California Environmental Protection Agency

Air Resources Board

California's 2000-2015 Greenhouse Gas Emissions Inventory

2017 Edition

Inventory Updates Since the 2016 Edition of the Inventory

Supplement to the Technical Support Document

State of California
Air Resources Board
Air Quality Planning and Science Division

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INTRODUCTION

Assembly Bill 1803 gave California Air Resources Board (ARB) the responsibility of preparing and updating California's greenhouse gas (GHG) inventory to track the State's progress in reducing GHG emissions. The GHG inventory is a critical piece, in addition to California Global Warming Solutions Act (AB 32) program data, in demonstrating the State's progress in achieving the 2020 statewide GHG target. The 2017 edition of California's GHG inventory covers emissions for 2000 through 2015 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 2016 edition of the inventory (2000-2014 emissions), staff has made several improvements to inventory categories, emissions estimation methods, and data sources. This document provides a description of the inventory updates since the previous edition of the inventory.

Each release of the California inventory incorporates the latest available data sources and current scientific understanding of GHG emissions. 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 statistical data supplied by other agencies for all years from 2000 to 2015, to maintain a consistent time-series of estimates within the inventory. Therefore, emission estimates for a given calendar year may be different between editions as methods are updated or if the data source agencies revise their data series.

In the sections to follow, a background on each updated category is presented followed by a description of the update. The sections in this document are organized by the hierarchical structure of IPCC inventory categorization (as shown in the Table of Contents). For reader's convenience, a table summarizing inventory updates organized by AB 32 Scoping Plan sector category is provided on the next page.

SUMMARY LIST OF UPDATES

Scoping Plan Sector Category	Description of Update	IPCC Category	Section Number In This Documentation
Industrial	Disaggregated oil & gas production fugitive emissions into three subcategories: production, processing, and storage fugitives	Energy	A.1
Industrial	Disaggregated natural gas pipeline/ transmission & distribution emissions into two subcategories to: storage fugitives and pipeline fugitives	Energy	A.2
Industrial (Excluded Category)	Updated petroleum seeps estimation with two studies on emissions from La Brea Tar Pits and Coal Oil Point	Energy (Excluded Category)	A.3
High GWP	Revised the refrigerant mix assumption for Transport Refrigeration Unit (TRU) based on new information	Industrial Processes and Product Use	B.1
High GWP	Updated the 2000-2010 time series for SF_6 emissions from electrical equipment based on an ARB survey	Industrial Processes and Product Use	B.2
Agriculture	Used the DeNitrification-DeComposition (DNDC) model to update N_2O emissions from synthetic fertilizers and crop residues	Agriculture, Forestry, and other Land Uses	C.1
Recycling and Waste	Updated the composting emission factor using California specific data in ARB's updated Compost Emission Reduction Factor (CERF)	Waste	D.1
NA	Incorporated GHG emissions from the exceptional natural gas leak event at Aliso Canyon	Energy	E.1

Interim Method for Addressing Temporary Data Unavailability During Data Transition

Scoping Plan Sector Category	Description of Update	IPCC Category	Section Number In This Documentation
Industrial	Updated the CO_2 consumption number to match USEPA's most recent estimates, and to ensure a consistent time series	Industrial Processes and Product Use	F.1
Industrial	Extrapolated parameter values for domestic wastewater based on previous years data	Waste	F.2

DESCRIPTION OF INVENTORY UPDATES

A. Energy

1. Oil & Gas Production Fugitive Emissions (IPCC 1B2): Disaggregate into Three Subcategories

1.1 Background

The existing categorization aggregates all the fugitive emission activities associated with the oil and gas production into a single category, process losses. This category is now expanded to include three new categories: Production, Processing, and Storage. ARB's Crude Oil and Natural Gas Industry Survey (ARB, 2007a), on which the data in this category was based, already delineated data into these three categories; therefore, disaggregating the GHG inventory using the same survey data is straightforward. This inventory update does not change the emission estimation methodology, but it is simply reporting emissions at a greater level of detail.

1.2 Estimation Methodology

The methodology has not changed, only the categories were expanded to provide more detail.

