APPENDIX B: CITY OF SAN DIEGO GREENHOUSE GAS EMISSIONS INVENTORY METHODOLOGY AND UPDATES

Supplement to 2024 Climate Action Plan Annual Report

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Prepared for the City of San Diego

The City of SAN DIEGO

Prepared by the Energy Policy Initiatives Center

EPIC
ENERGY POLICY INITIATIVES CENTER
UNIVERSITY OF SAN DIEGO SCHOOL OF LAW

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B1 OVERVIEW

This document presents a summary of the greenhouse gas (GHG) emissions estimates for the City of San Diego (referred to as San Diego or the City) for calendar years 2019–2023 and the methods used.

This document includes the following sections:

- Section B2 describes the background sources and common assumptions used for the GHG emissions inventory;
- Section B3 provides the 2019–2023 GHG emissions inventory results summary;
- Section B4 provides the methods used to prepare each category of the inventory; and
- Section B5 provides a table of methodological refinements made in each inventory year 2019 – 2023.

Rounding is used for the final GHG values within the tables and figures throughout the document. Values are not rounded in the intermediary steps in any calculation. Because of rounding, some totals may not equal the values summed in any table or figure.

B2 BACKGROUND

B2.1 Greenhouse Gases

The primary GHGs included in the emissions estimates presented here are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Each GHG has a different capacity to trap heat in the atmosphere, known as its global warming potential (GWP), which is normalized relative to CO_2 and expressed in carbon dioxide equivalents (CO_2e). In general, the 100-year GWPs reported by the Intergovernmental Panel on Climate Change (IPCC) are used to estimate GHG emissions. The GWPs used in this inventory are from the IPCC Fourth Assessment Report (AR4),[1] provided in Table 1. The GWPs used in this inventory are consistent with the California statewide GHG inventories and the national GHG inventories.[2]

TABLE 1 GLOBAL WARMING POTENTIALS USED IN SAN DIEGO GHG EMISSION INVENTORY & PROJECTIONS

Greenhouse Gas	Global Warming Potential
Carbon dioxide (CO2)	**1**
Methane (CH4)	**25**
Nitrous oxide (N2O)	**298**
IPCC 2013.	

B2.2 Demographics

California Department of Finance develops population and housing estimates for cities and counties in the State. The population and housing estimates used in the inventory are provided in Table 2.[3]

[1] IPCC Fourth Assessment Report: Climate Change 2007: Direct Global Warming Potentials (2013).
[2] Some CARB programs, other than the statewide GHG inventory, may use different GWPs. For example, the short-lived climate pollutants (SLCP) strategy uses the 20-year GWP because the SLCP has greater climate impacts in the near-term compared to the long-lived GHGs.
[3] California Department of Finance: E-4 & E5 Population and Housing Estimates for Cities, Counties, and the State, 2020-2025 with 2020 Census Benchmark (May 2025), accessed May 2025. E-4 Historical Population Estimates for Cities, Counties, and the State, 2011-2020 with 2010 Census Benchmark (May 2021), accessed May 2025.

TABLE 2 POPULATION, HOUSING, AND JOBS ESTIMATES (SAN DIEGO, 2019–2023)			
Year	Population Estimates	Housing Estimates (Units)	
		Total	Occupied
2019	1,389,543	545,645	514,548
2020	1,383,020	548,934	515,676
2021	1,376,694	552,410	518,029
2022	1,375,403	558,788	524,566
2023	1,387,001	565,822	531,199
2019 population and housing estimates are based on the 2010 census benchmark, and 2020 - 2023 population and housing estimates are based on the 2020 census benchmark. Population and housing estimates updated to reflect the most recent estimates by the California Department of Finance. Housing unit types include single detached units, single attached units, two to four units, five plus, or apartment units, and mobile homes. **California Department of Finance 2021, 2025**			

B3 SUMMARY OF 2019–2023 GHG EMISSIONS INVENTORY

B3.1 Greenhouse Gas (GHG) Emissions Inventory

In 2023, total emissions were 8.5 million metric tons of carbon dioxide equivalent (MMT CO_2e), a 19% reduction from the 2019 baseline and 1% increase from 2022. The overall decrease from baseline as well as the slight year over year increase can largely be tied to changes in the electricity and transportation sector. In the electricity sector, the consumption of electricity has decreased and the percent of renewables in the grid-supply have increased compared to the 2019 baseline. In the transportation sector, the citywide vehicle miles traveled has decreased and the overall fuel efficiency of cars has increased compared to the 2019 baseline. As electricity and transportation are the largest emissions categories, these changes are the primary drivers of the City's overall emissions decrease.
GHG emissions by category from San Diego in 2019–2023 are shown in Table 3.

