# California's 2000-2020 Greenhouse Gas Emissions Inventory 2022 Edition

## Inventory Updates Since the 2021 Edition of the Inventory

## Supplement to the Technical Support Document


Air Quality Planning and Science Division

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# A. Introduction

Assembly Bill (AB) 1803 gave California Air Resources Board (CARB) the responsibility of preparing and updating California's greenhouse gas (GHG) inventory ("the GHG Inventory") to track the State's progress in reducing GHG emissions. The GHG 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) and Senate Bill 32 (SB 32) (reduce emissions to at least 40% below the 1990 levels by 2030). The 2022 edition of California's GHG Inventory covers emissions for 2000 through 2020 and includes inventory improvements and accounting method updates.

The GHG Inventory was developed according to the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories ("IPCC Guidelines") [IPCC 2006], which are the internationally recognized standard for developing national GHG inventories. Since the 2021 edition of the inventory (2000-2019 emissions), staff have made improvements to emissions estimation methods and incorporated new data sources. This document provides a description of the inventory updates since the previous edition of the inventory.

The IPCC guidance for GHG inventories states that it is good practice to recalculate historic emissions when methods are changed or refined, when new source categories are included in the inventory, or when errors in the estimates are identified and corrected. Consistent with the IPCC Guidelines, recalculations are made to incorporate new methods or to reflect changes in data for all years from 2000 to 2020, to maintain a consistent time-series of estimates within the inventory.[1] Therefore, emission estimates for a given calendar year may be different between editions as methods are updated or if data is revised.

In the sections to follow, a background on each updated category is presented, followed by a description of the update. The sections of this document are presented in the alphabetical and 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., 2000-2019 activity data in the 2022 edition of the GHG Inventory, where 2020 is the most current year), their updated historical data are incorporated into the latest edition of CARB's inventory. This can result in differences in numbers between inventory editions. This type of update is routine and not a change in methodology, data source, or assumption. Such update is not explicitly enumerated in this document.

In addition to the specific updates noted below, starting with the 2022 edition of the GHG Inventory, CARB staff have implemented new business processes around the information and data exchange process for data collected under the Regulation for the Mandatory Reporting of Greenhouse Gases (MRR) and how these data are incorporated into the inventory. These new processes help to ensure accuracy and alignment between the MRR annually reported and third-party verified data and the inventory as the 2022 edition completes the final integration of MRR emissions and fuel data into the inventory and ensures the best available data are reflected in the inventory. This document includes increased detail on the sources and methods by which data are reflected in the inventory to support public transparency.

# B. Description of Inventory Updates

## B.1 In-State Electricity Generation: Incorporate Updated Data and Calculations from the Mandatory GHG Reporting Program

IPCC Categories: 1A1ai, 1A1aii, 1B3, 1B4

### B.1.1 Background

For in-state electricity generation facilities that report data pursuant to CARB's Regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR), CARB incorporates the reported MRR data into the GHG Inventory.

The data reported pursuant to MRR that is used for the GHG Inventory includes unit-level emissions and the amount and heat input of each fuel combusted by each unit, as reported by each facility subject to MRR.[2] For units where emissions are reported based on fuel amount and emission factor, MRR data include fuel-level emissions.[3] For units where $CO_2$ emissions are measured and reported using continuous emissions monitoring systems (CEMS), MRR data does not include fuel-level $CO_2$ emissions.

Also, the update described in Section B.9, which adjusted the volumes of natural gas and refinery fuel gas (RFG) used by the *Refinery and Hydrogen Production* sector, resulted in reallocation of the amount of fuels used for electricity generation

[2] "Unit" means a piece of equipment or multiple pieces of equipment that combust one or more fuels. "Unit-level emissions" means the total emissions from all fuels combusted by a unit.

[3] "Fuel-level emissions" means the emissions from each fuel combusted by a unit.

and cogeneration units at refineries for 2012 and later years. Section B.1.2 provides additional information on the method and data used for this update.

## B.1.2 Data and Method

This inventory method update is for MRR data from 2012 and later years. The update includes additional quality assurance checks and a reallocation of the amounts of natural gas and RFG used by electricity generation and cogeneration units at facilities in the *Refinery and Hydrogen Production* sector.

MRR data must be processed to determine emissions by fuel for each category in the GHG Inventory. After processing MRR data to determine emissions by fuel type for each category, CARB staffed conducted additional quality assurance checks with this edition of the inventory to ensure that the MRR data used in the inventory is consistent with the facility-level MRR Facility and Entity Emissions data. Processing MRR emissions data for use in the GHG Inventory includes the following steps:

1. Calculate fuel-level emissions for each fuel combusted by each unit such that the sum of fuel-level emissions for each fuel combusted by a unit equals the unit-level emissions. The calculation method depends on the availability of fuel-level data.
    a. When fuel-level emissions are reported, this data is used as reported.
    b. When fuel-level emissions are not reported (due to use of CEMS at the unit), the single CEMS total $CO_2$ emissions value is divided among the reported fuel amounts by a simple allocation procedure which weights each fuel used in the unit by its reported heat content. First, a default $CO_2$ emissions is calculated for each reported fuel amount using the MRR default emission factor and the reported heat input for the fuel. The default $CO_2$ emissions for each fuel are summed and compared to the reported CEMS total $CO_2$ emissions for the unit. The reported fuel amounts used in the unit are then proportionally scaled so the total default $CO_2$ emissions for all fuels used in the unit equals the reported CEMS total $CO_2$ emissions.
2. Identify the appropriate GHG Inventory classification for each unit.
3. Sum the fuel-level emissions by GHG Inventory classification.

### Quality Assurance Checks and Adjustments

For the 2022 edition of the GHG Inventory, CARB staff conducted the following checks for 2012 and later years:

1. For 2012 to 2020 data, staff confirmed that the sum of fuel-level emissions equals unit-level emissions for each unit, which ensures consistency with MRR Facility and Entity Emissions data.

2. For 2012 to 2013 data, staff confirmed that the fuel amounts associated with $CH_4$ and $N_2O$ emissions reported as *de minimis* pursuant to MRR are also associated with reported $CO_2$ emissions. This quality assurance check was limited to 2012 and 2013 because of the different reporting structure for *de minimis* emissions in those years compared to later years.
    - Data adjustment: If a fuel amount was missing from a $CO_2$ emissions record, staff filled in the fuel amount using the amount reported to calculate the $CH_4$ and $N_2O$ emissions for the same unit. These adjustments did not affect total emissions but did marginally affect the distribution of $CO_2$ emissions among fuels in the GHG Inventory for 2012 and 2013.
3. For 2012 to 2013 data, staff ensured no double-counting of fuel amounts related to *de minimis* emissions reporting. This quality assurance check was limited to 2012 and 2013 because of the different reporting structure for *de minimis* emissions in those years compared to later years.
4. For 2012 to 2020 fuel use data, staff confirmed that the fuel amount was consistent with the reported heat input based on the expected heat content range for the fuel.

## Updates to Electricity Generation and Cogeneration Fuel Volumes at Petroleum Refineries

Section B.9.2 describes how, for 2012 and later years, natural gas used in the refinery and hydrogen production sector is adjusted upward – with a corresponding downward adjustment of RFG use within the same sector – so that natural gas used in the sector aligns with net natural gas purchases by the sector reported pursuant to MRR. A portion of the adjusted fuel use is attributed to electricity generation and cogeneration units at refineries, and therefore is categorized as in-state electricity generation and reflected in IPCC categories 1A1ai and 1A1aii.

For electricity generation and cogeneration units in the *Refinery and Hydrogen Production* sector in 2012 and later years, staff made an annual upward adjustment in heat input from natural gas and a corresponding downward adjustment in heat input from RFG. The heat input adjustments are split between electricity generation and useful thermal output (UTO) categories in the GHG Inventory based on the amount of RFG combusted in each category prior to the adjustment. For example, if the "*Electricity generation, CHP: Industrial*"[4] category accounts for 70 percent of the RFG

[4] "CHP" means combined heat and power. The terms "CHP" and "cogeneration" are used interchangeably in the GHG Inventory.

combusted by electricity generation units in the *refinery and hydrogen production* sector, then 70 percent of the heat input adjustment is apportioned to that category.

The heat input adjustments are equal and opposite for RFG and natural gas. The associated fuel volume adjustments are not equal and opposite because RFG and natural gas have different heat contents. The emissions adjustments are equal and opposite to maintain a net zero change in total sector emissions. The emissions adjustments are calculated using emission factors for natural gas combustion because the fuel adjustment represents an amount of natural gas that was reported as RFG.

## B.2 In-State Electricity and Cogeneration: Use MRR Data to Re-allocate Cogeneration Emissions Attributed to Electricity Generation and Thermal Output

IPCC Categories: 1A1ai, 1A1aii, 1B3, 1B4

### B.2.1 Background

The GHG Inventory splits emissions from cogeneration units between electricity generation and useful thermal output (UTO). The portion of cogeneration emissions attributed to electricity generation is assigned to the in-state electricity generation sector, while the portion of cogeneration emissions attributed to UTO is assigned to either the industrial sector or the commercial sector, depending on where the UTO is used.

