California's 2000-2022 AB 32 Greenhouse Gas Emissions Inventory (2024 Edition)

Inventory Updates for the 2024 Edition

Supplement to the Technical Support Document

CALIFORNIA AIR RESOURCES BOARD

Industrial Strategies Division

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Table of Contents

A. Introduction

Assembly Bill (AB) 1803 gave the California Air Resources Board (CARB) the responsibility to prepare and update California's Assembly Bill 32 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 2024 edition of the Inventory covers emissions for 2000 through 2022 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 2024 edition of the Inventory (2000-2022 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 2022, 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 2024 edition of the Inventory. 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., 2000-2021 activity data in the 2024 edition of the Inventory, where 2022 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 Diesel Combustion: Revise Approach for Allocating Fossil Distillate, Renewable Diesel, and Biodiesel Among Sectors

IPCC Categories: 1A

B.1.1 Background

The Inventory uses sector-specific diesel volumes from facility-level data reported pursuant to the Regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR) as well as data published by the U.S. Energy Information Administration (EIA) [EIA 2022], the California Department of Tax and Fee Administration (CDTFA), and CARB's Off-Road Diesel Models [CARB 2024a] as the data sources for fuel quantity used by each sector/subsector. Diesel data from these sources represent the combined sum of fossil diesel and biofuels ("total diesel blend") and do not distinguish biofuels from fossil diesel. Since the 2020 edition, the Inventory has been using biodiesel and renewable diesel (RND) volumes (collectively referred to as "biofuels" in the context of this section) reported to the Low Carbon Fuel Standard (LCFS) program [CARB 2024b] to break out total diesel blend into three components: fossil diesel, biodiesel, and RND [CARB 2020]. To ensure that the original total diesel blend volume is conserved, equivalent volumes of biofuels are subtracted from the sector-specific total diesel blend volumes.

Further, diesel volumes for sectors/subsectors that use EIA data or CARB's Off-Road Diesel Models[2] are proportionally adjusted such that the final sum of fossil distillate in the Inventory is equal to the sum of fossil distillate reported by fuel suppliers pursuant to Section 95121 of MRR.[3]

In previous editions of the Inventory, the following steps were taken in preparation of the scaling calculation:

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[2] Except water-borne subsectors. See footnote 3.

[3] 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 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 2024a], 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 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.

Step 1. Compile sector-specific total diesel blend volumes for combustion categories using data sets from other government agencies and programs as shown in Table 1.[4]

Step 2. For combustion categories subject to biofuel allocation (see Table 2), allocate a proportional percentage of the total diesel blend volumes from Step 1 into biodiesel and RND using data collected by LCFS [CARB 2024b]. The remaining total diesel blend volume represents fossil distillate.

Step 3. Scale fossil distillate for applicable categories as noted in Table 1 so the sum of fossil distillate used by all categories in Table 1 matches the sum of all Distillate No. 1 and No. 2 volumes reported by MRR Section 95121 fuel suppliers for a given reporting year.[5]

This sequence of steps resulted in slightly different biofuel proportions for sectors/subsectors that are scaled to MRR totals than for sectors/subsectors that are not scaled.

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

[5] The on-road transportation fuel volume in the sector-specific Inventory compilation (step 1) represents the amount of fuel combusted within California borders. This includes fuel purchased by truck drivers at fueling stations outside of California but burned in California. This volume is captured by CDTFA's IFTA total diesel blend volume [CDTFA 2024a], which represents the "net" of fuel combusted in California by trucks that loaded fuel outside of California (which are not included in MRR fuel supplier data but are included in the Inventory) minus the fuel volumes combusted outside of California by trucks that loaded fuel inside of California (which are included in MRR fuel supplier data but not included in the Inventory). Therefore, in practice, the sum of fossil distillate used by all categories in Table 1 is being matched to the sum of the volumes reported under MRR Section 95121 and the portion of the IFTA total diesel volume attributed to fossil distillate.