2. Natural Gas Transmission and Distribution Fugitive Emissions (IPCC 1B2b): Disaggregate into Two Subcategories

2.1 Background

The existing categorization aggregates all the fugitive emission activities associated with natural gas transmission and distribution into a single category, natural gas pipelines fugitives. This category is now re-labeled as natural gas transmission and distribution to represent the broader natural gas delivery system, and is expanded to include two new categories: natural gas storage fugitives and natural gas pipeline fugitives. ARB's natural gas transmission and distribution survey (ARB, 2007b), on which the data in this category is based did not provide enough detail for this disaggregation; therefore, staff used the Mandatory GHG Reporting Regulation (MRR) (ARB, 2016a) data to break the storage emissions out from the total. The total aggregated emissions do not change, but they are now reported under two categories of finer detail.

2.2 Estimation Methodology

The MRR program collects emissions data on both storage and pipeline leaks from the natural gas industry. The emissions reported for storage were divided by the total emissions reported for the fugitive emissions from the natural gas transmission, distribution and storage to obtain the percentage of emissions associated with storage. Fractions attributed to storage were calculated from the MRR dataset for each year from 2011to 2015, and were applied to the existing total fugitive emissions to obtain an estimate for storage emissions. The rest of the emissions were then assigned to the pipeline fugitive category. For the back years 2000-2010, for which MRR does not have data, the 3-year average of 2013-2015 was used as the surrogate for the percent associated with storage. Staff has chosen to use the data for 2013-2015 instead of the data for 2011-2013 to estimate 2000-2010 emissions because the later years are considered more robust as the reporting program matured over time.

3. Petroleum Gas Seeps Fugitive Emissions (IPCC 1B2)(Excluded Emissions): Update with Two Studies on Emissions from La Brea Tar Pits and Coal Oil Point

3.1 Background

In the previous editions of the inventory, the petroleum seeps emission estimates were taken from the California Emission Inventory Database And Reporting System (CEIDARS)(ARB's inventory database for criteria pollutants). The Total Organic Gas reported for this category was speciated into methane and used as an estimate for seep emissions. In CEIDARS, this data is reported by the local air quality districts and not updated regularly. In this edition of the inventory, emission estimates from studies on the two largest seeps in the state, Coal Oil Point and The La Brea Tar Pits, were used to augment the estimate from CEIDARS. Petroleum seeps are considered a natural emission source and is classified as "excluded" emissions (that are tracked in the inventory but are not used to compare against California's 2020 emission limit).

3.2 Estimation Methodology

The studies each provided a single year emission estimate for the seep under analysis. Since there are no data available for other years, it is assumed that the estimate for a single year is representative of all years. The seeps emissions in all likelihood do fluctuate over time, but it is assumed that the fluctuations will be small and not more significant than the inherent uncertainties of the estimates. The study of the La Brea Tar Pits (Jeong, 2013) was conducted in 2010 and estimated the annual methane emissions at 1.5 $MMTCO_2e$. The study of Coal Oil Point (MMS OCS, 2003) was conducted in

1996 and estimated the methane emissions at 0.7 $MMTCO_2e$. The petroleum seeps category in the GHG inventory is now the sum of the emissions from these 2 studies and the estimate from CEIDARS.

B. Industrial Processes and Product Use

1. Product uses as Substitutes for Ozone Depleting Substances (IPCC 2F): Update the Refrigerant Mix Assumption for Transport Refrigerated Units (TRU)

1.1 Background

The emissions from refrigerant use in the transport sector include road transport refrigeration units (TRU) used in trailers over 25 feet in length, single unit trucks 11 to 25 feet in length, and vans less than 11 feet in length. Before 1994, no HFCs were used as refrigerants in TRUs; the refrigerants used were CFC-12 and R-502 (a blend of CFC-115 and HCFC-22), both of which are ozone-depleting substances (ODS). Due to the global phase-out of ODS required by the Montreal Protocol, beginning in 1995 new TRU units were manufactured using HFC refrigerants. The two refrigerants used in new units were HFC-134a (GWP of 1430), and R-404A (GWP of 3922), a blend of the following HFCs: HFC-143a (52%), HFC-125 (44%), and HFC-134a (4%).