### B.2.2 Data and Method

Prior editions of the inventory used U.S. Energy Information Administration (EIA) [EIA-923 2022a] estimates to allocate fuel consumption between electricity generation and UTO to determine the split between electricity generation and either industrial UTO or commercial UTO. For 2012 and later years, the updated approach uses electricity generation and thermal output data reported pursuant to MRR rather than EIA data to determine the split among electricity generation, industrial UTO, and commercial UTO. This change ensures that attribution of emissions aligns with reported data collected by the MRR program.

## B.3 Diesel Combustion: Adjust Distillate Volume for Certain Categories to Match MRR Total Distillate Volume

IPCC Categories: 1A1aii, 1A1cii, 1A2m, 1A3, 1A3bi, 1A3bii, 1A3biii, 1A3c, 1A3di, 1A3dii, 1A3eii, 1A4a, 1A4b, 1A4c

### B.3.1 Background

Fossil distillate reported by fuel suppliers subject to MRR Section 95121 reporting[5] includes total distillate volume delivered via the bulk distribution system (i.e. fuel terminal racks) for use in California, as well as fuel imported and distributed in California outside of the bulk distribution system [CARB MRR 2019].[6] Starting with the 2022 edition inventory, for calendar years 2012 and onward, CARB is aligning applicable sector-specific fuel volumes (compiled using various datasets from a list of government agencies and CARB programs) with the MRR total distillate volume reported under Section 95121 of MRR. The total fossil distillate volumes reported by fuel suppliers under Section 95121 of MRR represents an aggregated statewide sum, however, and does not provide the amount of fuel used by each end use sector.[7] Because of this, aligning the sector-specific data to match MRR requires proportionally scaling the fuel volume of applicable sectors so the sum of all those sectors matches the MRR Section 95121 total distillate fuel volume. Section B.3.2 of this document provides further information about which distillate combustion categories are subject to scaling, which are not, and how scaling is done.

### B.3.2 Data and Method

Table 1 lists the fossil distillate combustion categories in the GHG Inventory that are captured by fuel supplier reporting requirements of Section 95121 of MRR [CARB MRR 2019] and the data source used as the basis for each end-use category (i.e. the sector-specific data). Some sector-specific data in this group are not scaled because they are subject to regular audit and other legally mandated review processes or because they are not within the scope of MRR Section 95121 reporting (i.e., the fuel is consumed on-site and never enters supplier inventories).

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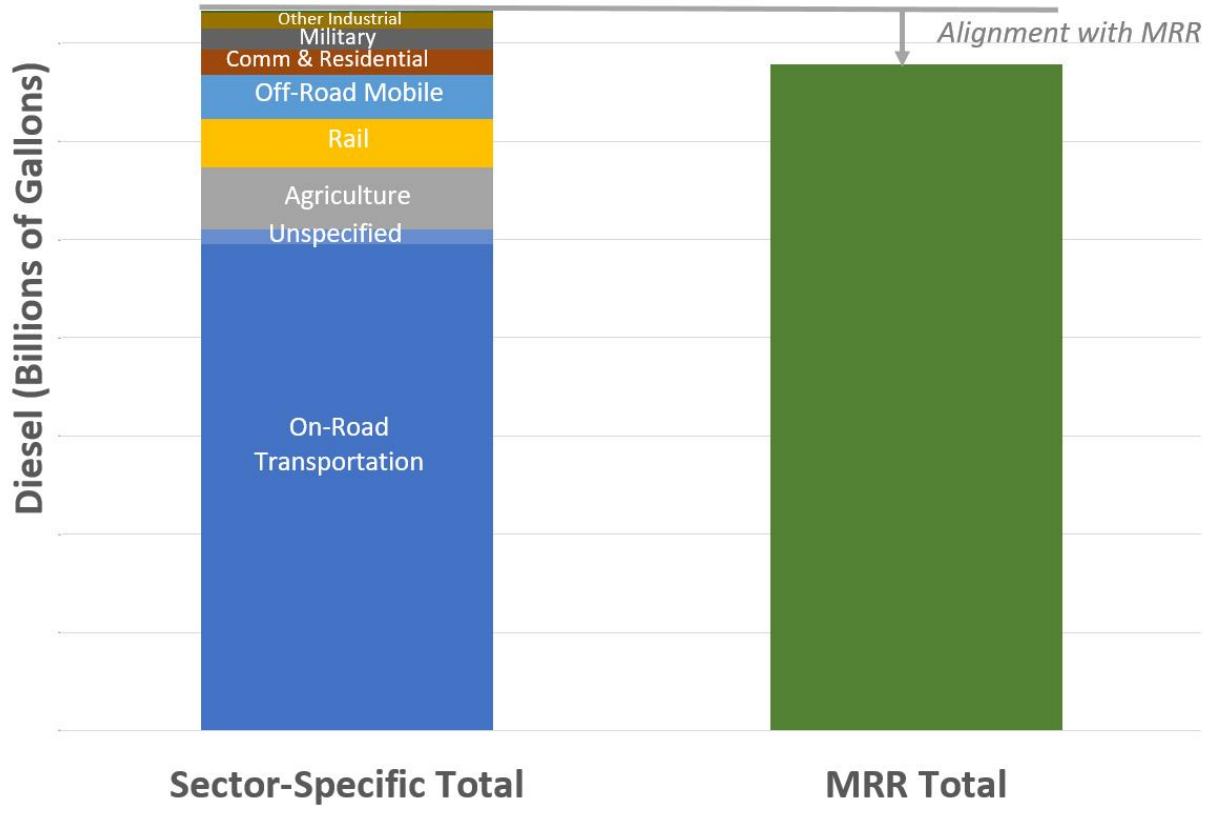
[5] In the data tables associated with CARB's GHG Inventory, the word "distillate" is used to refer to the remaining fossil diesel fuel after removing biodiesel and RND components from the total volume.

[6] The total fossil distillate fuel volumes that fuel supplier companies report to CARB under Section 95121 does not capture all the distillate fuel burned within California. MRR transportation fuel supplier (Section 95121) reporting does not capture data for the following GHG Inventory sectors: *Petroleum Refining and Hydrogen Production*; a fraction of *Water-borne*; and fuel purchased by truck drivers at gas stations outside of California but then burned in California. Fuel purchased by truck drivers at gas stations outside of California is captured by CDTFA's International Fuel Tax Agreement (IFTA) diesel fuel volume [CDTFA IFTA 2022], which represents the "net" of distillate volumes combusted in California by truck drivers who loaded fuel outside of California (which are not included in MRR fuel supplier data but are included in the inventory) minus the distillate volumes combusted outside of California by truck drivers who loaded up inside of California (which are included in MRR fuel supplier data but not included in the GHG Inventory). While a fraction of the fuel Water-borne vessels burn could be covered under MRR, because this volume is small, and because it is not tracked separately as an end-use under MRR, it is excluded from scaling.

- For on-road transportation, the 2022 edition of the GHG Inventory will continue to use taxation records from the California Department of Tax and Fee Administration (CDTFA) [CDTFA 2022] to represent the total distillate fuel used by the various on-road vehicle classes.
- Scaling is also not done for individual facilities subject to reporting requirements under MRR Sections 95110-95120 [CARB MRR 2019] and whose facility-specific data are directly incorporated in aggregate into the GHG Inventory and subject to third-party verification. These include cement manufacturing, in-state electricity generation facilities, and in-state cogeneration units.

Setting aside on-road transportation, unspecified use of fuel recorded by CDTFA, cement manufacturing, and in-state electricity generation and cogeneration, all other sector categories as noted in Table 1 are scaled to the balance of total fuel from MRR. A graphical illustration of this alignment is shown in Figure 1.

**Figure 1: An Illustration of Distillate Combustion Categories Within the Scope of MRR Section 95121 Reporting and Alignment with MRR Total Volume**



Specifically, the following steps are taken in preparation of the scaling calculation:

Step 1. As in the previous inventory editions, compile sector-specific distillate volumes for combustion categories using data sets from other government agencies and programs as shown in Table 1.[8]

Step 2. Implement the update described in Section B.5. Break out the distillate volumes from Step 1 proportionally by the biodiesel and renewable diesel volume collected by the Low Carbon Fuel Standard Program (LCFS) [CARB LCFS 2022b]. The remaining distillate volumes represent fossil distillate.

Step 3. Scale applicable categories as noted in Table 1 so the sum of all categories in Table 1 matches the total fuel volume from MRR Section 95121 reporting, which is the sum of all Distillate No. 1 and No. 2 volumes reported by MRR Section 95121 fuel suppliers for a given reporting year.[9] Repeat these steps for years 2012 and onward. Figure 2 shows the total sector-specific volume totals in comparison to MRR reported fuel to illustrate the magnitude of scaling for these years.

Note that scaling sector fuel data to MRR total fuel may result in new trends in historical data when compared to the trends in the original sector data. Because the difference between MRR total and the sector-specific inventory compilation total varies each year, the scaling factor also varies by calendar year and the variation can be significant for some years.