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 2024b]	No
Unspecified Fuel Use	CDTFA [CDTFA 2022c]	No
Electricity Generation (In-State)	MRR Sections 95112 and 95115 [CARB 2024c] and EIA [EIA 2024a]	No
Cement Manufacturing	MRR Section 95115 [CARB MRR 2024c]	No
Cogeneration Thermal Energy Allocated to Industrial Use	MRR Sections 95112 and 95115 [CARB 2024c] and EIA [EIA 2024a]	No
Cogeneration Thermal Energy Allocated to Commercial Use	MRR Sections 95112 and 95115 [CARB 2024c] and EIA [EIA 2024a]	No
Other Industrial Categories Not Yet Mentioned Above	EIA [EIA 2022]	Yes
Commercial (Except Cogeneration Thermal Energy)	EIA [EIA 2022]	Yes
Residential	EIA [EIA 2022]	Yes
Rail	EIA [EIA 2022]	Yes
Agriculture Sector Diesel Combustion	EIA [EIA 2022]	Yes
Military	EIA [EIA 2022]	Yes
Off-Road Mobile Sources	CARB's Mobile Source Inventory Models [CARB 2024a]	Yes

B.1.2 Data and Method

Starting with the 2024 edition of the Inventory, diesel adjustments to allocate biofuels (step 2 above) and to scale fossil distillate totals to align with MRR fuel supplier totals (step 3 above) are completed in a single step rather than sequentially. Table 2 lists the sectors/subsectors with diesel combustion, whether each receives a biofuel allocation, and whether each is scaled.

Table 2. Biofuel Allocation and Scaling Designations for Sectors/Subsectors with Diesel Combustion

Sector (Subsector)	Biofuel Allocation	In MRR Scope	Scale
Agriculture	Yes	Yes	Yes
Commercial (Combined Heat & Power)	Yes	Yes	No
Commercial (Not Specified)	Yes	Yes	Yes
Electricity Generation (In State)	Yes	Yes	No
Industrial (Combined Heat & Power)	Yes	Yes	No
Industrial (Manufacturing – Cement)	Yes	Yes	No
Industrial (Manufacturing – Not Specified)	Yes	Yes	Yes
Industrial (Oil & Gas)	Yes	Yes	Yes
Industrial (Off-Road Equipment)	Yes	Yes	Yes
Industrial (Petroleum Refining & Hydrogen Production)	Yes	No	n/a
Military	No	Yes	Yes
Residential	Yes	Yes	Yes
Transportation (Not Specified)	Yes	Yes	No
Transportation (On-Road)	Yes	Yes	No
Transportation (Rail)	Yes	Yes	Yes
Transportation (Water-borne: Harbor Craft)	Yes	No	n/a
Transportation (Water-borne: Port Activities and Transit)	No	No	n/a

Since two sectors/subsectors – *Transportation (Water-borne: Harbor Craft)* and *Industrial (Petroleum Refining & Hydrogen Production)* – receive a biofuel allocation but are not in the MRR fuel supplier scope, the biofuel fractions and scaling factor are interdependent. Staff defined a system of equations describing the relationships between the biofuel fractions, scaling factor, and known fuel volumes. Solving for the biofuel fractions and scaling factor in this system of equations results in the desired outcomes of allocating biofuels proportionally amongst all applicable sectors, aligning fossil distillate volumes with MRR fuel supplier data, and aligning biofuel volumes with LCFS data.

B.2 Fuel Combustion: Update Select Emission Factors and Higher Heating Values

IPCC Categories: 1A1cii, 1A2k, 1A2m, 1A3, 1A3a, 1A3b, 1A3bi, 1A3bii, 1A3biii, 1A3biv, 1A3c, 1A3di, 1A3dii, 1A3eii, 1A4a, 1A4b, 1A4c, 1A5

B.2.1 Background

Much of the state's GHG emissions from fuel combustion are calculated by multiplying the amount of fuel consumed by a default emission factor (EF) and higher heating value (HHV). In the 2022 edition of the Inventory, many of these default EFs used for the year 2012 and beyond were updated to align with MRR Section 95121's fuel supplier emission factors. For this 2024 edition, in accordance with the IPCC Guidelines of applying inventory updates to older data years to ensure consistency of the time series, CARB staff applied those same EFs and HHVs to calculations performed for the years 2000-2011.