In the 2016 and prior editions of the ARB GHG inventory, the assumption for TRUs built beginning in 1994 through the present was that 76% used HFC-134a and 24% used R-404A as the refrigerant, with a weighted average GWP of 2028. Emission factor assumptions are routinely reviewed and updated when necessary, and it was discovered that the given refrigerant usage assumptions for TRUs may have been applicable to European road transport, but did not reflect TRUs in California or the U.S. Multiple data sources were consulted[1], resulting in the update described below.

1.2 Model Update

Beginning in the 2017 edition of the GHG inventory, the refrigerant mix assumption for TRU built in 1994 through the present has been updated to 10% using HFC-134a and 90% using R-404A as the refrigerant, with a weighted average GWP of 3673. The updated GWP is 80% greater than the previous weighted average. HFC emissions in $MMTCO_2e$ from this sector are therefore also 80% greater than previously estimated.

[1] Schwarz, et. al., 2011; UNEP, 2015; 2011; Kwon, 1998; Carrier, 2015; Green Cooling Initiative, 2016; HDT, 2012; Michineau, et al., 2012; Racplus, 2013; Refrigerant HQ, 2014; Thermo King, 2016

2. Sulfur Hexafluoride from Use of Electrical Equipment (IPCC 2G1b): 2000-2010 Data Update

2.1 Background

Sulfur hexafluoride (SF_6) gas is used by the electric power industry in gas-insulated substations, circuit breakers, and other switchgear because of its dielectric strength and arc-quenching characteristics. Fugitive emissions of SF_6 are the result of leaks through seals of gas-insulated substations and switchgear. SF_6 can also be released during equipment installation and servicing.

2.2 Data Update

In the previous editions of the inventory, SF_6 emissions from gas-insulated switchgear (GIS) for years 2000-2010 were calculated by scaling the national emissions in the U.S. Environmental Protection Agency (USEPA) GHG inventory down to California level using the California-U.S. ratio of electricity generation. In this edition, the 2000-2010 time series was updated to include 2008 California-specific data compiled in a survey conducted by ARB in 2009 (ARB, 2009). The 2008 number estimated from the survey results is directly used in the GHG inventory and used as an anchor point for adjusting the estimates for other years in the 2000-2010 time series. The 2000-2010 emission trend from the previous inventory edition is mapped to the updated 2008 number. This update does not change the emission numbers for 2011-2015, as they are directly reported to ARB through the Regulation for Reducing Sulfur Hexafluoride Emissions from Gas Insulated Switchgear program (ARB 2007c).

C. Agriculture, Forestry and Other Land Use

1. Nitrous Oxide from Soil Management - Synthetic Fertilizer and Crop Residue (IPCC 3C4): A Tier 1 and Tier 3 Hybrid Approach

1.1 Background

Nitrous oxide (N_2O) emissions from soils are primarily produced through microbial-mediated processes of nitrification and denitrification, and are subject to controls of many soil environmental factors. Nitrogen (N) input from fertilizer, manure, and crop residue into soils can lead to increased N availability for nitrification and denitrification, therefore resulting in N_2O emissions released into the atmosphere. The agricultural soil management category in the GHG inventory includes estimates of direct and indirect N_2O

emissions from synthetic fertilizer, organic fertilizer, manure application, and crop residues returned on croplands.

Past editions of the inventory used an IPCC Tier 1 approach based on default emission factors to estimate emissions from these soil management activities. In this edition, the methodology for direct N_2O emissions from crop residues and synthetic fertilizer used on croplands without manure application has been updated to a Tier 1 and Tier 3-hybrid approach employing a process-based model, DeNitrification-DeComposition (DNDC). The methodology for other soil management activities remains unchanged from the previous inventory editions; and these include the use of organic fertilizer on croplands, dairy croplands receiving manure application (where synthetic fertilizer may be used in conjunction with manure), and organic farms (which may use a combination of organic and manure fertilizer), as well as indirect N_2O emissions from any type of croplands. In addition, with the availability of a new data source, staff updated the synthetic fertilizer application rates for dairy croplands although the calculation methodology remains unchanged from the previous inventory editions (i.e., Tier 1 approach). The table below summarizes methodologies for specific soil management activities used in this edition.

Table 1. Summary of methodologies used to calculate direct N2O emissions for specific soil management activities.

