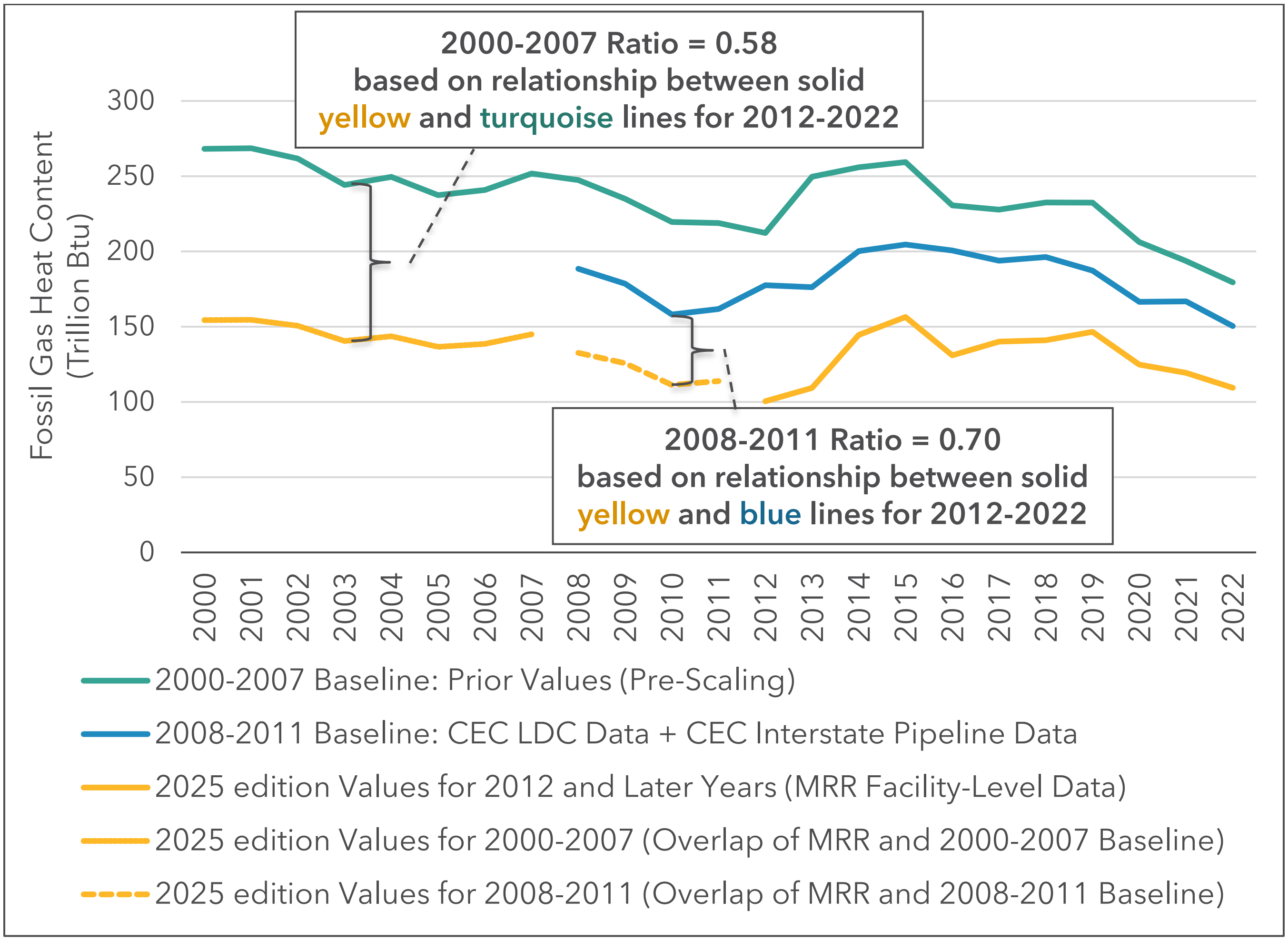


The 2000-2011 data were revised to reflect the changes seen in the data for 2012 and later years to maintain a consistent time series for oil and gas sector fossil gas combustion. This revision was necessary because the data sources used for the updates to 2012 and later years do not extend back to 2000. Verified MRR facility-level data goes back to 2012, and the CEC interstate pipeline data goes back to 2008. Therefore, the IPCC's Overlap Technique [IPCC 2006] was employed using the prior method and data sources for oil and gas sector fossil gas (CEC LDC data and EIA interstate pipeline data) and the updated data sources (MRR facility-level data and CEC interstate pipeline data).

As illustrated in Figure 2, the Overlap Technique was completed separately for 2008-2011 and for 2000-2007 based on data availability. In the figure,

- The turquoise line shows the 2024 edition Inventory fossil gas heat content before the scaling adjustment. This line is the Overlap Technique baseline for the 2000-2007 data adjustment.
- The light blue line shows the fossil gas heat content as provided by CEC LDC data and CEC interstate pipeline data (see section B.1.b.i) before deducting fossil gas used by electricity generation and cogeneration units (see section B.1.b.ii). This line is the Overlap Technique baseline for the 2008-2011 data adjustment.
- The yellow lines show the 2025 edition Inventory oil and gas sector fossil gas heat content for 2000-2023 in three segments:
    - 2012 and later years reflect MRR facility-level data (solid yellow line).
    - The 2008-2011 values (dashed yellow line) are calculated by multiplying the ratio of MRR data (solid yellow line) to CEC data (light blue line) for 2012 and later years (ratio = 0.70) by the CEC values for 2008-2011. This approach effectively removes cogeneration unit double-counting from the CEC data for 2008-2011.
    - The 2000-2007 values (dotted yellow line) are calculated by multiplying the ratio of MRR data (solid yellow line) to the 2024 edition Inventory data (turquoise line) for 2012 and later years (ratio = 0.58) by the 2024 edition values for 2000-2007. This approach effectively removes the overestimation caused by both the inflated interstate pipeline deliveries seen in the EIA interstate pipeline data and the cogeneration unit double-counting.

Figure 2. Overlap Technique for Backcasting Oil and Gas Sector Fossil Gas for 2000-2011



B.1.b.iv Remove Scaling Adjustment to Residential and Oil and Gas Sectors

The scaling adjustment for 2012 and later years described in section B.1.a is no longer applied to the residential sector nor to the oil and gas sector. The residential sector changed from a scaled to a non-scaled sector because there is close agreement amongst multiple data sources (MRR, EIA, and CEC) on residential fossil gas heat content.

The oil and gas sector changed from a scaled to a non-scaled sector because scaling is not done for sector-specific data sourced from MRR. The data source for the oil and gas sector changed to MRR (as described in section B.1.b.iii), so the sector no longer receives the scaling adjustment.

B.1.b.v Method for Reconciling Chemical Sector and Liquid Fuels Refining and Hydrogen Production Sector Fossil Gas Data from CEC and MRR

As shown above in Table 1, fossil gas data for the liquid fuels refining and hydrogen production sector ("refining") is sourced from MRR for 2009 and later. However, the CEC

LDC data also includes fossil gas data for refining, as well as data for the closely related chemicals and allied products sector ("chemicals"). This section describes how CEC and MRR fossil gas data are reconciled for the refining, chemicals, and industrial manufacturing not specified sectors.

For the 2025 edition Inventory, fossil gas use for these sectors is calculated as follows.

- Refining fossil gas use was set by the MRR facility-level data (no change from prior editions).
- Chemicals sector pre-scaled fossil gas use was defined as gas used per the CEC data by NAICS codes that begin with 324 or 325 except the refining NAICS codes, which are 324110 (refining), 324199 (coke calcining), and 325120 (hydrogen production). Then, the scaling adjustment described in section B.1.a was applied to the pre-scaled fossil gas use. This method is a change from the 2024 edition Inventory.
- Total fossil gas used by the industrial manufacturing not specified sector was calculated from CEC data and used without further adjustments (other than the scaling adjustment described in section B.1.a), which is a change from the 2024 edition Inventory method but is the same method used prior to the 2022 edition Inventory.

This method yields an improved, steady estimate of chemicals sector activity in California.

Figure 3 illustrates this method update using fossil gas heat content data from 2015 as an example.[2] In the figure, the first column shows CEC fossil gas heat content for the three sectors involved in the refining and chemicals reconciliation: refining, chemicals, and industrial manufacturing not specified. The second column shows the MRR fossil gas heat content for the refining sector. The last two columns show the fossil gas heat content assigned to each sector in the 2024 edition Inventory (third column) and in the 2025 edition Inventory (fourth column). The cross-hatched area in the third column represents the remainder of the CEC data for the refining plus chemicals sectors minus MRR data for the refining sector. This remainder was published as the chemicals sector prior to the 2022 edition Inventory. It was instead added to the industrial manufacturing not specified sector for the 2022-2024 editions of the Inventory. The fourth column in Figure 3 shows that the Inventory chemicals sector is now set using the CEC data, and the remainder between CEC and MRR data is no longer used to estimate chemicals sector fossil gas use.