In addition, staff reviewed EFs and HHVs used to calculate GHG emissions from 2000-2022 for 11 different fuels and made revisions where appropriate. The 11 fuels analyzed account for 93% of the state's fuel use over the 2000-2021 time period. This analysis did not apply to cement, refining and hydrogen production, in-state electricity generation, and cogeneration facilities because the Inventory incorporates facility data from those sources as reported pursuant to MRR. On-road gasoline and ethanol CH_4 and N_2O emissions were also excluded from this analysis. Those emissions continue to be quantified using EFs from CARB's EMFAC model [CARB 2021].

B.2.2 Data and Method

Table 3 summarizes the changes made to default fuel EFs and HHVs for the 2024 edition of the Inventory. Years referenced in the "Previous Editions" column are data years, not inventory editions. Additional details for certain changes are included below the table.

Table 3. Changes to the Source of Fossil Fuel Emission Factors

Fuel	Factor	Previous Editions	2024 Edition
Gasoline	CO_2	*2000-2011*: Year-specific national factors from prior U.S. EPA GHG Inventory reports. *2012+:* Year-specific statewide factors from MRR calculated per section B.7.2 of [CARB 2022].	*2000-2011:* Year-specific national factors from [USEPA 2023]. *2012+:* Year-specific statewide MRR factors reflecting data reported by 02/07/2024.
Gasoline, Ethanol, and Fossil Distillate	CH_4 and N_2O	*2000-2011*: Defaults for "Petroleum Products" from Table C-2 of [USEPA 2024a]. *2012+*: Defaults from Table 2-4 of [CARB 2019].	*2000-2011*: Defaults from Table 2-4 of [CARB 2019]. *2012+*: No change.
Renewable Diesel and Biodiesel	CH_4 and N_2O	*All years*: Defaults for "Petroleum Products" from Table C-2 of [USEPA 2024a].	*All years*: Defaults from Table 2-4 of [CARB 2019].
Biomethane	CO_2 and HHV	*All years*: Defaults for "Biogas" from Table C-1 of [USEPA 2009].	*All years*: Defaults for "Natural Gas: Pipeline (Weighted U.S. Average)" from Table C-1 of [USEPA 2009].
Fossil Distillate	CO_2	*2000-2011*: Default for "Distillate Fuel Oil No. 2" from Table C-1 of [USEPA 2024a]. *2012+:* Year-specific statewide factors from MRR calculated per section B.4.1 of [CARB 2022].	*2000-2011*: Default for "Distillate No. 2" from Table MM-1 of [USEPA 2024a]. *2012+*: No change.
Renewable Diesel	CO_2	*2000-2011*: Default for "Distillate Fuel Oil No. 2" from Table C-1 of [USEPA 2024a].	*2000-2011*: Default for "Distillate No. 2" from Table MM-1 of [USEPA 2024a].

Fuel	Factor	Previous Editions	2024 Edition
Renewable Diesel – Agricultural, Manufacturing, Oil & Gas, Off-Road, Rail, Residential, and Non-Specified Commercial Sources.	CO_2	*2012+*: Default for “Distillate Fuel Oil No. 2” from Table C-1 of [USEPA 2024a].	*2012+*: Year-specific statewide factors from MRR calculated per section B.4.2 of [CARB 2022].
Biodiesel – Agricultural, Manufacturing, Oil & Gas, Off-Road, Rail, Residential, and Non-Specified Commercial Sources.	CO_2 and HHV	*All years*: Default for “Distillate Fuel Oil No. 2” from Table C-1 of [USEPA 2024a].	*All years*: Default for “Biodiesel (100%)” from Table C-1 of [USEPA 2024a].
Natural Gas – On-Road Transportation and Transmission and Distribution Pipelines	HHV	*2000-2013*: State-specific default from [EIA 2024b]. *2014+:* Default for “Natural Gas: Pipeline (Weighted U.S. Average)” from Table C-1 of [USEPA 2009].	*All years*: State-specific default from [EIA 2024b].