Soil Management Activity	Non-Organic Cropland without Manure Application	Dairy Cropland with Manure Application	Organic Farms
Organic Fertilizer	Tier 1 (no change in method)	Tier 1 (no change in method)	Tier 1 (no change in method)
Synthetic Fertilizer	DNDC	Tier 1 (no change in method but updated application rates)	NA
Crop Residues	DNDC	Hybrid Tier 1 & 3 (updated crop residues using DNDC)	Hybrid Tier 1 & 3 (updated crop residues using DNDC)
Manure Application	NA	Tier 1 (no change in method)	Tier 1 (no change in method)

1.2 Methodology for Synthetic Fertilizer and Crop Residues on Cropland without Manure Application

DNDC Model

The DNDC model (Li et al., 1992; Li, 2000) is a process-based soil biogeochemical model developed for quantifying GHG emissions, and has been extensively evaluated against datasets of N_2O fluxes that were measured worldwide (e.g., Gilhespy et al., 2014; Giltrap et al., 2010) and in California (Li et al., 2013). DNDC accounts for both natural factors and farming management practices (FMPs) affecting N_2O emissions from soils. DNDC simulations of N_2O emissions from California croplands have been tested against field N_2O emissions from typical cropping systems in California. The tests showed that DNDC was capable of predicting observed seasonal and annual total N_2O emissions from typical California cropping systems and the model's performance was better than the Tier 1 approach. Therefore, the new hybrid methodology provides a better estimate of direct N_2O emissions from synthetic fertilizer and crop residue.

DNDC consists of two components. The first component, which consists of the soil climate, crop growth and decomposition sub-models, predicts soil temperature, moisture, pH, redox potential and substrate concentration distribution (e.g. ammonium, nitrate, dissolved organic carbon) based on ecological drivers (e.g., climate, soil, vegetation and anthropogenic activity). The second component, which consists of the nitrification, denitrification and fermentation sub-models, predicts carbon and nitrogen gases fluxes (such as carbon dioxide, N_2O, and methane) based on soil environmental variables.

N_2O Emission Calculation

DNDC was used to estimate direct N_2O emissions from croplands without manure application by linking the model with a California-specific database containing data on weather, crop types and areas, soil properties, as well as farming management practices. The total cropland areas simulated ranged between 2.591×10^6 and 3.159×10^6 ha from 2000 to 2015, representing an average of 92% of total California croplands (ranged from 90% to 93%). Four scenarios of irrigation methods (i.e., flooding, sprinkler, drip, and subsurface drip) were included in the model to reflect the diverse irrigation management practices in California (Orang et al., 2008; Tindula et al., 2013). For each individual year, DNDC was run for three consecutive years to initialize the model to allow the distribution of carbon and nitrogen speciation in soil to match closely to field conditions. The results for the third year were taken as the emission estimate for that individual year. These results represent direct emissions from synthetic fertilizer and crop residues. However, we used 3-year rolling average of emission estimates, as described in the next section, to represent emissions of a given inventory year.

In the previous editions, N_2O emissions from crop residues returned to soil were only calculated for 13 crops, six of which were adjusted for crop residue burning. The amounts of N inputs from crop residues of the 13 crops were calculated using default crop yields and N contents of above- and below-ground residues; and the conversion of crop residue N to N_2O was calculated using the IPCC default emission factor. DNDC produced N inputs from crop residues for 53 crops. The DNDC-derived N_2O emissions from crop residues were further adjusted for crop residue burning for the six crops by subtracting the portion of N that was released to the atmosphere by burning, instead of being returned to the soil.

Three-Year Rolling Average

Besides farm management practices, a primary driver of N_2O emissions from microbial-mediated process of nitrification and denitrification is the timing and the amount of precipitation, which can lead to high year-to-year variability in emissions. Since DNDC accounts for farming management practices as well as natural factors, N_2O emissions estimated by DNDC may also exhibit large variability from year to year due to weather conditions. To better track emission trend due to changes in farm management practices over time, without large year-to-year variability driven by natural forces, 3-year rolling average of annual DNDC outputs is used to represent emissions in this category in the inventory.