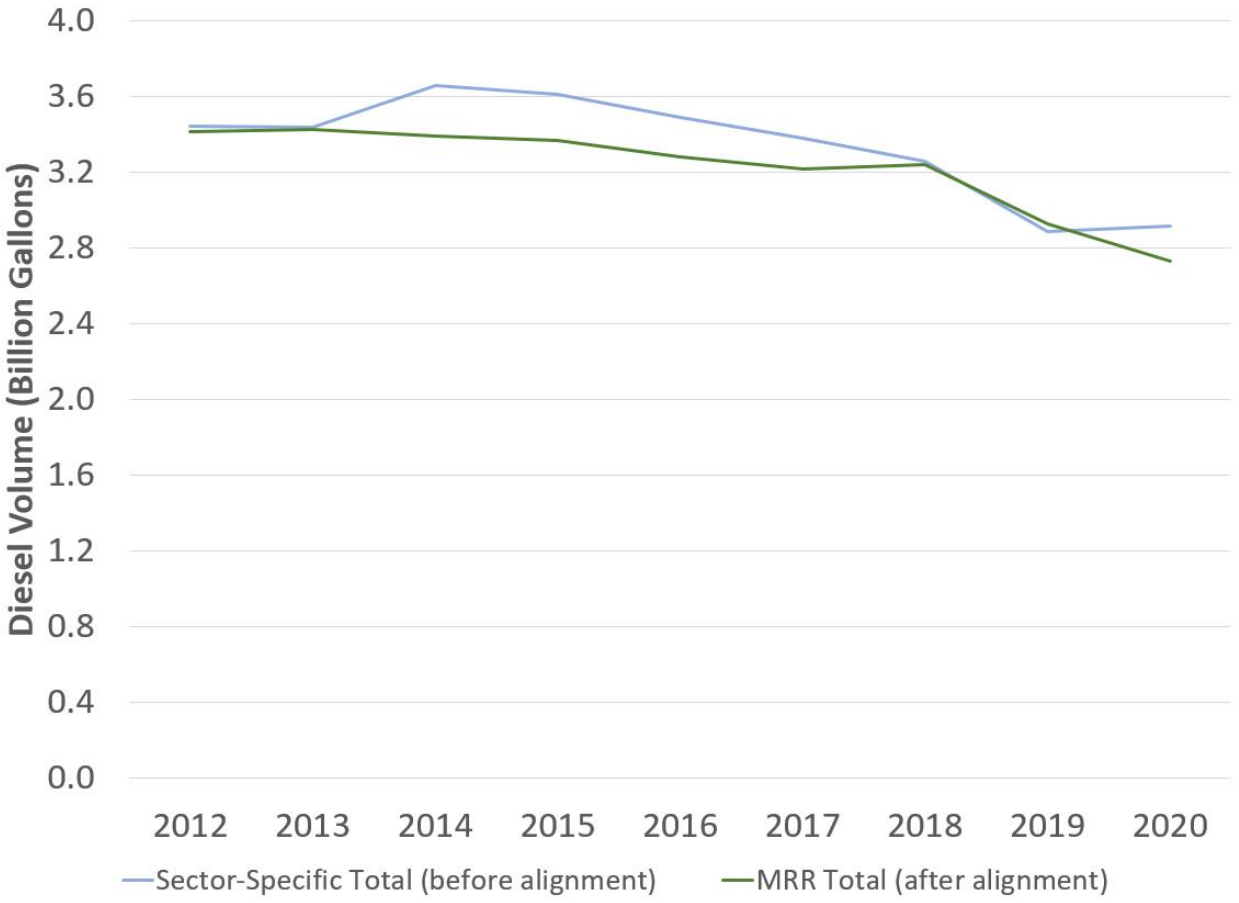
[8] No change to methodologies and data sources for Step 1 except as otherwise noted in this document. See the GHG Inventory Technical Support Document [CARB TSD 2016-2020] for a detailed description of methodologies and data sources.

[9] The on-road transportation fuel volume in the sector-specific inventory compilation represents the amount of fuel combusted within California borders. This includes fuel purchased by truck drivers at gas station outside of California but is burned in California. This volume is captured by CDFA's IFTA diesel fuel volume [CDTFA IFTA 2022], which represents the "net" of distillate volumes combusted in California by truck drivers who loaded fuel outside of California (which are not included in MRR fuel supplier data but are included in the inventory) minus the distillate volumes combusted outside of California by truck drivers who loaded up inside of California (which are included in MRR fuel supplier data but not included in the GHG Inventory). Therefore, in practice, the sum of all the categories in Table 1 is being matched to the sum of MRR Section 95121 total volume and IFTA volume.

**Table 1: Distillate Combustion Categories Within the Scope of MRR Section 95121 Reporting and Whether They Are Subject to Scaling**

| Sector-Specific Inventory Category | Sector Level Fuel Data Source | Subject to Scaling? |
|---|---|---|
| On Road Transportation | CDTFA [CDTFA 2022] | No |
| Unspecified Fuel Use | CDTFA [CDTFA 2022] | No |
| Electricity Generation (In-State) | MRR Sections 95112 and 95115 [CARB MRR 2022a] and EIA [EIA-923 2022] | No |
| Cement Manufacturing | MRR Section 95115 [CARB MRR 2022a] | No |
| Cogeneration Thermal Energy Allocated to Industrial Use | MRR Sections 95112 and 95115 [CARB MRR 2022a] and EIA [EIA-923 2022] | No |
| Cogeneration Thermal Energy Allocated to Commercial Use | MRR Sections 95112 and 95115 [CARB MRR 2022a] and EIA [EIA-923 2022] | No |
| Other Industrial Categories Not Yet Mentioned Above | EIA [EIA 2022b] | Yes |
| Commercial (Except Cogeneration Thermal Energy) | EIA [EIA 2022b] | Yes |
| Residential | EIA [EIA 2022b] | Yes |
| Rail | EIA [EIA 2022b] | Yes |
| Agriculture Sector Diesel Combustion | EIA [EIA 2022b] | Yes |
| Military | EIA [EIA 2022b] | Yes |
| Off-Road Mobile Sources | CARB's Mobile Source Inventory Models [CARB MSEI 2022] | Yes |

**Figure 2. Comparison of Total Sector-Specific and MRR Distillate Volumes**




## B.4 Diesel Combustion: Align Emission Factors with MRR Section 95121 Fuel Supplier Emission Factors

IPCC Categories: 1A1aii, 1A1cii, 1A2m, 1A3, 1A3bi, 1A3bii, 1A3biii, 1A3c, 1A3di, 1A3dii, 1A3eii, 1A4a, 1A4b, 1A4c

### B.4.1 Background

The previous editions of the GHG Inventory used USEPA Greenhouse Gas Reporting Rule (GHGRR) Subpart C [USEPA 2009-2011] default emission factors referenced in Section 95115 of MRR [CARB MRR 2019] and emission factors from CARB's EMFAC Model [CARB EMFAC 2021a]. In the 2022 edition inventory, some of these emission factors are replaced with emission factors consistent with MRR Section 95121 fuel supplier reporting. B.4.2, Data and Method.

Table 2 summarizes the changes to distillate emission factors in the 2022 edition inventory. For all categories within the scope of MRR Section 95121 fuel

supplier reporting[10], except for categories that use MRR facility data (i.e., electricity generation and cogeneration categories), distillate $CO_2$ emissions are estimated using a year-specific distillate $CO_2$ emission factor calculated as the annual total Distillate No. 1 and No. 2 emissions reported under Section 95121 of MRR divided by the annual total volume of Distillate No. 1 and No.2 used to calculate emissions reported under Section 95121 of MRR.

For all non-road in-scope categories, except categories that use MRR facility data, $CH_4$ and $N_2O$ emissions for distillate are calculated using emission factors in Table 2-4 of MRR, Section 95121 [CARB MRR 2019].

On-road distillate $CH_4$ and $N_2O$ emissions continue to be quantified using the emission factors from CARB's EMFAC model [CARB EMFAC 2021a].

**Table 2. Changes to the Source of Distillate Emission Factors (EF)**

| | CO2 EF | CH4 and N2O EFs |
|---|---|---|
| **Distillate** use by non-road sources – except cement, refinery/hydrogen, and in-state electricity generation facilities* | *Previous editions:* USEPA Part 98, Subpart C default EFs referenced in MRR Section 95115<br>*2022 edition:* Year-specific EFs calculated from MRR fuel supplier volume and emissions data | *Previous editions:* USEPA Part 98, Subpart C default EFs referenced in MRR Section 95115<br>*2022 edition:* MRR Table 2-4 default EFs |
| **Distillate** use by on-road sources | *Previous editions:* USEPA Part 98, Subpart C default EFs referenced in MRR Section 95115<br>*2022 edition:* Year-specific EFs calculated from MRR fuel supplier volume and emissions data | No Change<br>(EMFAC vehicle-class-specific EFs) |

* For cement, refinery and hydrogen production, and in-state electricity generation and cogeneration facilities, the GHG Inventory incorporates data that are reported to MRR. Therefore, default emission factors are not used for these facilities.

[10] In the context of using MRR data in the GHG Inventory, the term "distillate" represents fossil diesel.