The CO_2 EF and HHV of biomethane were changed from those assigned to “Biogas” in [USEPA 2009] to those assigned to “Natural Gas: Pipeline (Weighted U.S. Average)” in [USEPA 2009] because in California this gas is pipeline quality. This change also improves consistency with the way CH_4 and N_2O emissions from biomethane combustion are calculated, which have historically been based on the default EFs for “Natural Gas” from Table C-2 of [USEPA 2009].

The CO_2 EF of fossil distillate and renewable diesel from 2000-2011 was changed for consistency with [CARB 2019] which uses the value from Table MM-1 of [USEPA 2024a].

CARB’s MRR uses the [USEPA 2009] default HHV for natural gas. This factor was also used for natural gas combustion by on-road vehicles and in transmission and distribution pipelines in prior versions of the Inventory. While the Inventory typically uses the same EFs and HHVs as MRR, the HHV of natural gas used for on-road transportation and transmission and distribution pipeline consumption was updated to reflect state-specific default factors from the U.S. Energy Information Administration. This change was made for these specific sources because the Inventory's estimate of the amount of natural gas consumed by these sources comes from EIA. Also, the MRR factor is a national average, from one specific year, so EIA's annually varying factors for California are thought to better reflect the natural gas consumed by these sectors in California in each year.

B.3 Aviation: Consider New Aircraft When Allocating Jet Fuel Among Intrastate, Interstate, and International Flights and Other Data Updates

IPCC Category: 1A3aii

B.3.1 Background

To calculate emissions from the combustion of jet fuel and alternative jet fuel, the Inventory relies on data from the EIA [EIA 2024c] and LCFS [CARB 2024b]. The EIA dataset captures all blended jet fuel sold in California each year and the LCFS dataset captures the portion of that blended jet fuel that is alternative jet fuel. The resulting jet fuel and alternative jet fuel volumes are converted to emissions using the default higher heating value and emission factors for (fossil) jet fuel from U.S. EPA [USEPA 2024a] 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, interstate, and military flights. The CO_2 emissions from combustion of alternative jet fuel used for intrastate flights are also excluded and reported separately to align with IPCC guidance [IPCC 2006]. As a result, only the GHG emissions from (fossil) jet fuel combusted on intrastate flights and the CH_4 and N_2O emissions from alternative jet fuel combusted on intrastate flights are included in the statewide emissions estimate presented in the Inventory.

This approach requires apportioning EIA's blended jet fuel among intrastate, interstate, international, and military flights as well as between fossil and alternative components. The steps staff utilizes to apportion the jet fuel are described in detail in the Technical Support Document [CARB 2016] and the 2022 Edition Inventory Updates Document [CARB 2022]. The methodology remains unchanged for the 2024 edition of the Inventory; however, newly available data were incorporated which resulted in revised emission estimates for the sector from 2007-2021. A summary of these data updates is provided below, along with a summary of the related methodological steps.

B.3.2 Data and Method

The first step staff uses to allocate jet fuel and alternative jet fuel sold in California among the four types of flights is to assign a portion of EIA's blended jet fuel to military operations using data provided by the California Energy Commission (CEC). All jet fuel assigned to the military is assumed to be fossil jet fuel. Next, the portion of EIA's blended jet fuel captured by CDTFA [CDTFA 2024c] – which includes taxable jet fuel used for general aviation[6] – is assigned to intrastate flights. Finally, the remainder of EIA's blended jet fuel is subdivided among intrastate, interstate, and international flights using flight activity data from the U.S. Department of Transportation (DOT) [USDOT 2024]. The DOT dataset includes the origin, destination, type of aircraft, and flight length for all commercial flights taking off in California.

