California's 2000-2021 AB 32 Greenhouse Gas Emissions Inventory (2023 Edition)

Inventory Updates Since the 2022 Edition of the Inventory

Supplement to the Technical Support Document

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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 AB 32 GHG Inventory") to track the State's progress in reducing GHG emissions. The AB 32 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),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 2023 edition of California's AB 32 GHG Inventory covers emissions for 2000 through 2021 and includes inventory improvements and accounting method updates.

The AB 32 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 2022 edition of the AB 32 GHG Inventory (2000-2020 emissions), staff have made improvements to emissions estimation methods and incorporated new data sources. This document provides a description of the AB 32 GHG Inventory updates since the previous edition of the AB 32 GHG Inventory.

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 2021, 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 2023 edition of the AB 32 GHG 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., 2000-2020 activity data in the 2023 edition of the AB 32 GHG Inventory, where 2021 is the most current year), their updated historical data are incorporated into the latest edition of CARB's AB 32 GHG 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 In-State Electricity Generation: Recategorize Out-Of-State Biomethane Contracted by In-State Power Plants as Fossil Gas

IPCC Categories: 1A1a

B.1.1 Background

For in-state electricity generation facilities that report data pursuant to the Regulation for the Mandatory Reporting of Greenhouse Gases (MRR), CARB incorporates the reported MRR data into the AB 32 GHG Inventory.

The data reported pursuant to MRR that is used for the AB 32 GHG Inventory includes facility-level emissions and the amount and heat input of each fuel combusted, as reported by each facility subject to MRR. When reporting biomethane, facilities must report the names and addresses of the biomethane vendors and the facilities which produced it. Facilities can report biomethane produced outside of California that is not physically delivered to the purchasing facility but is accounted for based on contracts, invoices, or allocation and balancing reports. This practice is sometimes referred to as "book-and-claim" accounting.

B.1.2 Data and Method

This inventory method update applies to the in-state electricity generation sector. Staff has reclassified book-and-claim biomethane that was procured from out-of-state producers by in-state electricity generation facilities. This biomethane is now classified as fossil gas with non-biogenic CO_2 emissions for 2012 and later years. This reclassification reflects that the fuel combusted by facilities in California was fossil gas despite contractual book-and-claim purchases of biomethane from out-of-state producers.

B.2 Refining and Hydrogen Production: Recategorize Emissions from Flares and Thermal Oxidizers as "Flaring" instead of "Fuel Combustion"

IPCC Categories: 1A1b, 1B2aii

B.2.1 Background

In the Refining and Hydrogen Production sector, per MRR, GHG emissions from flares and thermal oxidizers are generally reported either as emissions from a flare or thermal oxidizer without listing a specific fuel, or as emissions from combustion of a specified fuel associated with a flare or thermal oxidizer. In the 2022 edition of the AB 32 GHG Inventory, emissions from flares and thermal oxidizers without specific fuel records were correctly categorized as "flaring," consistent with previous editions. However, when specific fuel types and volumes

were reported pursuant to MRR as associated with a flare or thermal oxidizer, the resulting emissions were categorized as "fuel combustion" instead of "flaring."

IPCC Guidelines note that "flaring" is broadly the combustion of waste gases as a "disposal option" rather than for "the production of useful heat or energy" and that all emissions associated with flares and incineration units "should be reported under the appropriate venting and flaring subcategories rather than under Category 1.A (Fuel Combustion Activities)" [IPCC 2006].

B.2.2 Data and Method

For the 2023 edition of the AB 32 GHG Inventory, all identifiable emissions from flares and thermal oxidizers were classified as "flaring" for 2012 and later years.

B.3 Updates to Fossil Gas Volumes

IPCC Categories: 1A1cii, 1A2, and 1A4

B.3.1 Background

The California Energy Commission (CEC) provides utility-reported fossil gas consumption data as well as fossil gas interstate pipeline delivery data to CARB. This data provides fossil gas consumption by sector for residential, commercial, industrial, and agricultural end uses. CARB uses this data, in conjunction with fossil gas supplier data and industrial facility-level consumption data from MRR, to estimate fossil gas combustion emissions in the AB 32 GHG Inventory.

B.3.2 Data and Method

For the 2023 edition of the AB 32 GHG Inventory, CEC provided a comprehensive dataset for the years 2000 to 2021 which included some minor updates to fossil gas volumes provided for prior editions of the AB 32 GHG Inventory. Most notably, interstate pipeline deliveries to the oil and gas production sector were added for the years 2008 to 2011.

In addition, an adjustment was made for 2018 to 2020 interstate pipeline deliveries that reallocated fossil gas volumes from the mining sector to the oil and gas production sector.

B.4 Livestock Manure Management: Reflect Dairy Emissions Reductions as a Result of Accelerated Use of Anaerobic Digesters

IPCC Category: 3A2ai

B.4.1 Background

Previous editions of the AB 32 GHG Inventory estimated dairy and livestock methane emissions using livestock population data derived from the U.S. Department of Agriculture (USDA) Census of Agriculture [USDA 2017], and parameters from the U.S. Environmental

Protection Agency (EPA) GHG Inventory methodology [USEPA 2015], including the manure distribution among waste management systems (lagoon, digester, pasture, etc.). The portion of manure managed with each system had not been updated since 2015.