## B.5 Diesel Combustion: Re-allocate Biodiesel and Renewable Diesel Volumes Among On-road and Non-road Diesel Combustion Categories

IPCC Categories: 1A1aii, 1A1cii, 1A2m, 1A3, 1A3bi, 1A3bii, 1A3biii, 1A3c, 1A3di, 1A3dii, 1A3eii, 1A4a, 1A4b, 1A4c

### B.5.1 Background

The GHG Inventory uses the sector-specific distillate volumes published by the EIA [EIA 2022b][11] as the data source for fuel quantity used by each sector/subsector. However, EIA's data represent the combined sum of fossil diesel, biofuels, and their blended mixtures ("total diesel blend") and do not distinguish biofuels from fossil diesel. Since the 2020 edition, the GHG Inventory has been using biodiesel and renewable diesel (RND) volumes (collectively referred to as "biofuels" in the context of this section) reported to the LCFS program [CARB LCFS 2022b] to break out EIA's total diesel blend into three components: fossil diesel, biodiesel, and RND [CARB IU 2020]. To ensure that the original EIA total diesel blend volume is conserved, equivalent volumes of biofuels are subtracted from EIA's total diesel blend volume.

In previous editions of the GHG Inventory, LCFS's biodiesel and RND volumes were allocated only to on-road transportation categories. However, the diesel fuel sold at California fueling stations is already a blend of fossil diesel, biodiesel, and RND, available to be purchased by both on-road and non-road end users. Recent discussions with CARB staff in the LCFS program provided additional clarification that LCFS biofuel volumes are used in all sectors of the economy except ocean-going vessels (OGVs) and military use. To better reflect distribution of biofuels across the economy, starting with the 2022 edition inventory, biodiesel and RND are re-allocated to all sectors except OGVs and military use. This update results in an increase in fossil fuel emissions in on-road transportation categories (as some biofuels that were previously assigned to on-road are now reassigned to other sectors, resulting in more fossil diesel assigned to on-road categories) and a corresponding emission decrease in non-road categories.

[11] In EIA's original dataset, EIA uses the term "distillate" to refer to the total of fossil diesel, biodiesel, RND, and their blended mixtures, without distinguishing each component. In the data tables associated with CARB's GHG Inventory, the word "distillate" is used to refer to the remaining fossil diesel fuel after subtracting out biodiesel and RND components from the total volume.

### B.5.2 Data and Method

To distribute biofuels among all sectors, except ocean-going vessels and military, the inventory uses an equal percentage allocation approach. The percentage of biodiesel and RND assigned to each category using distillate is calculated as:

*% biofuel = [Total Biofuel Volume (gallons)]/[Total Diesel Blend Volume (gallons)]*

where Total Diesel Blend Volume represents the sum of fossil diesel, biofuels, and their blended mixtures for all diesel combustion categories except OGV and military use.

The percentage of biofuel is multiplied by the total diesel blend volume of each applicable category to obtain the volume of biofuel allocated to each category, and this calculation is separately performed for biodiesel and RND for each year. After breaking out the biofuel volumes from the original total diesel blend volume from EIA, the remaining volume is assigned as fossil diesel. (Fossil diesel is shown as "distillate" in the GHG Inventory data tables.)

## B.6 Gasoline Combustion: Update the Assumption for Gasoline Content of Fuel Ethanol

IPCC Categories: 1A1b, 1A2k, 1A2m, 1A3a, 1A3bi, 1A3bii, 1A3biii, 1A3biv, 1A3dii, 1A4a, 1A4c

### B.6.1 Background

Fuel ethanol typically consists of pure ethanol of biomass origin, impurities or byproducts of ethanol fermentation, and denaturant (which is typically of fossil fuel origin or fossil gasoline). The previous editions of the GHG Inventory used an assumption that 5.4% of fuel ethanol volume is not pure ethanol (2.5% denaturant [USEPA 2010] and 2.9% impurities/byproducts [USEPA 2009]). This assumption was conservative, as it assigned the maximum fraction of denaturant and impurities/byproducts allowed under existing renewable fuel standards to the gasoline fuel category so these emissions would be accounted for in tracking the State's progress towards GHG limits. However, this results in an overestimation of fossil fuel emissions because the impurities/byproducts of ethanol fermentation come from biogenic feedstock and consist primarily of alcohols and water. This update modifies the assigned gasoline content of fuel ethanol to 2.5%, which is the maximum allowable percent denaturant in the U.S. Environmental Protection Agency's (USEPA) renewable fuel standard [USEPA 2010], and assigns the remaining impurities/byproduct volume to fuel ethanol.

### B.6.2 Data and Method

The total annual volumes of fuel ethanol are from data collected pursuant to MRR Section 95121 fuel supplier reporting requirements [CARB MRR 2022a]. To adjust for denaturant reported as ethanol, 2.5% of the total ethanol volume is assumed to be denaturant and added to total fossil gasoline volume, while the remainder continues to be designated as fuel ethanol.

## B.7 Gasoline Combustion: Align Emission Factors with MRR Section 95121 Fuel Supplier Emission Factors

IPCC Categories: 1A2k, 1A2m, 1A3a, 1A3bi, 1A3bii, 1A3biii, 1A3biv, 1A3dii, 1A4a, 1A4c

### B.7.1 Background

The previous editions of the GHG Inventory used emission factors from USEPA GHG Inventory [USEPA (2022c)], USEPA GHGRR Subpart C [USEPA 2009-2011] default emission factors referenced in Section 95115 of MRR [CARB MRR 2019], and CARB's EMFAC model [CARB EMFAC 2021a]. In the 2022 edition inventory, some of these emission factors are replaced with emission factors consistent with MRR Section 95121 fuel supplier reporting.

### B.7.2 Data and Method

Table 3 summarizes the changes to gasoline and ethanol emission factors in the 2022 edition inventory. For all on-road and non-road categories in the scope of MRR Section 95121 fuel supplier reporting, gasoline $CO_2$ emissions are now estimated using a year-specific gasoline $CO_2$ emission factor calculated as the annual total emissions from Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB) products reported under Section 95121 of MRR divided by the annual total volume of RBOB products used to calculate emissions reported under Section 95121 of MRR.[12]

For all non-road categories in the scope of MRR Section 95121 fuel supplier gasoline and ethanol data, $CH_4$ and $N_2O$ emissions for gasoline and ethanol are calculated using emission factors in Table 2-4 of MRR, Section 95121 [CARB MRR 2019].

[12] RBOB emissions are calculated under Section 95121 of MRR using the $CO_2$ emission factors for specific RBOB blends (i.e., RBOB summer/winter – regular, midgrade, winter) provided in USEPA GHGRR, Table MM-1 [USEPA 2009-2011].

On-road gasoline and ethanol $CH_4$ and $N_2O$ emissions continue to be quantified using CARB's EMFAC model [CARB EMFAC 2021a]. Ethanol $CO_2$ emissions continue to be calculated using the default emission factor and higher heating value (HHV) used in MRR facility emissions reporting (MRR Sections 95110-95120), which come from USEPA GHGRP, Subpart C [USEPA 2009-2011.

**Table 3. Changes to the Source of Gasoline and Ethanol Emission Factors (EF)**

| | CO2 EF | CH4 and N2O EFs |
|---|---|---|
| **Gasoline** use by non-road sources— except cement, refinery/hydrogen, and in-state electricity generation facilities* | *Previous editions:* USEPA<br>*2022 edition:* Year-specific EFs calculated from MRR supplier volume and emissions data | *Previous editions:* MRR Subpart C default EFs<br>*2022 edition:* MRR Subpart MM EFs |
| **Ethanol** use by non-road sources | No Change<br>(MRR Subpart C default EFs) | *Previous editions:* MRR Subpart C default EFs<br>*2022 edition:* MRR Subpart MM EFs |
| **Gasoline** use by on-road sources | *Previous editions:* USEPA<br>*2022 edition*: Year-specific EFs calculated from MRR fuel supplier volume and emissions data | No Change<br>(EMFAC vehicle-class-specific EFs) |
| **Ethanol** use by on-road sources | No Change<br>(MRR Subpart C default EF) | No Change<br>(EMFAC vehicle-class-specific EFs) |

* For cement, refinery and hydrogen production, and in-state electricity generation, and cogeneration facilities, the GHG Inventory incorporates facility data that are reported to MRR. Therefore, default emission factors are not used for these facilities.