For use in apportioning the remaining blended jet fuel between intrastate, interstate, and international flights, staff has developed fuel consumption factors that can be applied to each flight as a function of distance. These factors vary by type of aircraft and are based on data from the European Environment Agency (EEA) [EEA 2007]. Staff estimates the amount of blended jet fuel used for each flight in the DOT dataset taking off in California based on the type of aircraft, flight length, and these fuel consumption factors. The fuel volumes are then summed to intrastate, interstate, and international totals based on the destination of the flight in the DOT dataset. These three values are then summed, and a percentage of that total is determined for each of the three types of flights. The remaining EIA blended jet fuel is then divided between intrastate, interstate, and international flights using these percentages. Finally, this blended jet fuel is divided between fossil and alternative components using the assumption that the percentage of that fuel that is fossil and alternative is the same for intrastate, interstate, and international flights.

While preparing the 2024 edition of the Inventory, staff identified a number of aircraft types in the DOT dataset had not yet been assigned a fuel consumption factor. Staff followed the approach described in [CARB 2016] to develop a factor for each of these aircraft types. The aircraft that were newly assigned factors, as well as the factors themselves, are included in the Table 4 below, which follows the format of Table 26 in [CARB 2016].

Table 4. Fuel Consumption Factors for Aircraft Types Added for 2024 Edition

Aircraft IATA code	Aircraft	Engine type	LTO Fuel (kg)	Cruise Fuel (kg/mi)	Max Takeoff Weight (kg)
339	Airbus A330-900	Turbofan	2,293.5	12.00	251,000
359	Airbus A350-900	Turbofan	2,471.1	12.99	270,000
406	Beech 200 Super Kingair	Turboprop	93.76	1.10	12,500

[6] General aviation flights are private and commercial flights other than military, scheduled airline or regular cargo flights.

Aircraft IATA code	Aircraft	Engine type	LTO Fuel (kg)	Cruise Fuel (kg/mi)	Max Takeoff Weight (kg)
415	Cessna C208b/Grand Caravan	Turboprop	67.85	0.79	8,750
458	Beechcraft Super King Air	Turboprop	93.76	1.10	12,500
495	Hawker Beechcraft Hawker 4000	Turbofan	747.4	4.35	39,500
515	Bombadier Challenger 350	Turbofan	753.4	4.37	40,600
575	Bombardier Learjet 75	Turbofan	652.4	3.99	21,500
653	Cessna Ce-680 Citation Sovereign	Turbofan	700.7	4.17	30,775
685	Cessna 510 Mustang/560xl Citation Excel	Turbofan	645.8	3.96	20,200
688	Bombardier Global 5000	Turbofan	1,060.4	5.68	92,500
721	Airbus A321-200N	Turbofan	1,000.7	5.42	83,000
722	Airbus A320-200N	Turbofan	909.6	5.02	68,000
723	A220-100 BD-500-1A10	Turbofan	856.8	4.80	59,000
724	A220-300 BD-500-1A11	Turbofan	891.8	4.94	65,000
725	Dassault Falcon 8X	Turbofan	939.5	5.15	73,000
748	Embraer EMB195	Turbofan	794.3	4.54	48,000
750	Gulfstream G650	Turbofan	1,106.2	5.89	99,600
751	Bombardier Global 7500 BD-7500	Turbofan	1,207.4	6.36	114,850
774	Dassault Falcon 2000	Turbofan	641.8	3.95	19,414

Aircraft IATA code	Aircraft	Engine type	LTO Fuel (kg)	Cruise Fuel (kg/mi)	Max Takeoff Weight (kg)
788	Bombardier Global 6000/Global XRS	Turbofan	1,105.5	5.89	99,500
824	Airbus A330-900neo	Turbofan	2,293.5	12.00	251,000
833	Embraer Legacy 650	Turbofan	825.7	4.67	53,572
836	Airbus 350-1000	Turbofan	2,845.7	15.12	308,000
837	Boeing 787-10 Dreamliner	Turbofan	2,321.1	12.15	254,000
838	Boeing B737 Max 800	Turbofan	976.0	5.31	79,000
839	Boeing B737 Max 900	Turbofan	1,013.1	5.47	85,000
888	Boeing 737-900ER	Turbofan	1,031.1	5.47	85,000
889	B787-900 Dreamliner	Turbofan	2,321.1	12.15	254,000