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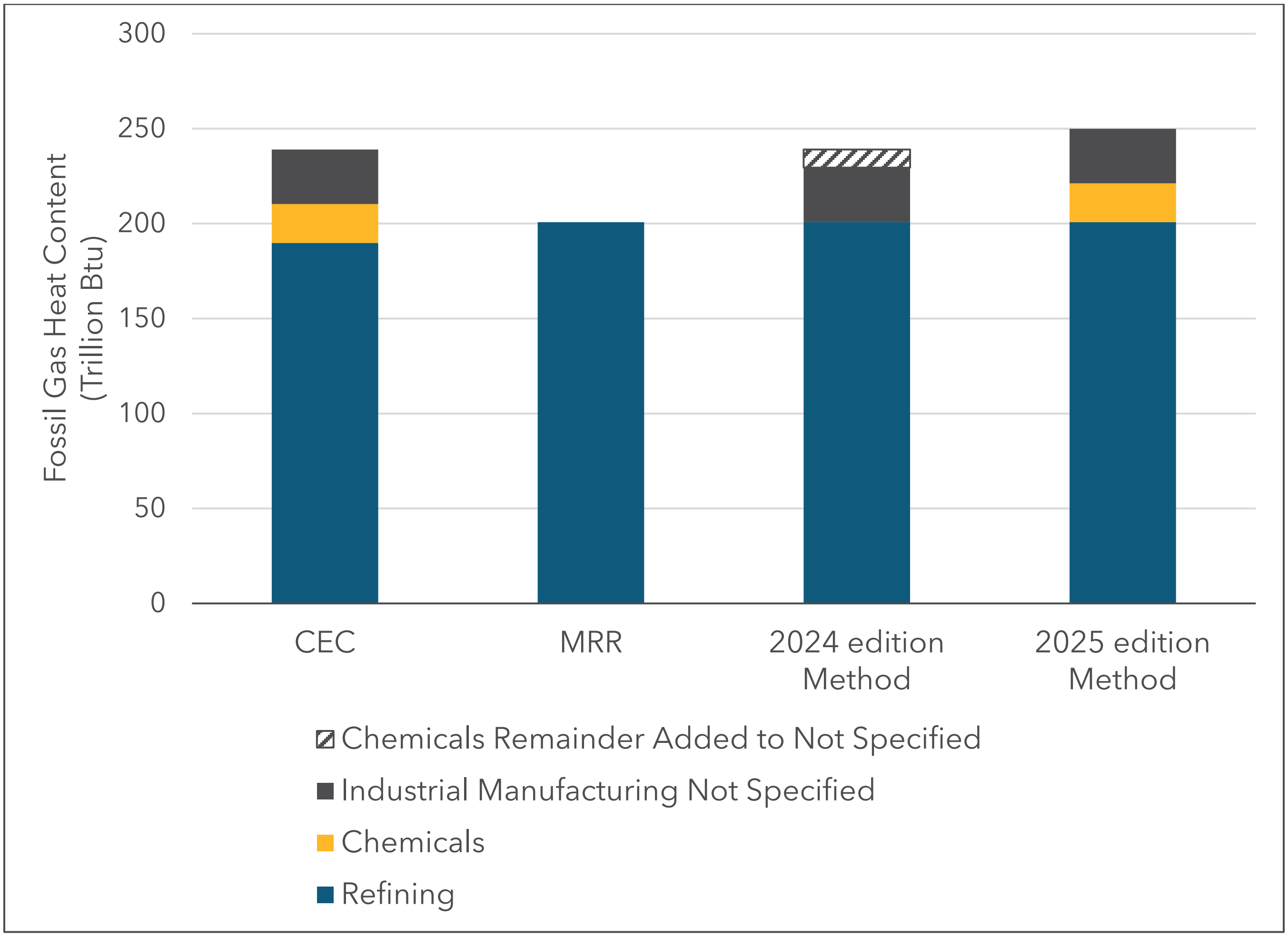
[2] This method update applies to 2012 and later years. Figure 3 uses data from 2015 because the data provided a more useful illustration than data from more recent years. The data reflects the heat contents prior to the scaling adjustment described in section B.1.a.

Figure 3. Refining, Chemicals, and Industrial Manufacturing Not Specified Fossil Gas Heat Content Before and After Method Update: Method Illustration using 2015 Data



This method update applies primarily to 2012 and later years because this is the timeframe during which MRR facility-level data is available and can be reconciled with CEC data. The 2000-2011 data were revised to reflect the changes seen in the data for 2012 and later years to maintain a consistent time series for chemicals sector fossil gas combustion. The relationship between the chemicals and refining sectors in the CEC data for 2008 and later years was used to estimate chemicals sector fossil gas heat content for 2000-2007. The CEC chemicals sector data was used as-is for 2008-2023 because the data granularity was sufficient.

B.1.c Emissions Impacts

The five fossil gas method updates described in section B.1.b resulted in a reallocation of total fossil gas heat content and emissions across Inventory sectors. For 2012 and later years, the impact on total emissions was negligible because the Inventory total fossil gas heat content is set by fossil gas fuel supplier data reported pursuant to Section 95122 of MRR. For 2000-2011, when the Inventory total fossil gas content was the sum of sector-specific data and not tied to MRR, these method updates had a significant impact on total Inventory emissions. Figure 4 shows total Inventory fossil gas combustion emissions in the 2025 edition Inventory compared to the 2024 edition.

Figure 4. Inventory Total Fossil Gas Combustion Emissions Before and After Method Updates B.1, B.2, and B.14

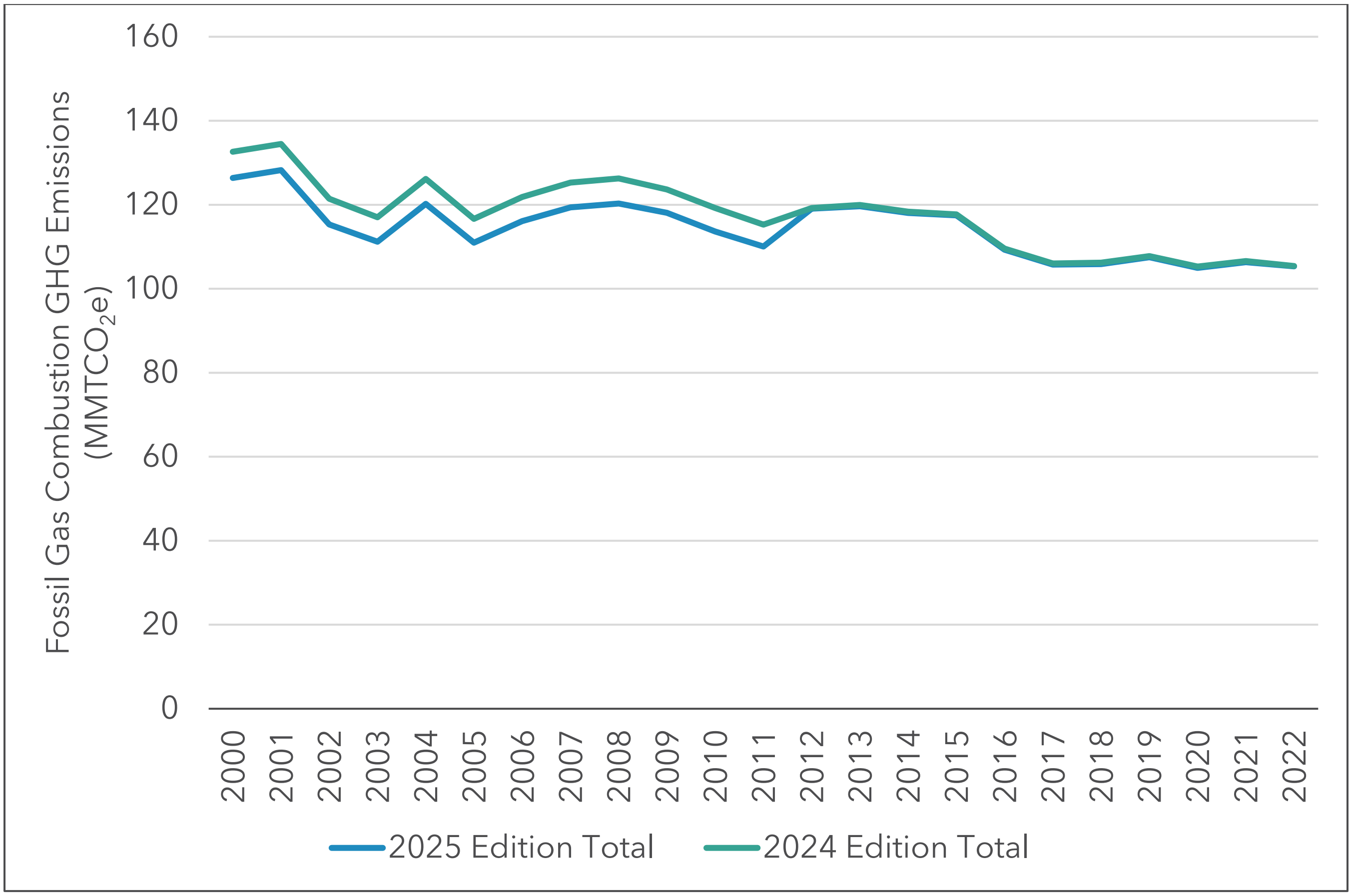
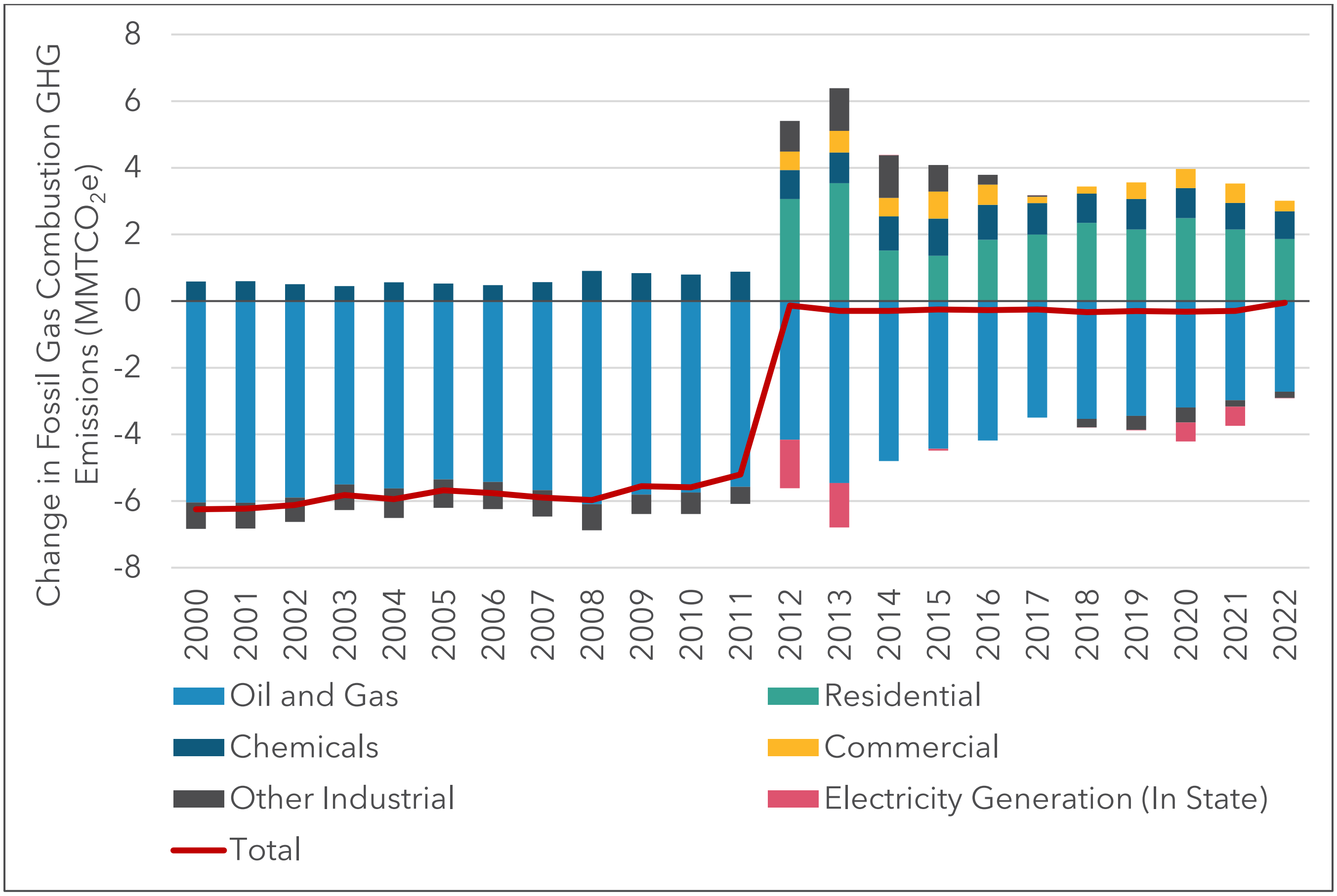