## B.8 Natural Gas Combustion: Adjust Natural Gas Volume for Certain Categories to Match MRR Total Natural Gas Volume

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

### B.8.1 Background

Fossil natural gas reported by natural gas fuel suppliers under Section 95122 of MRR [CARB MRR 2019] captures the total energy content of natural gas supplied to

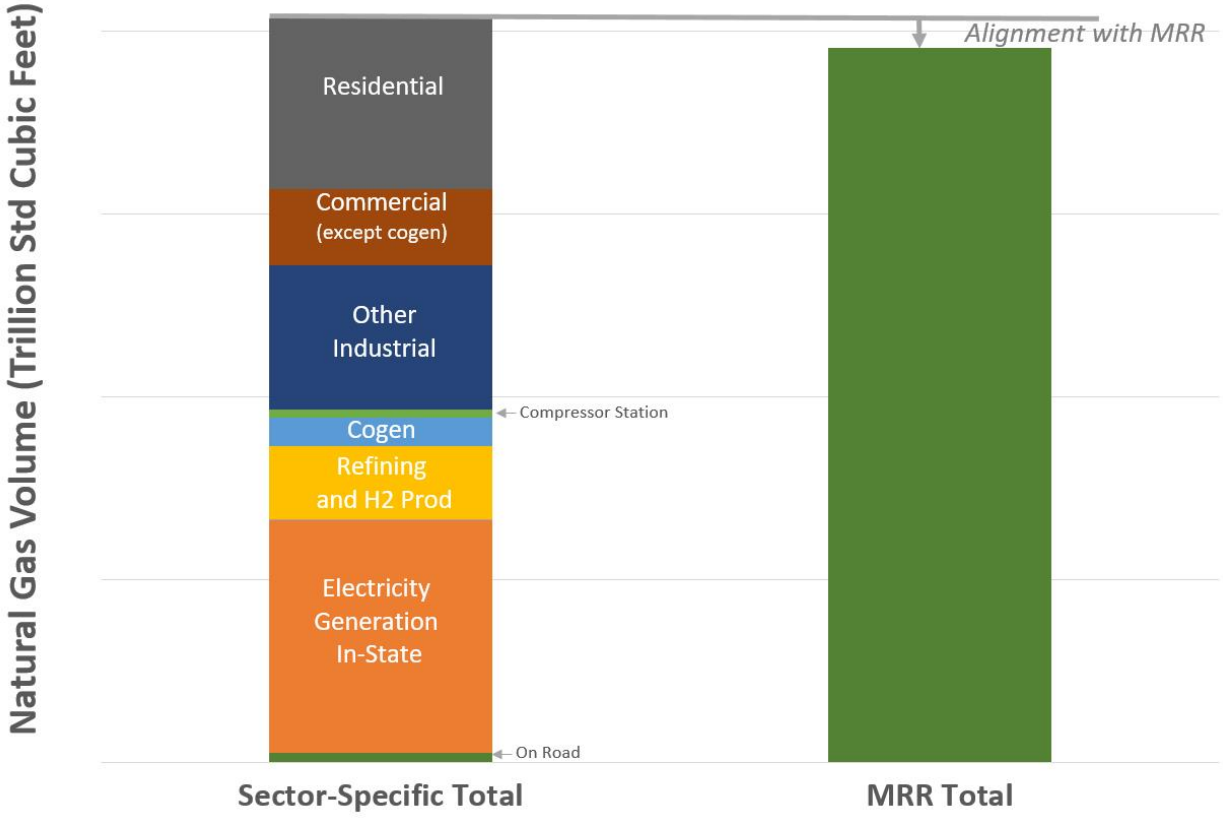
California customers by local distribution companies, intrastate pipeline operators, interstate pipeline operators, and LNG suppliers (as defined in the MRR regulation). Starting with the 2022 edition inventory, for calendar years 2012 and onward, CARB is aligning the total natural gas energy content in the inventory with the total natural gas energy content reported under Section 95122 of MRR. Because the total fossil natural gas heat content reported by natural 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, aligning the GHG Inventory to match MRR also requires proportionally scaling the fuel quantity of applicable sectors so the sum of all those sectors matches the MRR total natural gas quantity. Section B.8.2 provides further information about which natural gas combustion categories are subject to scaling, which are not, and how scaling is done.

## B.8.2 Data and Method

Table 4 lists the fossil natural gas combustion categories in the GHG Inventory that are captured by natural gas suppliers reporting under Section 95122 of MRR and the data source used as the basis for each end-use category (i.e., the sector-specific data). Scaling is not done for individual facilities subject to reporting requirements under MRR Sections 95110-95120 [CARB MRR 2019] and whose facility-specific data are directly incorporated into the GHG Inventory and subject to third-party verification. These include cement manufacturing, in-state electricity generation facilities, and in-state cogeneration units.

After setting aside cement manufacturing, refining and hydrogen production, in-state electricity generation, and in-state cogeneration units, all other sector categories noted in Table 4 are scaled to the balance of fuel and emissions from MRR. A graphical illustration of this alignment is shown in Figure 3.

**Figure 3: An Illustration of Natural Gas Combustion Categories Within the Scope of MRR Section 95122 Reporting and Alignment with MRR Total Volume**




Specifically, the following steps are taken in preparation of the scaling calculation:

Step 1. As in the previous inventory editions, compile sector-specific natural gas volumes (in standard cubic feet (scf)) and heating value (in British Thermal Units (Btu)) for combustion categories using data sets from other government agencies and programs as shown in Table 4.[13]

Step 2. Scale applicable categories as noted in Table 4 so the sum of all categories in Table 4 matches the total natural gas heating values (Btu) from MRR Section 95122 reporting (and scale the associated volumes (scf) as well). Repeat these steps for years 2012 and onward. Figure 4 shows the pre-scaled, sector-specific total

[13] No change to methodologies and data sources for Step 1 except as otherwise noted in this document. See GHG Inventory Technical Support Document [CARB TSD 2016-2020] for a detailed description of methodologies and data sources.

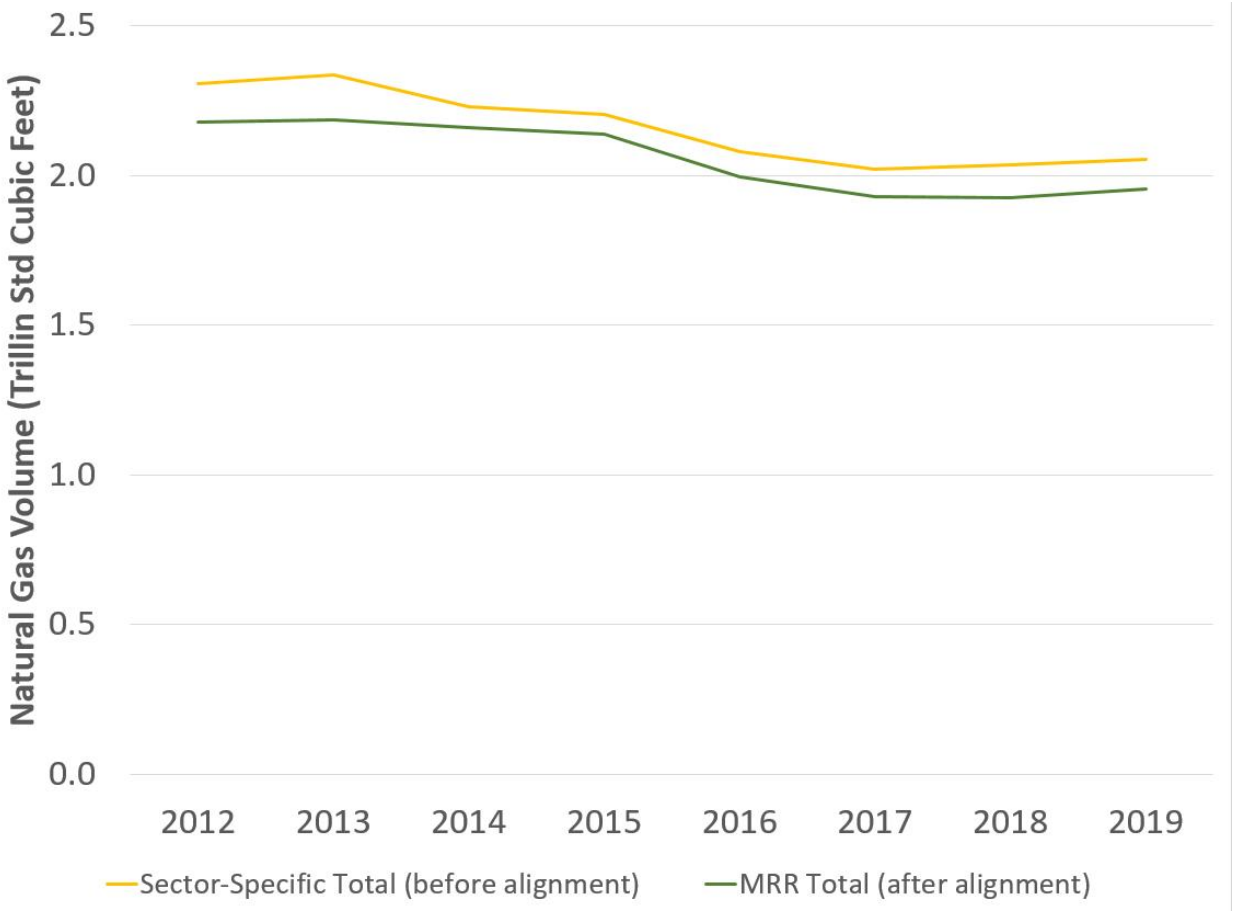
natural gas volumes in comparison to resulting volumes after matching the MRR reported heating values (Btu) to illustrate the magnitude of scaling for these years.

Note that scaling sector fuel data to MRR total fuel may result in new trends in historical data when compared to the trends in the original sector data. Because the difference between MRR total and the sector-specific inventory compilation total varies each year, the scaling factor also varies by calendar year and the variation may be significant for some years.