The inclusion of these aircraft in the allocation of blended jet fuel between intrastate, interstate, and international flights reduced the amount of fuel assigned to intrastate flights in all years between 2007 and 2021, except 2012 where there was a slight increase. These changes in fuel use had a proportional impact on the emissions from intrastate flights included in the Inventory.

Additionally, emissions for the years 2017-2021 were recalculated to incorporate revised jet fuel volumes from EIA and CEC. Since the 2023 edition of the Inventory was completed, EIA revised their estimate of California's total jet fuel consumption for 2019 and 2020. The 2019 value was reduced by 2.29% and the 2020 value was increased by 0.18%. These changes were incorporated into the 2024 edition of the Inventory, slightly reducing emissions for 2019 and slightly increasing them for 2020 relative to the 2023 edition.

The 2023 edition of the Inventory assumed military jet fuel use for 2017-2021 matched 2016 levels. Since the 2023 edition of the Inventory was completed, CARB staff obtained 2017-2021 military jet fuel use from CEC and incorporated this data for the 2024 edition. This change increased military consumption by 0.72-6.12% during these years. Because statewide jet fuel use remains fixed to the value provided by EIA, this change slightly reduced the amount of jet fuel available to be assigned to commercial flights, including intrastate flights. Thus, this change slightly reduced included emissions.

In total, the updates described above generally reduced the emissions from aviation included in the Inventory for 2007-2021. Emissions did increase in a few years, but never by more than 0.01 $MMTCO_2e$. Reductions exceeded 0.1 $MMTCO_2e$ in 2016-2021 only. The largest change was in 2019 when emissions were reduced by 0.42 $MMTCO_2e$.

B.4 Livestock Enteric Fermentation and Manure Management: Livestock Population Update

IPCC Category: 3A1, 3A2

B.4.1 Background

Livestock population data is sourced from the U.S. Department of Agriculture (USDA) 5-year Census of Agriculture [USDA 2024]. For years intervening census publication, data for many livestock categories are unavailable. Previous editions of the Inventory published an assumption of a 0.5% decline in population and emissions for dairy categories beginning in 2018. Other cattle categories were kept static year over year.

B.4.2 Data and Method

Dairy cows, other cattle populations, swine, sheep, goats, and beef cow populations were updated with available census data for 2022. In addition, swine, sheep, goats, and beef cow populations were updated for 2017.

Since the "Other Cattle" category population in the census increased from 2017 to 2022, the existing assumptions that dairy subpopulations were declining 0.5% per year was no longer valid. Therefore, staff updated the dairy subpopulation estimates for 2018-2021 to reflect a linear slope between the two census years.

For livestock categories where disaggregated data is not available in the USDA Census, population subtotals were determined by applying 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]. Other than this update, the methods for all livestock population estimates and emissions calculations were kept the same.

B.5 Livestock Manure Management: Reflect Dairy Emissions Reductions as a Result of Additional Anaerobic Digester Data

IPCC Category: 3A2

B.5.1 Background

The 2023 edition of the Inventory used updated sources for dairy manure management practices to account for a recent acceleration in the portion of manure managed by anaerobic digesters, which began around 2017. Populations of dairy cows with manure managed in anaerobic digester systems are based on data from LCFS and the Cap-and-Trade Program, which are verified by CARB-accredited third parties. Staff aggregate the adjusted population across all California projects in each year to provide the statewide population of dairy cows with manure managed in anerobic digesters and subtract this population from the proportion of dairy cow manure managed in anerobic lagoons.