Figure 5 shows the change in emissions by sector due to all 2025 edition method updates. The agriculture and transportation sectors had negligible changes and are not shown in the figure.

Note that there are some impacts to fossil gas combustion emissions from the method updates described in sections B.2 and B.14. The impacts of these method updates are also reflected in Figure 4 and Figure 5.

Figure 5. Change in Fossil Gas Combustion Emissions by Sector Due to Method Updates B.1, B.2, and B.14



B.2 Oil and Gas: Incorporate Data from the Mandatory GHG Reporting Program for Fuel Combustion and Flaring

IPCC Categories: 1A1cii, 1B2aii

B.2.a Background

The oil and gas: production and processing ("oil and gas") sector consists of emissions from fuel combustion, flaring, and fugitive emissions from upstream oil and gas producers in California. The distribution of GHG emissions in this sector can be summarized with the following approximations: fossil gas combustion 65%, associated gas combustion 18%, fugitive emissions 15%, and flaring 2%. Combustion of other fuels accounts for less than 0.5% of sector total emissions.

This section describes method and data source updates for oil and gas sector fuel combustion and flaring emissions. There are no changes to the method used to calculate fugitive emissions.

B.2.b Data and Method

Oil and gas facility fuel combustion and flaring data reported pursuant to MRR is incorporated into the 2025 edition Inventory for 2012 and later years. The reported fuel combustion data includes fuel quantities, heat content, and emissions for fossil gas, associated gas, diesel, gasoline, propane, and biomethane. Section B.1.b.iii describes the use of MRR data for oil and gas sector fossil gas combustion in the context of the other fossil gas method updates implemented in the 2025 edition Inventory. This section describes the use of MRR data for combustion of other fuels used in the sector – the most significant being associated gas.

B.2.b.i Associated Gas Combustion Emissions for 2012 and Later Years

When crude oil is first brought to the surface, it may contain a mixture of oil, gas (called associated gas), produced fluids such as salt water, and dissolved and suspended solids. The associated gas is separated out and consumed on site in steam generators and oil processing equipment, creating emissions. The separated crude oil is prepared for shipment to storage facilities and refineries.

Prior to the 2025 edition Inventory, all associated gas combustion data was sourced from the California Department of Conservation's Geologic Energy Management Division (CalGEM) [CalGEM 2025a]. For the 2025 edition Inventory, associated gas combustion data is sourced primarily from MRR. To estimate combustion of associated gas from facilities that are not subject to MRR, CARB obtained facility-level data from CalGEM [CalGEM 2025b] as a supplemental data source and reconciled this facility-level data with MRR facility data. Associated gas that could not be attributed to a facility already subject to MRR was added to the Inventory. The MRR data includes the 35 largest oil and gas sector emitters in California and covers approximately 95% of the total associated gas combustion emissions, leaving only 5% of the associated gas represented by the CalGEM data.

The CalGEM associated gas data consists of "gas used" and "gas blown" volumes. "Gas used" is mapped to associated gas combustion and "gas blown" is mapped to flaring for the 2025 edition Inventory. For prior editions of the Inventory, associated gas combustion emissions were calculated as the sum of the "gas used" and "gas blown" volumes multiplied by a sector-wide higher heating value (HHV) and emission factors.[3] The MRR data used in the 2025 edition Inventory includes unit-level associated gas volumes, heat content, and emissions data informed by gas analyses. For 2012 and later years, where MRR data is used directly, reported and verified emissions data removes the need for the WSPA-provided generic HHV and CO_2 emission factor. For associated gas combustion by facilities that are not subject to MRR and for all associated gas combustion for the years 2000-2011 (see section B.2.b.v), the WSPA-provided factors were replaced with factors consistent with the

[3] The sector-wide HHV and the CO_2 emission factor were provided by the Western States Petroleum Association (WSPA) [WSPA 2007]. The CH_4 and N_2O emission factors were default factors from MRR.

MRR data, as shown in Table 2. In addition to the updates to the HHV and CO_2 emission factor, the CH_4 emission factor was revised to reflect the relationship between reported CH_4 emissions and reported heat content for associated gas in the MRR data. The higher CH_4 emission factor (compared to the default that was used previously) reflects the associated gas combustion emissions calculation method prescribed by Section 95153(y)(2)(C) of MRR [CARB MRR 2019]. This calculation method provides a default destruction efficiency of 0.995, which results in greater CH_4 pass-through (and emissions) than the destruction efficiency implied by the prior emission factor.

Table 2. Associated Gas Combustion Emission Factors for 2000-2011 and for Supplemental CalGEM Gas for 2012 and Later Years

Factor	Prior Edition Value	2025 Edition Value
Higher Heating Value	808 btu/scf	1,028 btu/scf
CO_2 Emission Factor	65.14 kg/MMBtu	53.02 kg/MMBtu
CH_4 Emission Factor	0.001 kg/MMBtu	0.02 kg/MMBtu
N_2O Emission Factor	0.0001 kg/MMBtu	0.0001 kg/MMBtu (no change)

B.2.b.ii Method for Reconciling Gas Combusted by Electricity Generation and Cogeneration Units for 2012 and Later Years

As described in section B.1.b.ii, care must be taken to avoid double-counting emissions from electricity generation and cogeneration units located at industrial facilities. Using unit-level MRR data for the oil and gas sector allows for direct assignment of emissions to the appropriate sector. Electricity generation and cogeneration units are excluded when tallying MRR facility-level oil and gas sector data for the 2025 edition Inventory because emissions from these units are separately tallied in the electricity generation and cogeneration sectors. This method update ensures that there is no double counting of associated gas combustion emissions across the oil and gas, electricity, and cogeneration sectors.

B.2.b.iii Flaring Emissions for 2012 and Later Years

In the 2025 edition Inventory, emissions for 2012 and later years associated with oil and gas sector flares – as reported pursuant to MRR – are categorized as flaring emissions without a fuel specified.[4] For the associated gas combusted by facilities not subject to MRR and

[4] IPCC Guidelines note that "flaring" is broadly the combustion of waste gases as a "disposal option" rather than for "the production of useful heat or energy" and that all emissions associated with flares and

therefore sourced from CalGEM, the gas reported as "gas blown" is used with the factors in Table 2 to calculate flaring emissions and the gas reported as "gas used" is used to calculate combustion emissions. Section B.2.b.v discusses flaring emission estimates for 2000-2011. Prior inventory editions do not list oil and gas sector flaring as an emissions source.

B.2.b.iv Targeted Adjustments to Associated Gas and Fossil Gas for 2012 and Later Years

Oil and gas facilities commonly mix fossil gas and associated gas for on-site use in steam generators, cogeneration units, and other on-site combustion equipment. These mixed fuels may then be reported in the MRR data as associated gas or similar fuel names. This differing naming makes it difficult to differentiate fossil gas and associated gas quantities.

Targeted adjustments were made to facility- and unit-level fuel volumes and fuel names reported in the MRR data based on supporting data such as fossil gas purchases and facility-specific and unit-specific trends. These adjustments resulted in shifts to fuel volumes and emissions. These shifts occurred between associated gas and fossil gas in the years 2012-2013 and 2020-2021. The adjustments are few and address anomalies in the fossil gas and associated gas combustion trends within the sector.

Some of these adjustments were implemented for electricity generation and cogeneration units at oil and gas facilities. This resulted in adjustments to fossil gas and associated gas emissions in the electricity generation and cogeneration sectors in addition to the oil and gas sector. The 2025 edition Inventory also reflects a decrease in refinery gas emissions from electricity generation and cogeneration that resulted from the oil and gas sector fuel name and volume adjustments described above.

B.2.b.v Associated Gas Combustion and Flaring Emissions for 2000-2011

Associated gas combustion emissions were updated for 2000-2011 using the IPCC Overlap Technique [IPCC 2006]. The 2000-2011 associated gas volumes were estimated by backcasting MRR associated gas volumes based on the relationship between CalGEM and MRR associated gas volumes observed during 2013-2023. The associated gas backcast calculations were conducted as follows:

1. The total associated gas heat content (including gas to electricity generation and cogeneration units) was compared to the CalGEM total associated gas heat content for 2013 and later years using 2025 edition Inventory methods. This yielded a ratio of 1.43.
2. CalGEM associated gas heat content for 2000-2011 was multiplied by the step 1 ratio of 1.43 to estimate total associated gas heat content (inclusive of gas to cogeneration and electricity generation units).