**Table 4: Natural Gas Combustion Categories Within the 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 2022c] | Yes |
| Electricity Generation (In-State) | MRR Sections 95112 and 95115 [CARB MRR 2022a] and EIA [EIA-923 2022] | No |
| Cement Manufacturing | MRR Subpart C [CARB MRR 2022a] | No |
| Refining and Hydrogen Production | MRR Sections 95113 and 95115 [CARB MRR 2022a] | No |
| Cogeneration Thermal Energy Allocated to Industrial Use | MRR Sections 95112 and 95115 [CARB MRR 2022a] and EIA [EIA-923 2022] | No |
| Cogeneration Thermal Energy Allocated to Commercial Use | MRR Sections 95112 and 95115 [CARB MRR 2022a] and EIA [EIA-923 2022] | No |
| Natural Gas Pipeline Compressor Stations | EIA [EIA 2022c] | Yes |
| Other Industrial Categories Not Yet Mentioned Above | CEC [CEC QFER 2022] | Yes |
| Commercial (Except Cogeneration Thermal Energy) | CEC [CEC QFER 2022] | Yes |
| Residential | CEC [CEC QFER 2022] | Yes |
| Agriculture Sector Natural Gas Combustion | CEC [CEC QFER 2022] | Yes |

**Figure 4. Comparison of Total Sector-Specific and MRR Total Natural Gas Heat Content**




## B.9 Refineries & Hydrogen Production: Incorporate Updated Data from the MRR Program for 2012-2020

IPCC Categories: 1A1b, 1B2ai, 1B2aii, 1B2aiii, 2H3

### B.9.1 Background

For 2009 and later years, the GHG Inventory has been using data that the facility operators in the *Refinery and Hydrogen Production* sector ("the Refining Sector") annually report pursuant to MRR.

***Petroleum Coke***

Petroleum coke is a material generated by thermally cracking the high molecular weight residues remaining from petroleum processing. When petroleum coke is generated in fluid coking units, some of the petroleum coke generated is combusted to provide heat for the petroleum coke reactor. Raw or "green" petroleum coke generated by coking units can be processed in coke calciners, which remove

volatile hydrocarbons from the petroleum coke. The process of coke calcining results in $CO_2$ emissions originating from the chemical transformation of the green petroleum coke.

There are no changes to the method for calculating the emissions for petroleum coke, but emissions from certain processes in this inventory edition are categorized differently from prior editions of the inventory to allow the source of those emissions to be more easily identified. In previous editions of the GHG Inventory, $CO_2$ emissions from petroleum coke use in fluid coking units and coke calciners were inconsistently categorized as either "process emissions" or "petroleum coke fuel combustion emissions." In the updated method:

- All emissions reported to CARB pursuant to MRR from petroleum coke combustion in fluid coking units are categorized as "petroleum coke fuel combustion" emissions in the GHG Inventory, and
- all emissions, except emissions explicitly associated with supplemental fuel combustion, reported pursuant to MRR from coke calcining, are categorized as "process emissions" in the GHG Inventory.

This approach to categorization enables more consistent and clearer identification of the source of these emissions within the GHG Inventory. The "process emissions" category consists of emissions from coke calcining, as described above, and process emissions associated with asphalt blowing units. Emissions associated with coke calcining emissions make up over 95 percent of emissions in the "process emissions" category.

***Natural Gas Alignment***

For the Refining Sector, facilities calculate and report emissions from natural gas (NG) and refinery fuel gas (RFG) usage pursuant to MRR. Refineries commonly mix purchased NG with RFG to adjust the heat content or other properties of the RFG before on-site use. In MRR reporting, this blend of purchased NG and RFG is reported mainly as "RFG" when used. Thus, in MRR reporting, the amount of NG purchased by the Refining Sector is much larger than the amount of NG reported as being used. In past editions of the GHG Inventory, CARB estimated natural gas emissions from refinery operations based on MRR values for total natural gas used and not total natural gas purchased. This resulted in NG use in the Refining Sector being under-represented in previous editions of the inventory, which were based on reported NG use. CARB staff developed a method to calculate NG usage in the Refining Sector so that it aligns with total NG purchased by the sector. Accordingly, Refining Sector NG use increased in this inventory edition, and RFG use decreased by an equal amount. This update ensures that the Refining Sector natural gas use in the GHG Inventory is consistent with natural gas purchases for the sector reported pursuant to MRR.

## B.9.2 Data and Method

MRR is the only source of data for the Refining and Hydrogen Production Sector in the GHG Inventory. CARB staff conducted the following data updates listed below. In addition to including these supplementary data quality checks and adjustments, the updated approach also incorporates new systemic use of MRR data (1) to consistently categorize emissions from coke calcining and fluid coking and (2) to ensure the Refining Sector natural gas use is consistent with natural gas purchases reported pursuant to MRR.

- Where appropriate, corrected fuel amounts to be consistent with the reported heat input based on the expected heat content range for the fuel. These adjustments did not affect emissions, only fuel amounts.

- Categorized GHG emissions, fuel volumes, and heat inputs based on mapping of reported fuel names to various fuel types in the existing GHG Inventory structure.
- Where appropriate, corrected reported feedstock hydrogen content data used to calculate the ratio of $CO_2$ fuel combustion to $CO_2$ process emissions from hydrogen production units. This check did not affect total emissions from hydrogen production units, only their categorization as fuel combustion emissions or process emissions.
- Ensured no double-counting of hydrogen production unit fuel volumes and heat contents that may be reported for multiple purposes. This check did not affect emissions, only fuel activity data.

***Petroleum Coke***

Emissions attributed to fuel combustion (activity level 1) of petroleum coke (activity level 2) in the GHG Inventory are calculated by summing the data reported pursuant to MRR for "fluid coking units" except for any data specifically attributed to the combustion of other fuels, such as natural gas, at these units. If the amount or heat input of the petroleum coke is not included with the process unit data reported pursuant to MRR, it is calculated based on the default emission factor and heat content for petroleum coke.

***Natural Gas Alignment***

The steps below summarize the method developed by CARB staff to calculate the natural gas used in the Refining Sector so that it aligns with total natural gas purchases for the sector as reported pursuant to MRR. Accordingly, Refining Sector RFG values are decreased by an equal amount. All calculations are performed at the aggregate sector-level.

The heat input to refining and hydrogen production facilities that is reported pursuant to MRR as "RFG" use but should correctly be attributed to natural gas ($NG_{add}$) use in the Refining and Hydrogen Production sector is calculated as:

$$NG_{add} = (NG_{purchased} - NG_{reported}) \times RFG_{fraction}$$

Where:

"$NG_{purchased}$" is the total heat input from natural gas to the Refining Sector. $NG_{purchased}$ is calculated as the sum of all natural gas purchases by the sector less all natural gas supplied by the sector to other entities.

"$NG_{reported}$" is the sum of natural gas heat input reported as combusted or consumed by each facility within the sector. This includes natural gas use reporting for electricity generation and cogeneration units at refineries, which is included in the electricity or cogeneration sectors in the GHG inventory.

"$RFG_{fraction}$" is the fraction of $CO_2$ emissions associated with RFG use, excluding RFG combusted at electricity generation and cogeneration units, relative to all $CO_2$ emissions associated with RFG use by the Refining Sector as reported pursuant to MRR. The new method for the in-state electricity and cogeneration sector in the GHG Inventory method adjusts for the remainder of the difference in heat inputs between $NG_{purchased}$ and $NG_{reported}$, which goes to electricity generation and cogeneration units as discussed in Section B.1.

In the Refining Sector within the GHG Inventory, GHG emissions from natural gas use are attributed to both fuel combustion and fuel consumption (use as hydrogen production feedstock) activity levels. The additional natural gas heat input attributed to the fuel combustion activity level ($NG_{fc}$) is calculated as:

$$NG_{fc} = NG_{add} \times (RFG_{fc} / RFG_{total})$$

Where:

"$RFG_{fc}$" is the total $CO_2$ emissions attributed to the combustion of RFG as reported pursuant to MRR excluding RFG combusted at electricity generation and cogeneration units.

"$RFG_{total}$" is the total $CO_2$ emissions attributed to RFG as reported to MRR for both fuel combustion and process emissions associated with hydrogen production.

The additional natural gas heat input attributed to the fuel consumption activity level ($NG_{H2}$) is calculated as:

$$NG_{H2} = NG_{add} \times (1 - RFG_{fc} / RFG_{total})$$

$NG_{fc}$ and $NG_{H2}$ heat inputs are added to the Refining Sector GHG Inventory NG fuel combustion and NG fuel consumption heat inputs. $NG_{fc}$ and $NG_{H2}$ heat inputs are

subtracted from the RFG fuel combustion and RFG fuel consumption heat inputs. The appropriate modifications to fuel volumes and GHG emissions for natural gas and RFG are made by multiplying adjusted heat input values, either $NG_{fc}$ or $NG_{H2}$, by sector average emission factors and heat contents for each fuel.