1.3 Synthetic Fertilization Application Rates for Dairy Croplands and Organic Farms

Due to lack of comprehensive data on manure application in cropland at this time, N_2O emissions from dairy croplands that receive manure application are still calculated using the Tier 1 approach based on the IPCC default emission factors. In previous inventory editions, croplands with or without manure application were not differentiated, and the same synthetic fertilizer application rates (which vary by crop type) were used regardless of whether the cropland receives manure. In this edition, synthetic fertilizer application rates for dairy croplands are updated based on the 2013 Annual Dairy Reports obtained from the Regional Water Quality Control Boards (RWQCB, 2014). Staff surveyed data from 127 randomly selected dairy farms in the 2013 Annual Dairy Reports, representing at least 10% of the reports submitted for each county, and compiled the updated synthetic fertilizer application rates for dairy croplands. Table 2 summarizes the new synthetic N fertilizer rates used for dairy croplands.

Table 2. Updated synthetic fertilizer rate in dairy croplands

Crop	Synthetic Fertilizer Rate (lbs N/acre)
Almonds	0
Corn, grain	160
Corn, silage	41
Cotton	62
Grapes, all	0
Hay, alfalfa	11
Hay, (excl alfalfa)	2
Fruit, other	54
Nuts, other	0
Oats	6
Sorghum	4
Wheat, winter	27

Synthetic fertilizer rates for croplands in organic farms were assumed to be zero per organic certification requirement.

1.4 Methodology for Crop Residues on Dairy Croplands and Organic Farms

N_2O emissions from N input in crop residues returned to soil in dairy croplands and organic farms were calculated using a hybrid approach. The amounts of N inputs in crop residues produced from DNDC for croplands without manure application were adopted for the croplands in dairy and organic farms with the assumption that crops in those croplands normally receive sufficient N application to support full plant growth. However, the conversion of crop residue N to N_2O emissions was still calculated using the IPCC default emission factor as in previous editions.

1.5 Data Sources

To simulate N_2O emissions using DNDC, a California-specific database was created. The input information contained in the database include: (1) daily meteorological data, (2) land area of different crop types, (3) soil properties, and (4) farming management practices. These data were collected and organized for each county.

Meteorological data. Daily meteorological data were derived from weather data produced by the DAYMET model (Thornton et al., 2015).

Crop areas. Statewide crop total areas were obtained from the U.S. Department of Agriculture's (USDA's) National Agricultural Statistics Service

(NASS), Quick Stats (USDA, 2016a). County level crop area data were also from NASS Quick Stats for census years. For non-census years, statewide totals were allocated to the counties for each crop, based on the fraction of total cropland area in each county with respect to the statewide total cropland area, as interpolated from census years prior to 2012, or from the California Department of Food and Agriculture's (CDFA) California Agricultural Statistics reports after 2012 (CDFA, 2013-2016).

Croplands with manure application were not simulated by DNDC, and their acreages were therefore removed from the crop area used in the DNDC modeling. County dairy cropland areas were estimated from the dairy Geographic Information System (GIS) files obtained from the Regional Water Quality Control Boards (RWQCB, 2015). The dairy crop data (type of crops and planted areas) in dairy croplands were derived from 127 dairy farms sampled from 2013 Annual Dairy Reports (RWQCB, 2014). The organic farm areas and associated crops were obtained from the University of California- Davis reports on "Statistical Review of California's Organic Agriculture" (UCD, 2007-2013), and were also not modeled in DNDC.

Soil data. Soil data were collected from USDA's Soil Survey Geographic Database (SSURGO) database (USDA, 2016b). Key soil data, including bulk density, clay content, soil organic carbon content and pH, were compiled. The SSURGO map units were overlaid with the regions of agricultural landuse developed by the Land Use Surveys of the California Department of Water Resources (CDWR, 2014) and the area-weighted means of the four soil properties were calculated for each county. The area-weighted means of the soil properties were used as "representative" soil values for simulating N_2O emissions for the inventory.