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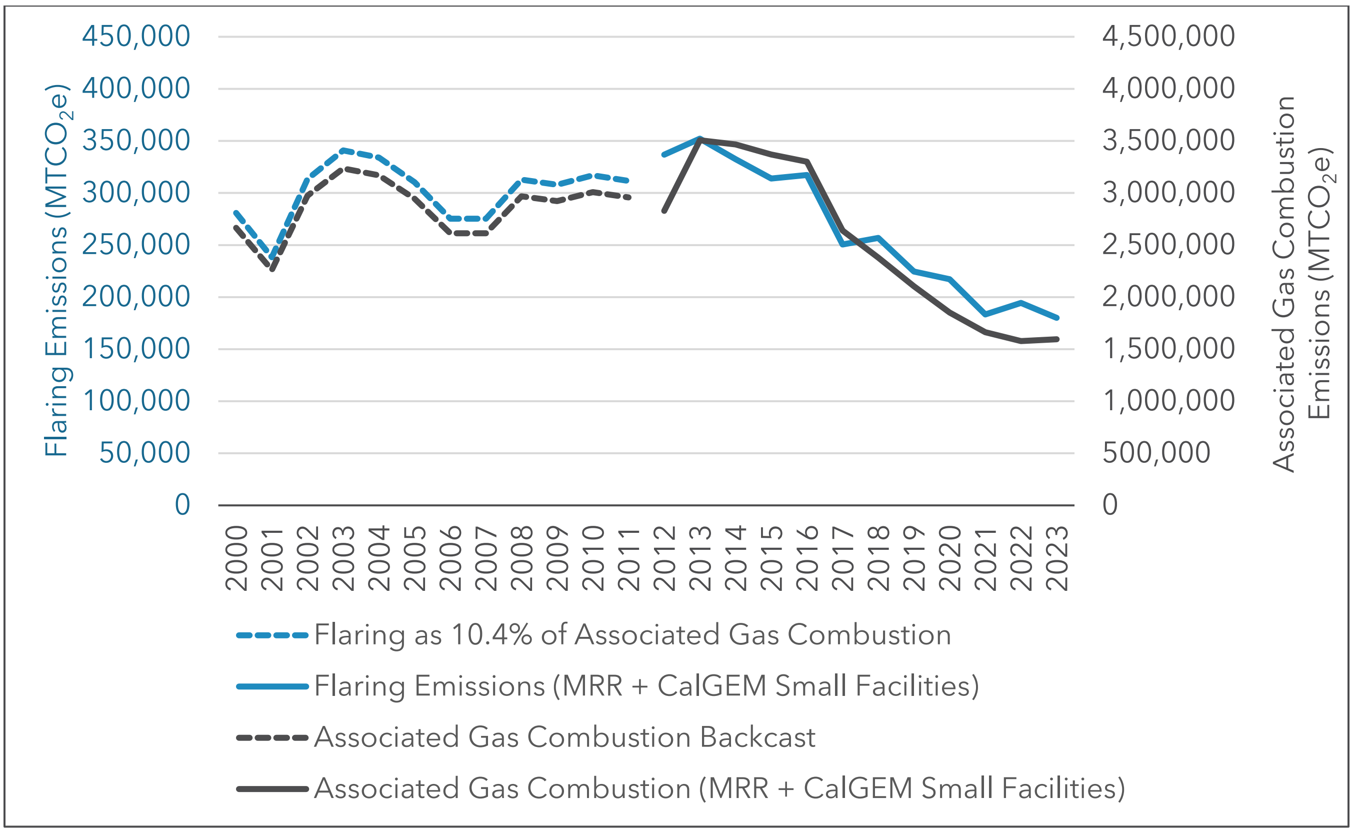
incineration units "should be reported under the appropriate venting and flaring subcategories rather than under Category 1.A (Fuel Combustion Activities)" [IPCC 2006].

3. The ratio of associated gas excluding electricity generation and cogeneration units to total associated gas including electricity generation and cogeneration units for 2013 and later years was calculated using the 2025 edition Inventory methods. This yielded a ratio of 0.60.
4. The 2000-2011 estimate of total associated gas from step 2 was multiplied by the step 3 ratio of 0.60 to estimate 2000-2011 associated gas, excluding gas to electricity generation and cogeneration units.
5. Emissions were then calculated using the updated HHV and emission factors listed in Table 2 in section B.2.b.i. The resulting emissions are shown in Figure 6.

Flaring emissions were estimated for 2000-2011 using the relationship between flaring emissions and associated gas combustion emissions in the MRR data for 2013-2023. As shown in Figure 6, there is a consistent relationship between flaring emissions and associated gas combustion emissions for 2013-2023, with flaring emissions averaging 10.4% of associated gas combustion emissions over those years. Based on this relationship, 2000-2011 flaring emissions were set to 10.4% of the backcasted associated gas combustion emissions.

Figure 6. Oil and Gas Sector Associated Gas Combustion and Flaring Emissions



B.2.b.vi Combustion Emissions for Other Fuels

Oil and gas sector diesel use was sourced from EIA's "Adjusted Sales of Fuel Oil and Kerosene" report [EIA 2022] for prior Inventory editions. Oil and gas sector diesel use is sourced from MRR data for 2012 and later years in the 2025 edition Inventory. Section B.3.b.ii describes the data source and method update for oil and gas sector diesel for 2000-2011. The 2000-2011 diesel data was not adjusted using a backcast of the MRR data and the IPCC Overlap Technique because there was no consistent relationship between MRR and EIA data for 2012 to 2020 – the years for which both data sources were available. Diesel accounts for one percent or less of sector total emissions in most years.

Emission estimates were not provided for oil and gas sector propane, gasoline, and biomethane combustion for prior Inventory editions. Emissions from combustion of these fuels are included for 2012 and later years in the 2025 edition Inventory because they were reported pursuant to MRR. Emissions estimates for these fuels were not added for 2000-2011 because of their small contribution to sector total emissions and because of lack of data. These fuels represent 0.03% of the total oil and gas sector emissions for 2012-2023.

B.3 Petroleum Fuels Consumption: Update Data Sources to Replace Discontinued EIA Publication

IPCC Categories: 1A1cii, 1A2m, 1A3, 1A3c, 1A4a, 1A4b, 1A4c, 1A5

B.3.a Background

Data from the EIA State Energy Data System (SEDS), the U.S. Environmental Protection Agency (EPA), and the Defense Logistics Agency (DLA) are now being used in place of EIA's discontinued Fuel Oil and Kerosene Sales (FOKS) data for petroleum products used in the residential, commercial, agriculture, industrial manufacturing not specified, oil and gas, rail, and military sectors.

More specifically, prior editions of the Inventory used data from the "Adjusted Sales of Fuel Oil and Kerosene" section of FOKS [EIA 2022] to determine fuel use for the fuels and sectors listed below in Table 3.

For the 2024 edition Inventory's initial estimate of the amount of blended diesel[5] used in these sectors for calendar year 2011 and prior, the blended diesel volumes included in the EIA data were divided into three components (RND, biodiesel, and fossil distillate) then directly incorporated into the Inventory. For calendar year 2012 and beyond, the blended diesel volumes reported by EIA were divided into the same three components and were scaled so the sum of fossil distillate used by all categories in Table 1 of Section B.1 of [CARB

[5] "Blended diesel" refers to the aggregation of fossil distillate, renewable diesel, and biodiesel.

2024] matched the sum of all Distillate No. 1 and No. 2 reported by MRR Section 95121 fuel suppliers in each year.[6]

The EIA FOKS data for RFO, kerosene, and blended diesel [EIA 2022] was discontinued after calendar year 2020. In recent Inventory editions, the amounts of RFO, kerosene, and pre-scaled blended diesel used by the sectors listed in Table 3 were assumed to be equal to the calendar year 2020 volume for calendar years 2021 and 2022. For the 2025 edition Inventory, alternative data sets were used to determine these volumes, in some cases all the way back to calendar year 2000, as described below.

B.3.b Data and Method

Table 3 lists the sectors and fuels whose data source is being updated for the 2025 edition Inventory. The four subsections that follow Table 3 describe the updated data sources and methods in more detail.

Table 3. Data Previously Sourced from EIA's "Adjusted Sales of Fuel Oil and Kerosene" Dataset and Updated Data Sources for 2025 Edition Inventory

GHG Inventory Sector	Fuels	2025 Edition Data Sources	2025 Edition Calendar Years
Residential	Blended Diesel[1] Kerosene	EIA SEDS [EIA 2025c] "Residential"	2000-2023
Commercial	Blended Diesel Kerosene RFO	EIA SEDS [EIA 2025c] "Commercial"	2000-2023
Agriculture	Blended Diesel Kerosene	Portion of EIA SEDS [EIA 2025c] "Industrial"	2000-2023
Industrial Manufacturing Not Specified	Blended Diesel Kerosene RFO	Portion of EIA SEDS [EIA 2025c] "Industrial"	2000-2023

[6] The total fossil distillate fuel volumes that fuel supplier companies report to CARB under Section 95121 do not include all the distillate fuel burned within California that is included in the Inventory. Reported MRR fossil distillate fuel volumes do not (or are conservatively assumed to not) include any fuel burned in California by liquid fuels refineries or water-borne sources. Reported MRR data also does not include diesel purchased by truck drivers at fueling stations outside of California but then burned in California.

GHG Inventory Sector	Fuels	2025 Edition Data Sources	2025 Edition Calendar Years
Industrial Oil and Gas Production and Processing	Blended Diesel RFO	Portion of EIA SEDS [EIA 2025c] “Industrial”	2000-2011
		MRR [CARB MRR 2025]	2012+
Rail	Blended Diesel	Portion of EPA Rail [USEPA as published by EDF 2025] and [USEPA 2024a]	2000-2023
Military	Blended Diesel RFO	DLA [DLA 2025]	2014-2023

1. The term “blended diesel” used in this table refers to the initial blended diesel estimate that is then allocated to RND, biodiesel, and fossil distillate and scaled (for 2012 and beyond) as described in section B.3.a.

For many of the sectors included in Table 3, the 2025 edition Inventory uses data from the EIA SEDS [EIA 2025c]. SEDS provides estimates of fuel consumption by state for the electric power, transportation, industrial, commercial, and residential sectors. The SEDS estimates are based on data in the discontinued FOKS [EIA 2022] dataset. For SEDS, the petroleum consumption data is scaled such that the individual data points sum to the total volume published in EIA’s *Petroleum Supply Annual*. SEDS estimates for 2021 and later years are extrapolated based on data from earlier years [EIA 2025d].