B.4.2 Data and Method

The 2023 edition of the AB 32 GHG Inventory uses updated data 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.

This update is for the livestock manure management sub-sector from 2017 onwards. With the new method, populations of dairy cows with manure managed in anaerobic digester systems are based on data from the Low Carbon Fuel Standard and the Cap-and-Trade Program, which are verified by CARB-accredited third parties. Staff utilize two program parameters to determine these populations:

1) Annual average population by livestock category;
2) Annual fraction of volatile solids (VS) sent to the anaerobic digester.

Staff tabulate verified data for each project (farm) located in California by year and adjust the population by the fraction of volatile solids sent to the anaerobic digester, such that the resulting VS-adjusted population data reflects the manure managed by anaerobic digesters.

Next, populations of milking and non-milking (dry) dairy cows are combined. Staff convert the dry cow population to the equivalent milking cow population[2] using the conversion factor of 1 dry cow = 0.915 milking cow-equivalent[3] to account for the difference in VS excretion rate.

Finally, staff aggregate the VS-adjusted population across all California projects in each year to provide the statewide population of dairy cows with manure managed in anaerobic digesters and subtract this population from the proportion of dairy cow manure managed in anaerobic lagoons.

B.5 Landfills: Update Landfill Model Parameters, Landfill Control Types, and N_2O Emission Factor

IPCC Category: 4A1

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[2] Milking and dry dairy cows represent essentially the same population - milking cows are dry cows for approximately two months of the year (1/6). Under the Cap-and-Trade Offset Protocol for Livestock Projects, these two populations are reported separately, and must be combined to align with the AB 32 GHG Inventory methodology. Milking and dry cows exhibit nearly identical Typical Average Mass and Maximum Methane Potential, but the volatile solids (VS) excretion rate of dry cows is significantly lower (5.56 vs. 11.41 kg/day/ton mass) [CARB 2014].

[3] 1 dry cow = $[(VS_{dry\ cow} * 1/6) + (VS_{milking\ cow} * 5/6)] / VS_{milking\ cow}$ milking cow

B.5.1 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 AB 32 GHG 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 AB 32 GHG 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 the Waste Reduction Model (WARM) [USEPA 2020] for several waste categories: Newspaper, Office Paper, Corrugated Boxes, Coated Paper, Food, Grass, Leaves, and Branches. In the 2022 edition of the AB 32 GHG Inventory, default fractions of TDOC and DANF referenced U.S. EPA's "Solid Waste Management and Greenhouse Gases, A Life-Cycle Assessment of Emissions and Sinks" [USEPA 2002].

B.5.2 Data and Method

In November 2020, U.S. EPA updated several WARM parameters that are used in CARB's landfill model. The 2023 edition AB 32 GHG Inventory uses U.S. EPA's updated values for these parameters in the landfill model.

Table 1 presents the relevant parameters updated in the 2023 edition of the AB 32 GHG Inventory as compared to those used in previous editions.

Table 1. Landfill Model Parameter Updates

	Total Degradable Organic Carbon (TDOC) (Mg DOC / Mg wet waste)		Degradable Anaerobic Fraction (DANF)	
Waste Type	Previous editions	2023 edition	Previous editions	2023 edition
Newspaper	0.471	0.426	0.150	0.160
Office Paper	0.385	0.291	0.870	0.880
Corrugated Boxes	0.448	0.390	0.442	0.450
Coated Paper	0.330	0.313	0.243	0.260
Food	0.148	0.135	0.865	0.840
Grass	0.133	0.081	0.474	0.470
Leaves	0.291	0.285	0.073	0.150
Branches	0.442	0.412	0.231	0.230

Staff also updated the control types for four landfills based on a review of data from CARB's Landfill Methane Regulation: three landfills were confirmed to have recently installed and operated gas collection and control systems (GCCS); one landfill was previously assumed to have operated a GCCS but is uncontrolled. Finally, staff updated the landfill gas combustion N_2O emission factor to match MRR [US EPA 2013]. These updates affect landfill data from 2000 onward. All other parameters and the methodology are the same as in the 2022 edition of the AB 32 GHG Inventory.

B.6 Miscellaneous Data Corrections

In the 2023 edition of the AB 32 GHG Inventory, CARB staff made minor data corrections to several parts of the inventory. These include:

- Ensured no double counting of diesel used in power take-off and construction equipment for 2016 and onwards; and

- Updated semiconductor emissions for the years 2000 to 2015 to correct an inconsistency between calculated and published data in the 2022 edition of the AB 32 GHG Inventory.

As a result of these data corrections, some emissions and fuel data for the same calendar year may be slightly different between the 2023 edition and 2022 edition of the AB 32 GHG Inventory.

C. References

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