Farming management data. Farming management data, including planting and harvest dates, tillage, fertilization, irrigation, and residue management, were developed for the crops largely from open literature, surveys, as well as personal communications with researchers, growers, and University of California Cooperative Extension staff. There was no discernable trend in N fertilizer application rates in the past 25 years, so we used static N application rates for 2000 to 2015 (Rosenstock et al., 2013; UCD, 2015). Irrigation methods for the crops were assumed to change overtime per the CDWR's Statewide Irrigation Methods Surveys (CDWR, 2015). The four irrigation methods modeled were surface gravity irrigation, sprinkler irrigation, surface drip, and subsurface drip. Fractions of irrigation methods for each crop were developed using linear interpolation for 2000 to 2010 and extrapolation for 2011 to 2015.

1.6 Changes in Estimates

Compared to the Tier 1 approach, the emission estimates obtained using the hybrid methodology are more dynamic, related closely to the environmental and farming management variables. In previous inventory editions, direct N_2O emissions from synthetic fertilizer and crop residue calculated using Tier 1 approach were relatively constant over time due to the use of a constant emission factor. In contrast, the N_2O emissions based on the hybrid methodology showed an overall decreasing trend from 2000 to 2015, which was primarily due to: (1) reductions in cropland area and associated N inputs from synthetic fertilizer and crop residue; (2) lowered N_2O emission rate per unit N input due to large-scale changes in irrigation management practices that moved from flood irrigation towards sprinkler and drip irrigation; and (3) the use of the updated synthetic fertilizer rates for dairy and organic farming croplands.

D. Waste

1. Composting of Organic Waste (IPCC 4B): Updated Compost Emission Factor

1.1 Background

Composting of organic waste such as food scraps, yard trimmings, branches, leaves, grass, and organic municipal solid waste, is common in California as a way to divert such waste from landfills. Composting is a controlled decomposition process that destroys pathogens in the waste material, reduces its volume greatly and yields a stable organic-rich soil-like mixture called compost. This section pertains to emissions from industrial-scale composting facilities and does not include small-scale backyard composting. These industrial facilities predominantly use a process called windrow composting, in which large amounts of organic waste undergo decomposition in long rows. The windrows are actively managed (e.g. shredding, aeration, watering, etc.) to maximize the aerobic decomposition of the organic feedstock. During the composting process, a large fraction of the degradable organic carbon (DOC) in the waste material is converted into carbon dioxide. However, studies have indicated that some anaerobic pockets occur in the piles where methanogenic bacteria produce some methane, and some nitrous oxide is emitted as the byproduct of nitrifying or denitrifying bacteria.

1.2 Compost Emission Reduction Factor (CERF) Update

The ARB's Compost Emission Reduction Factor (CERF) was updated in March of 2016 (ARB, 2016b). This edition of the inventory utilizes information

from the updated CERF, including the fugitive emissions from composting and the CH4 and N2O emission factors. The previous emission factors (4.1 gCH_4/kg feedstock and 0.09 gN_2O/kg feedstock) did not incorporate California-specific studies and were based on information that is now outdated. The new emission factors used in this inventory edition (1.96 gCH_4/kg feedstock and 0.075 gN_2O/kg feedstock) are the averages of 3 studies from IPCC and 3 additional California-specific studies. A more detailed description of the revised CERF and the referenced studies can be found in the CERF report (ARB, 2016b).

E. Other Emissions

1. Natural Gas Fugitive Emissions (IPCC 1B2b): ARB's Estimation for the Aliso Canyon Leak Event

1.1 Background

On October 23, 2015, Southern California Gas (SoCalGas) informed the State of a natural gas leak at its Aliso Canyon natural gas storage facility. The leak was caused by an uncontrolled breach in the natural gas storage infrastructure and occurred outside the envelope of instruments put in place to measure the flow of natural gas at the facility. On February 11, 2016, SoCalGas temporarily controlled the leak by injecting mud from a relief well intersecting the bottom of the leaking well. A permanent seal of the well was announced by The Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) on February 18, 2016. To quantify the methane release rate from the Aliso Canyon gas leak, state agencies, in collaboration with scientific experts, relied on existing and new methane measurements in the Los Angeles basin. The data include ambient measurements around the well site, at nearby air monitoring towers, and using airplanes, as well as data from remote sensing and satellites. These measurements allow for an estimation of the leak's cumulative emissions.