B.5.2 Data and Method

LCFS data is incorporated into the Inventory after a pathway has been certified. Pathway certification applications can include population data for years prior to the current inventory year. In this case, the population data is aggregated and incorporated into the statewide dairy cow population with manure managed in anaerobic digesters for prior years. In the 2024 edition of the Inventory, the dairy cow population with manure managed in anaerobic digesters was increased for data years 2020 and 2021 compared to the 2023 edition of the Inventory based on new LCFS pathway certification data.

B.6 Landfills: Update Factors for Lumber/Wood Products and Integrate U.S. EPA's Latest Greenhouse Gas Reporting Program Data

IPCC Category: 4A1

B.6.1 Background

Methane emissions from landfills are estimated as a function of the types and amounts of organic waste disposed in each year, precipitation, the fraction of landfill gas generated that can be collected, landfill gas destruction efficiency, and landfill cover oxidation fraction as described in the Inventory Technical Support Document [CARB 2016]. Landfill emissions also include CH_4 and N_2O from the combustion of landfill gas.

Landfill emissions in the Inventory are calculated using a landfill model developed by CARB staff. The model uses parameters from a variety of sources. Model inputs include total degradable organic carbon (TDOC) and the anaerobically degradable fraction of organic carbon (DANF, carbon that will decompose in the anaerobic conditions of a landfill). These two parameters are obtained from U.S. EPA's "Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)" [USEPA 2020] for several waste categories: Newspaper, Office Paper, Corrugated Boxes, Coated Paper, Food, Grass, Leaves, and Branches. For the remaining material types, TDOC and DANF are obtained from IPCC. In the 2023 edition of the Inventory, TDOC and DANF for lumber referenced CEC 2006.

B.6.2 Data and Method

In December 2023, U.S. EPA updated the TDOC and DANF factors for the 'Coated paper' waste category. The 2024 edition of the Inventory uses U.S. EPA's updated factors for 'Coated paper' in the landfill model, which has no impact on emissions because the product of TDOC and DANF remains unchanged.

Staff also replaced the parameters for 'Lumber' from the previously used CEC 2006 report with values from USEPA's 2023 WARM model, which reduced emissions from wood waste in all years. WARM provides parameters for three types of wood: Dimensional Lumber, Medium Density Fiberboard, and Wood Flooring. Staff used annual disposal data to determine the shares of each type of wood product and calculated the weighted average TDOC and DANF representing the 'Lumber & Wood Products' waste category.

Table 5 presents the relevant parameters updated in the 2024 edition of the Inventory as compared to those used in previous editions.

Table 5. Landfill Model Parameter Updates

	Total Degradable Organic Carbon (TDOC) (Mg DOC / Mg wet waste)		**Degradable Anaerobic Fraction (DANF)**	
Waste Type	2023 edition	2024 edition	2023 edition	2024 edition
Coated Paper	0.313	0.239	0.260	0.340
Lumber & Wood Products	0.430	0.352	0.233	0.099

The 2024 edition also integrates the latest USEPA corrections to landfill gas collection data from USEPA's GHG Reporting Program [USEPA 2024b] by updating data for 2010–2021. This update increases emissions in the prior years. All other parameters and the methodology remained the same as in the 2023 edition of the Inventory.

B.6 Other Noteworthy Updates

For the 2024 edition, CARB staff made minor updates to several parts of the inventory. These include:

- Incorporated 2017 compost feedstock survey data [CalRecycle 2019] in the existing linear slope calculation method which is used to estimate annual emissions for 2000–2022; and

- For 2009 and later data years, the Inventory uses EIA data [EIA 2024a] for in-state electricity generation emissions from facilities with emissions below the MRR reporting threshold. For the 2024 edition of the Inventory, staff conducted additional quality assurance review of the EIA data for these facilities and adjusted or excluded some data that was either already accounted for in MRR data or was unreliable as reported to EIA.

As a result of these data corrections, some emissions and fuel data for the same calendar year may be slightly different between the 2024 edition and 2023 edition of the Inventory.

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