B.3.b.i Use EIA SEDS Data for Residential and Commercial Petroleum Fuels Consumption

Data that defines the consumption of residential kerosene and initial blended diesel , as well as commercial kerosene, RFO, and initial blended diesel, are now sourced from SEDS “Residential” and “Commercial” sectors [EIA 2025c] for all years. Because these SEDS sectors align with GHG Inventory sectors, no adjustments were made to the SEDS data other than the diesel apportionment and scaling described in section B.3.a.

B.3.b.ii Apportion EIA SEDS "Industrial" Data for Industrial and Agriculture (All Years) and Oil and Gas (2000-2011) Petroleum Fuels Consumption

Data that defines the consumption of miscellaneous industrial (Industrial Manufacturing Not Specified) sector kerosene, RFO, and initial blended diesel, as well as agriculture sector kerosene and initial blended diesel, are now sourced from the SEDS "Industrial" sector [EIA 2025c] for all years. Oil and gas sector RFO and initial blended diesel are also sourced from the SEDS "Industrial" sector [EIA 2025c] for 2000-2011. As described in section B.2.b.iv, all fuel combustion data for the oil and gas sector is sourced from MRR for 2012 and later years starting with the 2025 edition Inventory.

The SEDS "Industrial" sector data represents fuel consumption for "industrial heating," "farm use," "oil company use," "off-highway use," and "all other uses" [EIA 2025d]. The SEDS data does not provide the contribution of each of these uses to the "Industrial" sector total. The Inventory presents emissions from "farm use" in the agriculture sector, from "oil company use" in the oil and gas sector, and from "industrial heating" plus "all other uses" in the industrial manufacturing not specified sector. The discontinued [EIA 2022] data used in prior Inventory editions listed these "industrial" uses separately. To determine the fraction of the SEDS "Industrial" sector total to assign to the sectors listed above, for calendar years 2000-2020, the percentage of [EIA 2022] fuel use for each of the sectors was applied to the SEDS "Industrial" total. For 2021 and beyond, the average [EIA 2022] sub-sector percentages for the years 2015-2019 were applied to the SEDS "Industrial" totals to perform the sub-sector disaggregation.

One additional step was performed to determine initial blended diesel for the industrial manufacturing not specified sector. To determine this value, the initial blended diesel used in the cement and liquid fuels refining and hydrogen production sectors – which the Inventory sources from elsewhere, as described in [CARB 2022a] – was deducted from the SEDS-based estimate for industrial manufacturing not specified to avoid double-counting.

Finally, the diesel apportionment and scaling process described in section B.3.a is applied to the initial blended diesel volumes described in this section.

B.3.b.iii Use EPA Data for Rail Diesel Consumption

The steps described in Section B.3.a above allocate rail sector blended diesel between RND, biodiesel, and fossil distillate (all years) and scale fossil distillate so the total used by all Inventory categories matches the statewide supply-side total (2012 and beyond only). These steps remain unchanged. However, due to the discontinuation of the [EIA 2022] dataset, the following steps were used to determine the pre-scaled blended diesel volume used for rail transport in California that feeds into the Section B.3.a process:

1. The amounts of blended diesel used nationally for rail transport in 2000-2023 were determined. The 2000, 2010, and 2012-2023 values were taken from [USEPA as published by EDF 2025] while the 2001-2009 and 2011 values were taken from [USEPA 2024a].

2. For 2000-2020, the percentage of [EIA 2022]'s total U.S. rail blended diesel used in California was calculated by year.
3. Also for 2000-2020, the percentages calculated in step 2 were applied to the national volumes determined in step 1. The resulting volume was used as the pre-scaled blended diesel volume for rail transport in California in these years.
4. The average percentage of [EIA 2022]'s total U.S. rail blended diesel used in California between 2016 and 2020 was calculated.
5. For 2021 and beyond, the percentage calculated in step 4 was applied to the national volume determined in step 1. The resulting volume was used as the pre-scaled blended diesel volume for rail transport in California in these years.

B.3.b.iv Use DLA Data for Military Petroleum Fuels Consumption

The discontinuation of the [EIA 2022] dataset also required use of a new method to determine the amount of diesel and RFO used by the military. For calendar years 2014 and beyond, the 2025 edition Inventory used military diesel and RFO consumption data provided by DLA [DLA 2025]. For calendar years 2000-2013, the 2025 edition Inventory continues to rely on data from [EIA 2022] because DLA data were not available for 2013 and prior. The DLA data were provided to CARB by "product code", which provides more specificity than is needed for the Inventory. The product codes were mapped to diesel and RFO. The resulting volumes were incorporated in the Inventory by year.[7] As in prior editions of the Inventory [CARB 2022a], all diesel used by the military is assumed to be fossil distillate. The emissions from military uses of fossil distillate and RFO are published on the "Excluded emissions" tab of the "Full Inventory" spreadsheets available from [CARB 2025a].

B.4 Statewide Conventional Jet Fuel Consumption: Use CEC Data

IPCC Categories: 1A3ai, 1A3aii

B.4.a Background

The calculation to determine emissions from the combustion of conventional jet fuel begins with the amount sold in California each year. That volume is converted to emissions using the default higher heating value and emission factors from the U.S. EPA [USEPA 2024b] and the IPCC [IPCC 2006]. The Inventory presents these emissions in four sub-categories reflecting different types of flights: intrastate, interstate, international, and military. IPCC guidance states that all emissions from fuels used for international aviation are to be excluded from national totals but are to be calculated and reported separately as a memo item [IPCC 2006]. The Inventory follows this approach for international and interstate flights. Military flights are treated similarly. As a result, only the GHG emissions from conventional

[7] The diesel volumes for 2000-2013 remain subject to the scaling process described in [CARB 2024] while the volumes for 2014 and beyond are not. The DLA volumes (2014+) are considered to be more similar to volumes traditionally not subject to scaling than volumes which are scaled.

jet fuel combusted on intrastate flights are included in the statewide emissions estimate presented in the Inventory.

Data from CEC is used as the primary data source for statewide consumption of conventional jet fuel starting with the 2025 edition of the Inventory. Prior versions of the Inventory have used data from EIA SEDS to determine total conventional jet fuel consumed in California by year [EIA 2025e] and [EIA 2025f]. In a 2020 update, EIA revised their method for determining statewide conventional jet fuel use and used the new method to revise state-level consumption for 2010 forward. Unfortunately, the new EIA method is not comparable with estimates before 2010 [EIA 2025g], which introduces inconsistency. Alternative data sets were explored in support of CARB's goal to maintain a consistent method throughout the time-series from the year 2000 through the current data year. Staff identified data from MRR [CARB MRR 2025] and CEC [CEC 2025] and [CEC 2020] that could be used to determine statewide consumption of conventional jet fuel.

B.4.b Data and Method

After review, data from CEC was selected as the primary data source for statewide consumption of conventional jet fuel. CEC data were found to be consistent and comparable for 2007 and beyond, an improvement over the revised EIA data. Further, MRR production data, in the years available, more closely aligned with CEC data than EIA, suggesting the CEC data are more accurate. MRR data was not selected as the primary data set because it only covered production of conventional jet fuel, not imports or exports, and is only available for 2014 and beyond.

Specifically, for 2007 and beyond, statewide conventional jet fuel consumption is now calculated by summing production from California's refineries, the net reduction in stocks at these refineries, and net imports. Both the amount produced (throughput) and net reduction in stock at refineries are from [CEC 2025]. Weekly throughput from CEC is allocated to calendar years.[8] Net reduction in stock is calculated by subtracting the total stocks listed in the first data point for each calendar year from the total stocks listed in the final data point of that year. Monthly imports and exports of conventional jet fuel were provided to CARB staff by CEC via personal communication [CEC 2024a]. Net imports were calculated by subtracting exports from imports.

Prior to 2007, CEC did not collect all the activity data used to derive total conventional jet fuel supplied in California in a manner consistent with the approach described above [CEC 2024b]. EIA SEDS provided consistent state-level conventional jet fuel consumption through 2018 [EIA 2020] prior to the method update completed for the 2020 data year [EIA 2025g]. A reasonably consistent relationship was identified between total conventional jet fuel

[8] Weekly data points are typically mapped to the year listed in the "Date" column which represents the last day of the reporting period. Data points with a "Date" between January 1st and January 6th include some conventional jet fuel produced in the listed year and some produced in the prior year. These throughput volumes were divided between the two years assuming equal production per day within such weeks.

supplied as derived from CEC data and EIA's 2020 estimate between 2007 and 2018. In these years, the CEC value ranged between 74.8% and 87.8% of EIA's 2020 estimate, averaging 82.4%. The IPCC's Overlap Technique [IPCC 2006] was employed using the EIA SEDS 2020 estimate for 2000-2006 and the ratio of CEC to EIA SEDS 2020 conventional jet fuel supply in 2007-2018 to estimate total conventional jet fuel supply in 2000-2006.

The processes described in Sections B.5 and B.6 below are then followed to allocate this conventional jet fuel among the four types of flights and calculate associated emissions.

B.5 Military Conventional Jet Fuel Consumption: Use DLA Data

IPCC Categories: 1A3ai, 1A3aii, 1A5bi

B.5.a Background

As noted above, the Inventory presents emissions from conventional jet fuel consumption in four sub-categories reflecting different types of flights: intrastate, interstate, international, and military. The first step to allocate the fuel among the four types of flights is to assign a portion of the total to military operations. All jet fuel assigned to the military is assumed to be conventional jet fuel, meaning none is assumed to be alternative jet fuel. As explained in [CARB 2016], historically, the amount of jet fuel used by the military for 2004 onward was provided by CEC. The amount used in 2000-2003 was estimated by assuming that the amount of fuel reported by CEC for 2004-2010 fluctuated in proportion with the amount consumed by military aviation nationwide [USEPA 2015].

B.5.b Data and Method

The amount of conventional jet fuel used by military flights in California is provided by DLA for 2011 onward, and CARB now uses these data directly in the Inventory [DLA 2024a]. The amount of conventional jet fuel used nationwide for military activity is reported in EPA's GHG Inventory [USEPA 2024a]. Military conventional jet fuel use in California in 2000-2010 was estimated by assuming that the percentage of U.S. conventional jet fuel used by the military in California in these years was the same as that over the 2011-2020 period, as calculated using the DLA and EPA data described above. That volume is converted to emissions using the default higher heating value and emission factors from EPA [USEPA 2024b] and the IPCC [IPCC 2006]. Those emissions are then published on the "Excluded emissions" tab of the "Full Inventory" spreadsheets available from [CARB 2025a].