1.2 Categorization of Emissions

The Aliso Canyon natural gas leak released 1.96 $MMTCO_2e$ of methane emissions during calendar year 2015 and an additional 0.52 $MMTCO_2e$ in 2016. Because this is a one-time event, and its emissions will be fully mitigated in future years according to legal settlement, these emissions are presented alongside but tracked separately from routine inventory data. In this edition of the GHG inventory, a new "Other Emissions" category has been added to the inventory data tables to house the exceptional Aliso Canyon leak event. The 2017 edition of the inventory includes the portion of emissions released in 2015, while the portion released in 2016 will be included the 2018 edition of the inventory.

1.3 Estimation Methodology

A collaborative effort between several different project teams utilized a suite of various methodologies in order to produce the best estimation. The full detailed report, which describes these methodologies, can be found at https://www.arb.ca.gov/research/aliso_canyon/aliso_canyon_methane_emissions-arb_final.pdf

INTERIM METHOD DURING DATA TRANSITION

The ARB utilizes data from several data sources in calculating California GHG emissions. Occasionally, a data source agency may go through administrative changes or experience other delays in data compilation; and as a result, the data needed for ARB to calculate emissions may not be available at the time of GHG 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, ARB staff uses data extrapolation techniques to temporarily fill in the data gaps until revised data become available in future inventory cycles. The following sections describe the interim methods used in this inventory edition that are not permanent updates to the inventory, but are expected to be revised once the data become available.

F. Interim Method

1. Carbon Dioxide Consumption (IPCC 2G4a): Interim Emission Estimation

1.1 Background

Carbon dioxide (CO_2) is used in a variety of processes including food processing, carbonated beverages, and refrigeration. The CO_2 used in these applications is eventually released to the atmosphere, thus is a source of GHGs. California CO_2 consumption data is estimated from the USEPA GHG inventory (USEPA, 2015a) and scaled the national emissions to California using population ratio. USEPA is in the process of updating the national CO_2 consumption emission estimates, but had not completed updating older years in the time series at the time California's inventory was compiled. Therefore, staff used an interim emission quantification methodology to estimate CO_2 consumption emissions for the older years.

1.2 Interim Emission Estimation Methodology

The USEPA has completed the update for national CO_2 consumption emissions for years 2010-2015, but has not yet back-calculated the remainder of the 2000-2009 time series. The change in emission estimation method in the middle of the time series led to a significant disparity between emission levels prior to 2010 and those since 2010, an artifact of method update that does not represent an actual change in emissions. California's GHG inventory used USEPA's updated 2010-2015 numbers and scaled it to California using population ratio, consistent with previous editions. However, to address the artificial emission increase due to a change in method, the 2000-2009 emissions are adjusted by mapping the emission trend from the previous

inventory edition to the revised 2010 number in the interim. When the USEPA completes the update to years prior to 2010, ARB will revise the emission estimate for these years.

2. Domestic Wastewater (IPCC 4D1): Extrapolated parameter values based on previous years data

2.1 Background

Methane emissions from wastewater are estimated from the volume of wastewater generated, organic loading in wastewater (measured in biochemical oxygen demand (BOD) or chemical oxygen demand (COD)), and percentage of wastewater that is centrally treated (aerobic or anaerobic systems), anaerobically digested or treated in septic systems. Methane is emitted from wastewater when it is treated in anaerobic conditions. Nitrous oxide is emitted as the result of the nitrification and denitrification processes, which take place at wastewater treatment plants, but also in the water bodies where effluent is discharged.

2.2 Data Extrapolation

The California GHG inventory has been using a mixture of California-specific data when available, supplemented with national data scaled to the California population, in the domestic wastewater calculations. All of the parameter data come from USEPA, which compiles data on a yearly basis. Some of the 2015 data were not available at the time the inventory was compiled, so the data were extrapolated. The parameters extrapolated were:

- CA population served by biological denitrification
- Protein consumption rate
- Sewage sludge N not entering aquatic environment
- Proportion anaerobic
- Proportion anaerobic with primary treatment
- Proportion anaerobic without primary treatment
- Proportion aerobic
- Proportion aerobic with primary treatment
- Proportion aerobic without primary treatment
- Wastewater flow to plants with anaerobic digesters.

All of these parameters were showing linear trends, so a first-order extrapolation was performed to estimate the 2015 value.

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