## B.10 Refineries & Hydrogen Production and Industrial Sector Natural Gas Combustion: Re-estimate Refinery Fuel Gas and Natural Gas Volumes for 2000-2011 to Reflect the Update in Section B.9

IPCC Categories: 1A1b, 1A2c, 1B2aiii, 1B4, 1A2m, 2H3

### B.10.1 Background

Before the inception of the MRR program, the GHG Inventory estimated NG and RFG emissions of the refinery sector using the fuel volume data collected by the CEC under the Petroleum Industry Information Reporting Act (PIIRA) [CEC PIIRA 2010]. PIIRA data were used for 2000-2008, and MRR data were used for 2009 and later years. The GHG Inventory also uses natural gas data from the CEC Quarterly Fuels and Energy Report (QFER) [CEC QFER 2022], which captures most of the sectors in the economy including refineries and industrial gas producers. The GHG Inventory uses the CEC QFER data for categories whose data source is not EIA or MRR. See Table 4 in Section B.8 for an overview of the natural gas data sources. Because the coverage of CEC QFER data overlaps with PIIRA data and MRR data, the refinery natural gas use quantity reported in MRR or PIIRA is deducted from the fuel quantity of the refineries and industrial gas producers category provided by the CEC QFER [CEC QFER 2022] to avoid double counting.

As described in Section B.9, CARB staff aligned the natural gas and RFG volumes use by the refinery sector for 2012 and later years, resulting in an increase in natural gas and a corresponding decrease in RFG volume for the refinery sector. As in previous editions of the inventory, the natural gas volume used by the refinery sector is reconciled with CEC's QFER natural gas data [CEC QFER 2022] for the broader industrial sector. The method for this reconciliation calculation is the same as in previous editions, and there is no change in methodology. However, the outcome of the reconciliation calculation is different due to the update described in Section B.9. Higher amount of natural gas now being assigned to the refinery sector (as described in Section B.9) results in lower amount of natural gas assigned to other non-refinery industrial sub-sectors. After deducting the Refinery Sector natural gas volume from the broader industrial sector, the remaining amount of natural gas is assigned to the

unspecified industrial manufacturing category of the inventory (*Industrial > Manufacturing > Not Specified*).[14]

Similar ambiguity in how refinery operators define RFG exist in CEC PIIRA data, which was the data source for refinery fuel volumes for 2011 and prior years in the previous edition of the GHG Inventory. In accordance with the IPCC Guidelines of applying inventory updates to older data years to ensure consistency of the time series, CARB staff applies similar adjustments to 2000-2011 data using a backcasting approach. The method for backcasting is described in Section B.10.2.

## B.10.2 Data and Method

CARB staff uses the average of the 2012-2020 natural gas heat values (in unit of MMBtu) that refinery operators reported to MRR ("MRR NG") as the baseline from which to backcast refinery natural gas to 2000. The CEC QFER NG heat data for refineries and industrial gas production ("CEC NG"), which MRR refinery natural gas is reconciled against, are close to the corrected refinery natural gas amounts from the update described in Section B.9. This CEC NG data was used as the surrogate to backcast the 2012-2020 MRR refinery natural gas average to 2000.

The backcasted NG volume is calculated as follows:

*Backcasted NG (Year X) =*

*CEC NG (Year X) * [2012-2020 Average MRR NG]/[2012-2020 Average CEC NG]*

This backcast results in a higher Refinery Sector natural gas heat amount than in the previous inventory editions. Following the same methodology as described in Section B.9, the backcasted natural gas heat values were deducted from the RFG heat amount for each year, so the total heat input remains the same for the Refinery Sector, and as with the current data year, higher amount of natural gas now being assigned to the refinery sector (as described in Section B.9) results in lower amount of natural gas assigned to other non-refinery industrial sub-sectors in the backcast.

[14] In the previous inventory editions, remaining amount after reconciliation calculation was assigned to the *Chemicals and Allied Products* category in the inventory. In the 2022 edition inventory, the *Chemical and Allied Products* category is merged with the "*Industrial > Manufacturing > Not Specified*" category.

## B.11 On-Road Transportation: Incorporate EMFAC 2021 Updates in Allocation of Statewide Transportation Fuels to Various Vehicle Types

IPCC Category: 1A3bi-iv

### B.11.1 Background

In 2021, CARB released an update version of the EMFAC model (EMFAC 2021) [CARB EMFAC 2021a], which incorporated several refinements to the on-road vehicle inventory since the previous version of the EMFAC model (EMFAC 2017). The refinements include updated vehicle fuel consumption using the latest *www.fueleconomy.gov* numbers [USEPA 2022a], updated $CH_4$ and $N_2O$ emission factors, and other real-world data from CDTFA, Department of Motor Vehicle (DMV), etc. that have been published for more recent years since the development of EMFAC 2017. The EMFAC Technical Document has more details [CARB EMFAC 2021b].

### B.11.2 Data and Method

There is no change to the methodology for how EMFAC outputs are used in the GHG Inventory. The EMFAC Technical Document [CARB EMFAC 2021b] contains descriptions of methodologies and data sources, as well as added features, updates, and changes since EMFAC 2017 (see pages 5-13 of the EMFAC Technical Document).

## B.12 Transportation and Industrial Sectors: Reclassify Non-Transport Off-Road Mobile/Portable Sources from the Transportation Sector to the Industrial Sector

IPCC Category: 1A3eii

### B.12.1 Background

In previous inventory editions, off-road mobile sources were grouped under the transportation sector. This was a legacy of how data sources of activity data used in the GHG Inventory evolved over time since the inception of the GHG Inventory program. Some off-road mobile sources are primarily intended for transportation purposes (e.g., all-terrain vehicles, snowmobiles, and jet skis), but other off-road mobile or portable equipment are not intended for transportation purposes, such as industrial mobile equipment, construction and mining equipment, oil drilling equipment, and airport ground support equipment.

To make the organization of inventory categories more intuitive to the public, off-road mobile source categories not intended for transportation purpose are

recategorized from the transportation sector to the industrial sector. The four categories being recategorized are: *Construction and Mining Equipment*, *Airport Ground Support Equipment*, *Industrial Equipment*, and *Oil Drilling Equipment*. This reclassification does not affect the overall statewide total emissions but shifts some emissions from the transportation sector to the industrial sector.

### B.12.2 Data and Method

The data and methods used to estimate the four off-road mobile source categories are the same as in previous editions. Only the broad sector categorization of these four categories is being modified.

## B.13 Aviation: Incorporate Alternative Jet Fuel Volume Reporting to the LCFS Program

IPCC Categories: 1A3a, 1A3aii

### B.13.1 Background

Historically, jet fuel consisted entirely of fossil fuel. In recent years, jet fuel of biological origin ("alternative jet fuel") has started being sold in non-negligible volumes. Since 2019, the LCFS program started to collect data on alternative jet fuel or the alternative fuel portion of a fossil/biofuel blend (consisting of a mixture of conventional and alternative jet fuel) that is uploaded to an aircraft in California.[15] The 2022 edition inventory is updated to account for the additional biofuel in the state's jet fuel supply by incorporating LCFS's alternative jet fuel volume into the inventory.

### B.13.2 Data and Method

The alternative jet fuel volume come from the LCFS Quarterly Report [CARB LCFS 2022b]. There is no change to methodology and data for calculating emissions as described in the GHG Inventory Technical Support Document [CARB TSD 2016-2020]. Alternative jet fuel uses the same factors as fossil-based jet fuel[16]. Emissions are calculated as gallons of fuel multiplied by heat content (Btu/gallon) multiplied by an emission factor (grams $CO_2$/Btu). The methodology for apportioning fuel volume into

[15] Alternative jet fuel is an opt-in fuel in the LCFS program pursuant to Section 95482 of the California Code of Regulations [CARB LCFS 2019] beginning in the 2019 data year. Therefore, reporting is voluntary and the reported volume may not be comprehensive. Alternative jet fuel or the alternative fuel portion of a blend (a mixture of conventional jet fuel and alternative jet fuel) that is uploaded to an aircraft in California is eligible for LCFS reporting.

[16] $CO_2$ emission factor of 0.07222 grams/Btu and heat content of 135,000 Btu/gallon are from MRR Table 2-3, page 153 [CARB MRR 2019]. $CH_4$ emission factor of 0.00000053 grams/Btu and $N_2O$ emission factor of 0.0000021 grams/Btu are from IPCC Guidelines [IPCC 2006].

intrastate, interstate, and international is also the same as in previous inventory editions. The biomass-based carbon content of alternative jet fuel is classified as bio-$CO_2$ in the GHG Inventory.

## B.14 Oil & Gas Production: Recalculate Fugitive Methane Emissions for 2000-2020 Based on Updated Information for 2017

IPCC Category: 1B2

### B.14.1 Background

In previous inventory editions, estimates of fugitive methane and $CO_2$ emissions from the "*Oil & Gas: Production & Processing*" category were distributed among three sub-categories: *Production*, *Processing*, and *Storage*. Aggregated data from CARB's Oil and Gas Industry Survey Report ("the 2017 Industry Survey") [CARB O&G 2007] were used in conjunction with other surrogate data to estimate emissions for this sector. The GHG Inventory Technical Support Document [CARB TSD 2016-2020] contains a technical description of how CARB staff utilizes the survey, which represents a one-year snapshot of emissions, in estimating emissions for the entire inventory time series.