B.6 Allocating Jet Fuel Among Flight Categories: Use Updated Aircraft Factors

IPCC Categories: 1A3ai, 1A3aii

B.6.a Background

Once a portion of total jet fuel (conventional and alternative) supplied in California is assigned to the military, the remainder is divided between intrastate, interstate, and international flights. As described in [CARB 2016], the first step of that process is to assign all jet fuel used for general aviation to intrastate flights. That step remains unchanged. The remainder, which represents commercial flights, is then divided between intrastate, interstate, and international flights using the process described in [CARB 2016], [CARB 2022a], and [CARB 2024] employing flight activity data from [USDOT 2025] and aircraft-specific fuel consumption factors based on data from the European Environment Agency EMEP/CORINAIR Air Pollutant Emissions Inventory Guidebook (Guidebook). The source of flight activity data remains unchanged, however data from the 2023 edition of the Guidebook [EEA 2023] were used in place of the 2007 version [EEA 2007], which had been used previously.

B.6.b Data and Method

The U.S. Department of Transportation's (DOT) Air Carrier Statistics database [USDOT 2025] includes information on all commercial flights taking off and/or landing in California. This database provides the type of aircraft used, the length of the flight in miles, and the destination airport for each flight. A total of 178 unique types of aircraft were reported to have made at least one commercial flight originating in California since January 1, 2000. The first step in allocating commercial jet fuel between the intrastate, interstate, and international categories is to estimate fuel used for each flight in the DOT database.

The 2023 version of the Guidebook [EEA 2023] contains jet fuel consumption (in kg) as a function of flight distance for most[9] of the aircraft included in the DOT database. For each aircraft type, the Guidebook provides a single fuel consumption value for the

[9] CARB staff directly matched 151 of the 178 unique types of aircraft in the DOT database to a specific type of aircraft in the EEA guidebook. For another 18, what was a single aircraft type in the DOT database appeared to be represented by two or more aircraft types in the EEA guidebook. In these cases, the factors used for the DOT aircraft was the average of the associated aircraft in the EEA guidebook. The 169 aircraft types in the DOT database for which CARB determined fuel consumption factors, and the factors themselves, are available for download from *ww2.arb.ca.gov/sites/default/files/2025-11/nc-ghg_inventory_aircraft_factors_2025*. Two DOT aircraft appeared to be helicopters which were omitted from the analysis. The remaining 7 DOT aircraft types were also excluded from the analysis because they could not be mapped, these 7 aircraft types represented only 0.02% of flights departing California in the DOT database.

landing/takeoff (LTO) phase of the flight[10]. The fuel consumed during LTO is assumed to be independent of the flight distance. For each aircraft type the EEA guidebook also provides the total fuel consumed during the climb, cruise, and descent (CCD) phase,[11] for flights of various lengths (in nautical miles).

The first step to calculate the amount of fuel used for each California-origin flight in the DOT database is to assign the amount of fuel used for LTO from the Guidebook. To this value, the amount of fuel used for the CCD phase was added. For each flight, the Guidebook's CCD fuel consumption factor for a flight of the closest distance less than or equal to the actual distance was assigned.[12] The difference between the miles flown by the actual flight and the miles associated with the assigned factor was then calculated. Then, fuel used for the remaining miles was determined based on the fuel use per mile implied by the Guidebook at the distances immediately below and above the actual flight distance. In cases where the miles traveled by the flight exceeded the maximum distance for which the Guidebook provided a factor fuel use per mile for the remaining distance reflects the rate implied by flights operating between the two largest distances included in the Guidebook.

Next, the fuel used for each flight is assigned to the intrastate, interstate, or international category using the process described in [CARB 2016]. Those volumes are then converted to emissions using the default higher heating value and emission factors from EPA [USEPA 2024b] and the IPCC [IPCC 2006]. The emissions from the intrastate flights are then published on the "Included emissions" tab of the "Full Inventory" spreadsheets available from [CARB 2025a] while those from the interstate and international flights are published on the "Excluded emissions" tab.

Prior editions of the Inventory used the regression model described in [CARB 2016] to determine fuel consumption factors for the significant number of aircraft not included in [EEA 2007]. Use of the regression model has been discontinued because 99.98% of total flights departing California were matched to a specific type (or types) of aircraft in [EEA 2023].

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[10] The 2023 EEA guidebook provides LTO values for both "a busy European airport, year 2022" and "ICAO" (International Civil Aviation Organization). The ICAO factors were used in the Inventory because these values are thought to be more indicative of fuel used for flights originating in California across the time series.

[11] The portions of a flight occurring above 3,000 feet.

[12] After converting the EEA guidebook's CCD factors from nautical miles to miles, the unit of distance used in the DOT database.

B.7 Aviation Gasoline: Assign a Portion to the Military

IPCC Categories: 1A3aii, 1A5bi

B.7.a Background

California's total sales of aviation gasoline are reported by CDTFA [CDTFA 2025] and have historically been directly incorporated in the Inventory using the assumption that 100% was used for civil operations. Starting with the 2025 edition of the Inventory, a portion of this total is assigned to the military using data from DLA [DLA 2024b].

B.7.b Data and Method

Data provided by DLA includes military aviation gasoline consumption for 2011 onwards. This volume is now allocated to the military while the remainder reported by CDTFA remains assigned to civil operations. The military volume in 2000-2010 was set equal to the DLA average from 2011-2013 after a review of trends in the data for 2011 and beyond. In 2000-2010, all aviation gasoline reported by CDTFA not assigned to the military was assumed to have been used for civil operations, as was done for 2011 onward. The emissions from civil uses of aviation gasoline are published on the "Included emissions" tab of the "Full Inventory" spreadsheets available from [CARB 2025a] while those from military uses are published on the "Excluded emissions" tab, consistent with the past methodology for jet fuel.

B.8 On-Road Transportation: Incorporate Updated EMFAC Model

IPCC Categories: 1A3bi, 1A3bii, 1A3biii, 1A3biv

B.8.a Background

In 2025, CARB released an updated version of the EMFAC model (EMFAC2025) [CARB 2025b], which incorporated several refinements to the on-road vehicle inventory since the previous version of EMFAC (EMFAC2021). The refinements include updated historical fuel consumption by vehicle category, updated CH_4 and N_2O emission factors, inclusion of vehicles aged 45 years and older, and vehicle activity data and emission factors for speeds between 70 and 90 miles per hour. These updates to the EMFAC model were informed by real-world data from CARB's Truck and Bus Surveillance Program, CDTFA, Department of Motor Vehicles, and other sources that have been published since the development of EMFAC2021. More details on EMFAC2025's development and the emissions impact of refinements incorporated in this version can be found on EMFAC's Conference and Workshops webpage [CARB 2025c].

B.8.b Data and Method

EMFAC2025 is now used in the Inventory instead of EMFAC2021. There is no change to the method for using EMFAC model outputs in the Inventory. Only the refinements to historical fuel consumption by vehicle category and updates to the CH_4 and N_2O[13] emission factors affected the Inventory.

B.9 Ocean Going Vessels: Consolidate Sub-Sectors

IPCC Categories: 1A3di, 1A3dii

B.9.a Background

Included emissions from combustion of fossil distillate and RFO from ocean going vessels have historically been presented in six categories. First, the total amount of each fuel consumed has been divided between port and transit related activities. Then, each of those categories have been divided into three sub-categories, reflecting the vessel's origin/destination: international, interstate, and intrastate. The apportionment of fuel between the international, interstate, and intrastate sub-categories in 2000-2010 has been accomplished using data from a prior version of CARB's statewide ocean-going vessels model based on geographically specific shipping activity data which was developed for the Goods Movement Plan [CARB 2011]. The most recent version of the model [CARB 2021a] does not differentiate between the three types of trips for 2011 and beyond. Therefore, the percentage splits assumed for 2011-2022 have historically been set equal to the percentage splits in 2010, the most recent year data were available.

B.9.b Data and Method

The modeled splits from 2010 discussed above may no longer accurately reflect the percentage splits in more recent years. The international, interstate, and intrastate sub-categories were aggregated into a single total for all years as part of this update to address this. The distinction between fuel consumed for port and transit-related activities remains in the most recent version of the model and will continue to be presented in the Inventory for all years. This method change does not affect total emissions from ocean going vessels in any year.

B.10 Commercial Harbor Craft: Increase Renewable Diesel Allocation

IPCC Categories: 1A3dii

B.10.a Background

The 2024 edition of the Inventory used the method described in Section B.1 of [CARB 2024] to allocate RND, biodiesel, and fossil distillate among sectors. To summarize, for commercial

[13] At the time Inventory data were being finalized for this source category, an issue with N_2O emissions had yet to be rectified in EMFAC2025 version 2.0.0. EMFAC staff provided Inventory staff with an advance copy of draft data that would be released later to correct the issue. Those data were used for this edition of the Inventory.

harbor craft (CHC), the volume of blended diesel from CARB's CHC model [CARB 2021b] is used. This volume is used, without scaling, because the fossil distillate component of that blended diesel is not in the MRR fuel supplier scope while the biodiesel and renewable diesel components are never scaled. The percentage share of fossil distillate, biodiesel, and renewable diesel was calculated using the method described in [CARB 2024] which essentially assures that the percentage of each component is the same for all sources in the state that use blended diesel.

A recent CARB Regulation [CARB 2022b] requires that, beginning January 1, 2023, commercial harbor craft with a diesel engine must use either R100 fuel or R99 fuel blend with limited exceptions. R100 is pure RND while R99 is a blend of 99% RND and 1% fossil distillate. R99 is widely available for use while R100 is less common.

B.10.b Data and Method

First, to align the Inventory with the requirements of [CARB 2022b], 99% of the CHC model's calendar year 2023 blended diesel estimate was allocated as RND while the remaining 1% was allocated as fossil distillate. Second, the allocation process to determine calendar year 2023 diesel volumes used by other sources was performed as described in [CARB 2024]. The only changes to that process as a result of this method update were:

- The reduced RND volume (Low Carbon Fuel Standard Program (LCFS) [CARB 2025d]total minus the amount assigned to CHC) was used instead of the total reported to LCFS[14], and
- None of the remaining RND was allocated to CHC because it was assigned directly.