TABLE 3 CITY OF SAN DIEGO GREENHOUSE GAS EMISSIONS (2019 – 2023)						
Emissions Sector	**2019 Emissions[1] [MT CO_2e]**	**2019 Emissions Revised[2] [MT CO_2e]**	**2020 Emissions [MTCO_2e]**	**2021 Emissions [MTCO_2e]**	**2022 Emissions [MTCO_2e]**	**2023 Emissions [MTCO_2e]**
On-Road Transportation	5,805,000	5,854,000	4,650,000	4,683,000	4,628,000	4,674,000
Electricity[3]	2,375,000	2,336,000	2,286,000	1,617,000	1,527,000	1,615,000
Natural Gas	1,911,000	1,912,000	1,827,000	1,918,000	1,837,000	1,898,000
Solid Waste[4]	277,000	277,000	273,000	216,000	212,000	213,000
Off-Road Transportation (Construction Equipment Only)	70,000	69,000	57,000	57,000	57,000	57,000
Water[5]	68,000	61,000	70,000	70,000	73,000	50,000
Wastewater	26,000	26,000	23,000	24,000	13,000	13,000
Total Emissions	**10,532,000**	**10,535,000**	**9,186,000**	**8,585,000**	**8,347,000**	**8,520,000**

[1] 2019 Emissions match those reported in 2022 CAP
[2] 2019 Emissions updated to reflect best available data. This report will reference the 2019 Revised Emissions for the remainder of this report.

Sums may not add up to totals due to rounding. GHG emissions for each category are rounded to the nearest thousand. Values are not rounded in the intermediary steps in the calculation.
[3] Historical emissions from electricity have been modified from previous Annual Reports to incorporate newly public data for direct access electricity customers. Additional details on changes can be found in the Electricity section.
[4] 2021 - 2022 emissions from solid waste have been modified from previous Annual Reports to incorporate new statewide waste characterization studies after impacts of mandatory organics recycling regulations.
[5] 2022 water emissions have been updated from the previous Annual Report as water sales to other agencies were incorrectly not removed. This Annual Report corrects that error.
GHG emissions for each category and the totals are rounded to the nearest thousands. Sums may not add up to totals due to rounding.
MT CO2e = metric tons of carbon dioxide equivalent.
Energy Policy Initiatives Center, University of San Diego 2025

This report will reference the 2019 revised emissions for the remainder of the report and will refer to them as the '2019 emissions.' More information on the methods, data availability, and sources used to calculate GHG emissions are provided in Section B5: Methodology Differences and Data Refinement. Table 4 shows how emissions in each category have changed relative to 2019.

TABLE 4 EMISSIONS CHANGE FROM 2019 BASELINE BY EMISSIONS SECTOR (%)

Emissions Sector	2019	2020	2021	2022	2023
On-Road Transportation	--	-21%	-20%	-21%	-20%
Electricity	--	-2%	-31%	-35%	-31%
Natural Gas	--	-4%	0%	-4%	-1%
Solid Waste	--	-1%	-22%	-23%	-23%
Off-Road Transportation (Construction Equipment Only)	--	-17%	-17%	-17%	-17%
Water	--	15%	15%	20%	-18%
Wastewater	--	-12%	-8%	-50%	-50%
Total Emissions	**--**	**-13%**	**-19%**	**-21%**	**-19%**

Sums may not add up to totals due to rounding.
Energy Policy Initiatives Center, University of San Diego 2025

In 2023, total emissions were 8.5 $MMTCO_2e$, a 20% reduction from the 2019 baseline but a 1% increase from 2022. Most citywide emissions reductions can be attributed to changes in the transportation and electricity sectors given their relative emissions scale to other sectors, including: (1) an increase in renewable electricity supplied to the City, and (2) a citywide reduction in vehicle miles traveled and (3) an increase in on-road vehicle efficiency and adoption of electric and hybrid vehicles. While water constitutes a small (1%) portion of the City's overall emissions, the sector did see a 30% year over year reduction due to the increased portion of local water in the water supply, eliminating upstream emissions associated with transporting water, and a reduced statewide electricity emissions intensity associated with the remaining imported water.