Recent review of additional details of the original survey results led to two adjustments to the inventory: (1) redistribution of emissions among the *Production*, *Processing*, and *Storage* categories to more accurately represent the scope of each category; and (2) removing combustion emissions from the calculation of using the survey results in estimating emissions for the entire inventory time series. The first adjustment reallocated emissions among the three categories but does not result in a change in overall emissions for this sector. For the second adjustment, methane emissions in the 2007 Industry Survey categories of *Production, Processing, and Storage* included methane emissions from combustion in addition to fugitive methane emissions. Because methane emissions from combustion at Oil & Gas Production facilities are captured elsewhere in the GHG Inventory, the methane combustion emissions in the *Production*, *Processing*, and *Storage* categories have been removed.

In addition, a third adjustment to the inventory is made to the *Oil & Gas: Production & Processing* fugitive methane emissions estimates, based on updates made to the 2007 Industry Survey data during the development of CARB's Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities Regulation (Oil & Gas Methane Regulation, adopted in 2017) [CARB O&G 2016]. These updates to the survey data are described in more details in Section B.14.2.

### B.14.2 Data and Method

Previously in the GHG Inventory, fugitive methane emissions of the *Oil & Gas: Production & Processing* category were estimated using the 2007 survey results and were extrapolated to the whole (2000-2019) time series using the emission trends in USEPA's national GHG inventory as surrogates [USEPA 2021] [CARB TSD 2016-2020]. For fugitive methane emissions from *Oil & Gas: Production & Processing*, staff are now using the emissions presented in the 2017 Initial Statement of Reasons (ISOR) for the Oil & Gas Methane Regulation [CARB O&G 2016] as the anchor point for mapping the trend line of the entire 2000-2020 time series in the GHG Inventory.

Significant changes from the 2007 survey emissions to the 2017 ISOR emissions are as follows:

- Tanks and Separators: Staff updated the methodology to estimate emissions from tanks and separators as part the rulemaking. See Appendices B and D of the ISOR for details [CARB O&G 2016].
- Compressors: Compressor emissions were overestimated in the survey report because an emission factor for large compressors was applied to all compressors, including small in-field compressors that accounted for about 70% of the reported compressors. See Appendix B of the ISOR for details [CARB O&G 2016].
- Leak Detection and Repair (LDAR) components: For LDAR components (valves, flanges, connectors, etc.) CARB used high leaker emission factors to estimate emissions as part of the rulemaking. See Appendix B of the ISOR [CARB O&G 2016] and Attachment 2 of the 15-day Notice [CARB O&G 2017] for details.

## B.15 Natural Gas Transmission & Distribution (T&D): Implement Technical Clarification by Consolidating Inventory Categories

IPCC Category: 1B2b

### B.15.1 Background

In previous editions of the GHG Inventory, estimates of fugitive methane leaks that occur when natural gas is transported through pipelines, fittings, and meters was based on CARB's 2007 Natural Gas Transmission and Distribution (T&D) Industry Survey ("the T&D Survey") [CARB T&D 2007]. In consideration of confidential business information, the survey results were aggregated to one single value that represented all fugitive leaks from the T&D system. It was previously assumed that underground natural gas storage emissions were included in the T&D Survey results. Recent additional review by CARB Oil & Gas Program staff concluded that underground natural gas storage emissions were not captured in the T&D Survey but were captured

in the Oil & Gas Production survey [CARB O&G 2007]. Therefore, the T&D natural gas storage category ("*Transmission and Distribution > Natural Gas > Natural Gas Storage"*) is removed and all natural gas emissions associated with the T&D Survey are placed in the *Industrial T&D Natural Gas Pipeline Fugitive Emissions* category.

### B.15.2 Data and Method

The T&D natural gas storage category is removed and all natural gas emissions associated with the T&D Survey are placed in the *Industrial T&D Natural Gas Pipeline Fugitive Emissions* category. There is no change to data and method, and the total Industrial T&D Natural Gas emissions do not change.

## C. Interim Method During Data Transition

CARB utilizes data from several data sources in calculating GHG emissions. Occasionally, a data source agency may experience delays in data compilation due to various reasons; and as a result, the data needed for CARB to calculate GHG emissions may not be available at the time of inventory compilation. In other instances, a data source agency may begin revising statistical data using an improved method but could not complete the entire time series in one year, resulting in an artificial change in emissions numbers without an actual change in emissions. In these situations, CARB staff temporarily fills in the data gaps by either using the previous year value as a placeholder or employing data extrapolation techniques until revised data become available in future inventory cycles. This section describes the interim methods used in this inventory edition that are not permanent changes to inventory methodology, but that are expected to be revised when updated data become available in the future.

## C.1 Off-Road Gasoline and Ethanol Fuel Use

IPCC Categories: 1A2k, 1A2m, 1A3a, 1A3dii, 1A4a, 1A4c

### C.1.1 Background

In the GHG Inventory, on-road gasoline fuel use data come from CDTFA reported net taxable volumes [CDTFA 2022], which includes gasoline subject to taxation for use on highways and roads. MRR provides the full reported amount of gasoline used in California [CARB MRR 2022a]. The total fuel quantity assigned to non-road categories is calculated as the difference between the MRR total gasoline volume and CDTFA on-road volume:

*MRR total statewide gasoline volume – CDTFA taxable gasoline volume (on-road vehicle) = Remaining gasoline allocated to non-road categories*

For 2019 data, CDTFA's total gasoline volume for on-road was greater than MRR's total gasoline volume. Because the total non-road fuel volume cannot be a

negative number, CARB staff used 2018 data as a placeholder for 2019 data in the 2021 edition. Now that 2020 data have become available, the placeholder for 2019 is updated to the average of 2018 and 2020 data. The placeholder calculation does not apply to ethanol volume. As a result, the 2019 total gasoline volume in the GHG Inventory is higher than MRR's total gasoline volume, but the 2019 total ethanol volume in the GHG Inventory continues to match MRR's total ethanol volume.

### C.1.2 Interim Emission Estimation Methodology

CARB staff follows the same methodology as in previous inventory editions to allocate gasoline and ethanol across all gasoline combustion categories, then implements the update described in Section B.6. CARB uses the average of 2018 and 2020 non-road total gasoline as the placeholder for 2019. The on-road gasoline volumes in the 2022 edition inventory continue to come from CDTFA data. (In the GHG Inventory data tables, the fossil component of gasoline is presented as "gasoline.")

## C.2 Wood Combustion in the Industrial, Commercial, and Residential Sectors

IPCC Categories: 1A2m, 1A4a, 1A4b

### C.2.1 Background

The CARB GHG Inventory uses EIA SEDS data [EIA SEDS 2021b] for wood combustion. The EIA data provide an annual fuel use amount for the industrial, commercial, and residential sectors. The EIA data for 2020 wood use were not available at the time of GHG Inventory compilation. In the interim, 2019 wood use data from EIA are used as a placeholder for 2020 data.

### C.2.2 Interim Emission Estimation Methodology

For 2020 wood combustion data for the industrial, commercial, and residential sectors that were not available in time for the 2022 edition inventory compilation, staff temporarily filled in 2019 data as placeholders for the 2020 values.

## C.3 Limestone and Dolomite Consumption

IPCC Category: 2G4b

### C.3.1 Background

The GHG Inventory uses limestone (CaCO3) and dolomite ($CaCO_3MgCO_3$) data from the United States Geological Survey (USGS) Minerals Yearbook [USGS 2016].

California specific limestone and dolomite data have not been made available in recent times; and therefore, CARB has not had access to the necessary data for emission estimation. CARB staff temporarily filled the data gap with placeholder values until these data are updated in future year.

### C.3.2 Interim Emission Estimation Methodology

For 2017-2020 USGS data that were not available in time for the 2022 edition inventory compilation, staff temporarily filled in 2016 values as placeholders.

## C.4 Livestock Population

IPCC Category: 3A1, 3A2, 3C4

### C.4.1 Background

In the GHG Inventory, livestock emission estimates are primarily based on the emission factors used in the USEPA national GHG inventory [USEPA 2022b], while California's livestock numbers mostly rely on population data from U.S. Department of Agriculture (USDA) 5-year Census of Agriculture [USDA 2022)]. For intervening years between the Census of Agriculture years, data for many of California's livestock categories are unavailable, leaving gaps in the inventory data until the next Census of Agriculture is published.

### C.4.2 Interim Emission Estimation Methodology

For dairy categories, CARB staff continues to follow previously published assumption of a 0.5% decline per year in population and emissions starting in 2018 [CARB IU 2020] until the next Census of Agriculture is available. For any other livestock categories with 2020 data gaps, staff filled in the most recent available population values as placeholders until new data are published.

# D. Miscellaneous Updates

## D.1 Inventory Sector Activity Codes

The Scoping Plan categorization, which groups the Sector Activity Codes (SACs) of the detailed inventory categorization into aggregated categories used in the Scoping Plan document, was updated in the 2022 edition of the GHG Inventory. With the reclassification of off-road mobile source SACs from the transportation sector to the industrial sector (see Section B.13 for more information), a similar reclassification was made in the Scoping Plan categorization. Additionally, some SACs have been reclassified to make the presentation more intuitive for the public. These include: recategorize lubricants for fuel combustion equipment as "other fugitive and process emissions" (formerly grouped with the fuel combustion category); and break out distillate fuel from the generic "other fuel" category within the commercial and residential sector.

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