The percentage of RND, biodiesel, and fossil distillate in the blended diesel used by CHC remains unchanged for 2022 and prior data years.

B.11 Process Emissions from Glass Manufacturing: Add Emissions from Limestone and Dolomite Consumption

IPCC Categories: 2A3

B.11.a Background

Limestone ($CaCO_3$) and dolomite ($CaCO_3MgCO_3$) are used by a wide variety of industries such as glass production, construction, agriculture, chemical, metallurgy, and environmental pollution control. In some of these applications, limestone (or dolomite) is heated to a high enough temperature to generate CO_2 as a by-product. Prior editions of the Inventory did not include an emissions estimate for consumption of limestone and dolomite for glass production, only emissions from other process uses of these carbonates were included.

[14] Because a portion of calendar year 2023 LCFS RND was assigned to CHC in the first step of the process.

B.11.b Data and Method

A new method was developed to estimate emissions from consumption of limestone and dolomite for glass production in the 2025 edition of the Inventory. For 2011 and later years, MRR [CARB MRR 2019] requires each glass manufacturing facility that exceeds the reporting threshold[15] to report the amount of limestone and dolomite (in tons) used in furnaces. In these years, the Inventory converts the reported amount of limestone used to metric tons (MT), then calculates CO_2 emissions by multiplying the total amount reported to MRR by a default emissions factor of 0.43971 $MTCO_2$ per MT limestone.[16] The same approach is used for dolomite, but with an emission factor of 0.47732 $MTCO_2$ per MT dolomite.

Emissions in 2000-2010 are estimated by scaling 2017 emissions, similar to the method used by EPA in their national Inventory [USEPA 2024a]. Emissions are scaled using the Federal Reserve's Industrial Production Index for glass, which expresses real output for each calendar year relative to real output in a base year.[17] The base year is currently 2017 [Federal Reserve 2023]. Emissions in 2000-2010 are calculated by multiplying 2017 emissions by the index value for the corresponding year and dividing by the base year index (100). The annually varying index values for 2000-2010 are provided in Table 4 below.

Table 4. Federal Reserve Industrial Production Index for Glass

Year	Index
2000	122.1
2001	114.0
2002	111.1
2003	109.5
2004	112.2
2005	113.1
2006	113.5

[15] The reporting threshold of 10,000 metric tons CO_2e is thought to capture the majority of California's emissions from this source. Emissions from smaller facilities have not been accounted for due to limited data.

[16] The emissions factors for limestone and dolomite are from the IPCC Guidelines [IPCC 2006]

[17] By convention, the index in the base year is assigned the value 100.

Year	Index
2007	109.4
2008	106.2
2009	90.8
2010	93.0
2017	100.0

B.12 Use of Electrical Equipment: Method Updates

IPCC Categories: 2G1b

B.12.a Background

The electric power industry uses sulfur hexafluoride (SF_6) in gas-insulated substations, circuit breakers, and other switchgear. These equipment types are collectively referred to as gas-insulated equipment (GIE). Fugitive emissions of SF_6 can result from leaks through equipment seals and also during equipment installation and servicing. Historically, for 2011 onwards, the Inventory estimate for emissions from this source reflected data reported pursuant to CARB's Regulation for Reducing Greenhouse Gas Emissions from Gas-Insulated Equipment (GIE Regulation) [CARB 2021c]. Those emissions were divided between the "Electricity Generation (Imports)" and "Electricity Generation (In State)" economic sectors based on the percentage of California's electricity imported and generated in-state, respectively.

As explained in [CARB 2017], emissions for 2008 have historically reflected data compiled in a survey conducted by CARB [CARB 2009]. Using the 2008 value as an anchor point, emissions were estimated in the remaining years between 2000 and 2010 by scaling national emissions from the U.S. GHG Inventory down to the California level using the California-U.S. ratio of electricity generation.

Discussions with stakeholders have demonstrated some confusion over the Inventory's prior division of SF_6 emissions from GIE between the "Electricity Generation (Imports)" and "Electricity Generation (In State)" economic sectors. All the emissions reported pursuant to the GIE Regulation and included in the Inventory occur within the state of California, but some stakeholders interpreted the emissions allocated to the Imports category to occur out-of-state and to be associated with delivering imported electricity to California, which is not the case. To avoid confusion these emissions will now be presented as a single line item within the "Electricity Generation (In State)" sector.

Also, EPA has revised their national estimate for emissions from this source since California's 2000-2010 emissions were last calculated, and the data from the 2008 survey (which did not reflect 100% of California emissions) was found to be a low outlier relative to the national emissions trend. Therefore the 2008 data point was discarded and a slightly revised method was used to determine emissions from 2000-2010 as described below.

B.12.b Data and Method

For 2011 onwards, all GIE owners in California are required to annually report their SF_6 emissions to CARB pursuant to the GIE Regulation. The reported emissions are aggregated and directly incorporated into the Inventory for these years, as was the case in prior editions of the Inventory.

Emissions for 2000-2011 are downscaled from EPA's national emission estimate as published in their GHG Inventory [USEPA 2024a]. Specifically, the percentage of U.S. emissions that occurred in California in 2012 (4.31%) is calculated using data reported pursuant to the GIE Regulation and data from [USEPA 2024a]. Then, that same fraction of national emissions in 2000-2010 is allocated to California.

B.13 Carbon Dioxide Consumption: Use MRR Data

IPCC Categories: 2G4

B.13.a Background

In California, carbon dioxide is used for a variety of purposes including food processing, carbonated beverage production, and refrigeration. Nationally, most CO_2 supplied into the economy is used for enhanced oil and gas recovery, but CO_2 is not known to be used for this purpose in California [USEPA 2025a]. Based on the known uses, it is assumed that all CO_2 supplied into the economy in California is eventually released to the atmosphere. This section of the Inventory accounts for those emissions.

For 2011 onwards, MRR [CARB MRR 2019] requires all CO_2 producers to report the amount supplied to the economy. MRR also requires reporting of CO_2 supplied by all importers and exporters with annual California bulk imports or exports of 10,000 metric tons or more. Reporting producers, importers, and exporters include the biogenic CO_2 supplied in addition to non-biogenic CO_2. Because all CO_2 producers are required to report and the reporting threshold for importers and exporters is relatively low, it is thought that the net supply of both biogenic and non-biogenic CO_2 as reported to MRR (production + imports – exports) provides a reasonable estimate for the amounts supplied into California's economy annually. In turn, the amounts of biogenic and non-biogenic CO_2 supplied are thought to be good proxies for the amounts emitted.

B.13.b Data and Method

For 2011 onwards, the Inventory estimates of biogenic CO_2 and non-biogenic CO_2 emissions from CO_2 consumption are equal to the net supply reported to MRR. These values are presented in Table 5 below.

Table 5. Net Carbon Dioxide Supplied in California by Year for 2011-2023

Year	Non-Biogenic CO_2 (MT)	Biogenic CO_2 (MT)	Total CO_2 (MT)*
2011	737,895	179	738,074
2012	770,632	0	770,632
2013	712,462	16	712,478
2014	753,922	87	754,009
2015	702,731	19,486	722,217
2016	647,261	59,010	706,272
2017	654,088	63,186	717,274
2018	694,788	67,133	761,921
2019	673,499	95,777	769,276
2020	535,603	136,888	672,491
2021	534,870	147,862	682,731
2022	550,049	139,846	689,895
2023	563,156	88,293	651,448

**Totals may not sum due to independent rounding*

Total net CO_2 supplied (biogenic + non-biogenic) in 2000-2010 is assumed to equal the average net supply from 2011-2019 (739,128 MT). This is due to a lack of any other data and the low variability in net supply reported to MRR for 2011-2019. All CO_2 supplied in 2000-2010 is assumed to be non-biogenic, both because the percentage of the total that is biogenic as reported to MRR is very low in 2011-2014, and to be conservative (biogenic CO_2 emissions are not included in the statewide emissions total).

B.14 Liquid Fuels and Hydrogen Production: Deduct CO_2 Captured from Hydrogen Production Process

IPCC Categories: 2H3

B.14.a Background

In California, hydrogen production by and for liquid fuel producers generates substantial amounts of CO_2 because the most common processes use carbon-based feedstock inputs (e.g., methane (CH_4) from fossil gas) as a source of hydrogen and emit the carbon as CO_2. Hydrogen production plants are often located at liquid fuel refineries. Flue gas and other exhaust streams at these plants have a high concentration of CO_2 which leads to lower energy requirements for CO_2 separation than exhaust streams from many other industries [NETL 2025].

Data reported by CO_2 suppliers pursuant to MRR [CARB MRR 2019] demonstrate the vast majority of CO_2 supplied in California is captured at facilities that produce liquid fuels from hydrogen production units. Previous versions of the Inventory estimated total CO_2 emissions from hydrogen production plants based on the amount of fuel consumed and did not adjust CO_2 emissions downward in recognition some of the CO_2 was captured and supplied into the economy rather than emitted. Emissions from the eventual release of that CO_2 supplied to the economy are included within the CO_2 consumption sector of the Inventory, meaning, these emissions were being counted in two places within the Inventory. See Section B.13 for more information about MRR's reporting requirements for CO_2 suppliers and the method for estimating Inventory emissions from CO_2 consumption.

B.14.b Data and Method

The following method was employed to determine CO_2 emissions from transformation of fossil gas, petroleum feedstocks, and refinery gas at liquid fuels refining and hydrogen production facilities for all calendar years. As a first step, CO_2 emitted from the transformation of each fuel at these facilities was estimated as described in previously published technical documentation in the "Technical Documentation" section of [CARB 2025a]. Next, the total emissions from transformation were determined by combining the estimates for each of the three fuels. Then, the percentage of the CO_2 from transformation that was captured was determined by dividing the emissions calculated for CO_2 consumption by the transformation total. Finally, the initial estimate of CO_2 emitted from transformation of each fuel at these facilities was reduced by the calculated percentage. The result is the final CO_2 emissions estimate for each fuel at these facilities.

B.15 Livestock Enteric Fermentation and Manure Management: Livestock Population Update

IPCC Category: 3A1, 3A2

B.15.a Background

As described in [CARB 2024], livestock populations for the years 2017 to 2022 were updated to reflect United States Department of Agriculture's (USDA) 2024 Census of Agriculture (Census) [USDA 2024]. The Inventory's historical populations were not previously revisited as part of annual Inventory calculations. The Census does not publish cattle populations to the same specificity as the Inventory. Therefore, population subtotals were determined by multiplying the USDA livestock populations by the historical subpopulation disaggregation percentages, originally sourced from the 2015 and 2019 editions of the Inventory of U.S. Greenhouse Gas Emissions and Sinks [USEPA 2015] [USEPA 2019].

In the 2025 edition of the Inventory of U.S. Greenhouse Gas Emissions and Sinks, EPA published state-specific cattle populations modeled by the Cattle Enteric Fermentation Model (CEFM), which tracks cattle sub-populations at different growth and production stages [USEPA as published by EDF 2025].

B.15.b Data and Method

Livestock populations were updated for the entire Inventory time series. For all cattle types, populations were taken directly from the results of the 2025 edition CEFM. Other livestock population data, except for horses, come from the most recent edition of the USDA National Agricultural Statistics Service (NASS) [USDA 2024]. , Interim data was interpolated using the Census populations for animal types where there was no annual population data available, such as when there is only Census data available every five years.

California horse population numbers were also derived from the USDA NASS but were adjusted upward using data available on public websites [CTBA 2019] [CHPC 2024] [DP 2025] which reported on findings from the American Horse Council (AHC) Economic Impact Studies. These adjustments were needed because the USDA NASS populations exclude horses kept for recreation. Horse populations were annualized by interpolating a linear trend between Census data points from the USDA NASS. Then, an average factor between USDA and the available AHC data was calculated and applied to the annualized data to estimate annual California horse populations.

Emission factors and waste management distribution percentages were not changed from previous editions of the Inventory.

B.16 Landfills: Incorporate Data from the Landfill Methane Regulation Program

IPCC Categories: 4A1

B.16.a Background

The GHG Inventory method for estimating landfill emissions emphasizes using reported data from landfills wherever possible. Historically, CARB sourced reported landfill gas data from Subpart HH of EPA's Greenhouse Gas Reporting Program (GHGRP) [USEPA 2025b] for reporting landfills.[18] For the state's smaller landfills, the Mathematically Exact First-Order Decay (FOD) model from the 2006 IPCC Guidelines [IPCC 2006] was used to estimate emissions. CARB's Landfill Methane Regulation (LMR) program mandates that municipal solid waste (MSW) landfills with a design capacity of at least 450,000 tons that have accepted waste at any time after 1977 report their gas collection and control systems records effective 2010. More landfills report to LMR than GHGRP due to the differences in program applicability. Staff continued using GHGRP data as in prior editions, but used LMR-reported gas data instead of FOD derived estimates where possible. This change significantly increased the amount of reported data used in the Inventory.

B.16.b Data and Method

Of the 372 landfills in California, 152 submitted site-specific survey data to CARB's LMR program through 2023. Gas flow data along with annual CH_4 and carbon dioxide concentrations for the entire LMR time series (2010–2023) was used to supplement missing data points in the GHGRP-reported dataset for 28 landfills and replaced FOD model estimates with LMR data at an additional 29 landfills that only report to LMR. The emissions model now includes site-specific data for 146 landfills in total after combining datasets from the GHGRP and LMR programs. Merging these datasets allows the application of the same method to calculate emissions for the 146 largest landfills operating gas control and collection systems, ensuring method consistency across both datasets. During integration, the model excluded any unreliable LMR data points identified through trend analysis. Also, a review of all available LMR reports led to revisions in the control system status for two landfills across the entire time series.

The changes resulted in an increase in captured landfill gas over the time series (2010–2022). The average CH_4 concentrations also changed throughout those years. This method update increased the estimate of landfill gas collection by up to 6% for the years 2016–2022.

[18] See *https://www.epa.gov/ghgreporting/subpart-hh-information-sheet* for more information on Subpart HH applicability.

B.17 Landfills: Revise Biogenic CO_2 Calculation Method

IPCC Categories: 4A1

B.17.a Background

Historically, the non- CH_4 portion of landfill gas (LFG) was considered CO_2 (i.e., %CO_2 = 100% - %CH_4). However, studies suggest that CO_2 and CH_4 make up roughly equal portions of LFG.[19] For example, a landfill with 30% CH_4 would be expected to have close to 30% CO_2, not 70% as previously assumed in the emissions model. The CO_2 fraction in LFG is not reported to GHGRP (only the CH_4 fraction is reported), but both CH_4 and CO_2 fractions are reported to LMR.

CO_2 emissions from landfills are considered biogenic because they originate from the decomposition of organic materials derived from biomass [USEPA 2010a]. These materials are part of the natural carbon cycle, and their decomposition would release CO_2 under natural aerobic conditions anyway. Therefore, these emissions are not included in CARB's GHG inventory.

B.17.b Data and Method

CARB developed a formula to estimate CO_2 emissions for landfills reporting to GHGRP program, by relating CO_2 and CH_4 based on a trend analysis of the CH_4 and CO_2 percentages reported pursuant to LMR. A trendline was established between the annual average CH_4 and CO_2 percentages, resulting in the following equation.[20]

$$\%CO_2 = 0.5088 * \%CH_4 + 12.45$$

Where, %CH4 = 0% to 58%

This equation was then used to estimate CO_2 fractions for landfills reporting only to the GHGRP. For the landfills reporting to LMR, the model uses reported CO_2 fractions. The revision in the CO_2 calculation reduced the average CO_2 fraction throughout the time series.

B.18 Other Landfill Updates

IPCC Categories: 4A1

B.18.a Background

As mentioned in section B.16, the inventory uses landfill gas estimates derived from FOD model calculations for landfills that do not report gas collection data. The inventory uses

[19] See *https://www.epa.gov/lmop/basic-information-about-landfill-gas* for basic information on landfill gas composition.

[20] CH_4 percentages ranged from 0% to 58% within the dataset used to develop the formula, implying the formula's upper and lower limits for CH4%.

reported gas collection data, when possible, instead of the FOD model due to the inherent FOD model assumptions and resulting uncertainties. Subpart HH of EPA's GHGRP requires landfills above the landfill reporting threshold to monitor and report greenhouse gas emissions, including CH_4.

When reported landfill gas data is unavailable, the inventory uses FOD model to estimate landfill emissions based on waste-in-place (WIP) amounts. The model assumes that waste carbon degrades into equal amounts of CO_2 and CH_4, with decay rates determined using EPA data on annual precipitation.

B.18.b Data and Method

Annual captured landfill gas flow, annual average CH_4 concentration, and destruction efficiencies for the years 2010–2022 were reviewed for the 122 landfills that report to EPA and these values were revised accordingly within CARB's model to reflect EPA's latest data [USEPA 2025b]. These revisions led to a decrease in captured landfill gas for the years 2010–2012. Similarly, annual average CH_4 concentrations decreased over time, with more pronounced declines during the earlier years (2010–2012). Destruction efficiencies showed minor increases for the years 2016–2021 and minor decreases for the years 2013, 2015, and 2022.

Landfill gas flow had previously been counted twice for the Clover Flat Landfill due to the assignment of a new GHGRP identification number in recent years, so this has been corrected. Otherwise, there have been no method changes in how GHGRP-reported data are incorporated into the Inventory.

Each year, the most recent annual WIP data [CalRecycle 2025a] is used as an input to the FOD model for those landfills that have not reported landfill gas collection data.[21] Past data were requested from CalRecycle and received to check for updates. The data received for 2020 through 2023 revealed annual WIP increased by 0.49% for disposal year 2020, by 3.05% for 2021, and by 0.002% for 2022, in comparison to the WIP data used within last year's 2024 edition Inventory.

B.19 Other Noteworthy Updates

Minor updates were made to several other parts of the Inventory. These include:

- The name of the "Petroleum Refining and Hydrogen Production" sector was changed to "Liquid Fuels Refining and Hydrogen Production." This change recognizes some California liquid fuels refineries have begun to use bio-based feedstocks [CCCD 2025], and clarifies where the applicable emissions from those facilities are captured within this Inventory.

[21] This data is also published through the Recycling and Disposal Reporting System (RDRS) [CalRecycle 2025b].

- As explained in [CARB 2022a], the GHG Inventory's emission estimates for the Liquid Fuels Refining and Hydrogen Production sector have reflected annual data reported pursuant to MRR for 2009 and later years. For 2011 and beyond, refineries reported combustion of gasoline, and in 2012 (only), combustion of ethanol. Prior editions of the Inventory assumed the combusted "gasoline" reported was pure, containing no ethanol. GHG Inventory staff learned that "gasoline" used at refineries would most commonly be used in vehicle test engines. Therefore, for 2012 and beyond, the percentage fossil gasoline and ethanol in the blend is now assumed to match the percentages in on-road gasoline each year. The ethanol combustion reported by refineries in 2012 was adjusted downward due to a change in interpretation of reported data and then combined with the reported gasoline prior to apportioning the total between fossil gasoline and ethanol.
- Emissions from soda ash consumption, which prior editions of the Inventory published in aggregate, were divided into two sub-categories. One sub-category reflects emissions from soda ash consumption used to make glass while the other reflects all other uses. The method to determine these emissions remains the same as prior editions of the Inventory. The breakout was made possible using data from Tables 4-14 and 4-20 of [USEPA as published by EDF 2025].
- Prior editions of the Inventory presented emissions from petroleum gas seeps on the "Excluded emissions" tab[22] of the "Full Inventory" spreadsheets available from [CARB 2025a]. As noted in [CARB 2016] and [USEPA 2016], emissions from these seeps are not included in EPA's National GHG Inventory. These emissions are considered a natural source of GHG [USEPA 2010b] which differ from the anthropogenic sources whose emissions are to be monitored and reported in national Inventories developed following IPCC Guidance [IPCC 2006]. To better align California's GHG Inventory with established convention, no emissions estimate will be presented for this source beginning with the 2025 edition of the Inventory.

[22] Excluded emissions are not included in statewide emissions totals.

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