For more information on GHG changes and CAP performance, refer to Appendix A: Progress Tracking owards CAP Measures

B3.2 Per Capita Greenhouse Gas Emissions

The 2019 – 2023 per capita GHG emissions in the City of San Diego are given in Table 5. This represents emissions from the six emissions categories analyzed.

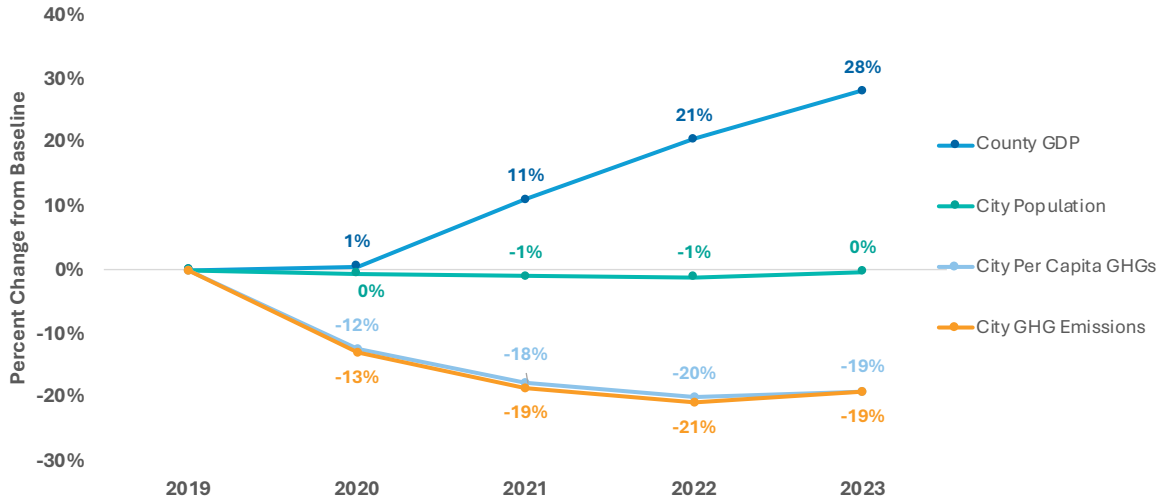
TABLE 5 PER CAPITA GHG EMISSIONS (2019 – 2023)					
Year	**2019**	**2020**	**2021**	**2022**	**2023**
Total Emissions ($MMTCO_2e$)	10.54	9.19	8.59	8.35	8.52
Total Population	1,389,543	1,383,020	1,376,694	1,375,403	1,387,001
Per Capita GHG Emissions ($MTCO_2e$ per capita)	7.58	6.64	6.24	6.07	6.14

MT CO2e = metric tons of carbon dioxide equivalent
Per capita emissions based on six emission categories only and cannot be compared with California statewide per capita emissions or per capita emissions targets.
2019 population is based on 2010 census benchmark. 2020, 2021 and 2022 population estimates are based on 2020 census benchmark. Populations are updated with the latest California Department of Finance population estimates.
Energy Policy Initiatives Center, University of San Diego 2025

The GHG emissions categories and inventory methodology for the City of San Diego are based on the U.S. Communities Protocol, which requires five basic emissions-generating activities to be included in a Community GHG inventory. These categories are generally recognized as being under the collective control and management of the community whereas other emissions-generating activities such as air travel, shipping, or high global warming potential gases are not considered as such. Therefore, allocating emissions from these categories to cities is either not possible due to lack of data or lack of proxy data, or is better handled at a higher geographic level of aggregation. In contrast, the California statewide GHG emissions inventory includes all economic sectors of the state. Therefore, the estimated City per capita emissions cannot be compared directly with the California statewide per capita emissions or per capita emissions targets calculated using the CARB statewide inventory or statewide emissions targets, which include all economic sectors and additional emissions categories.

Figure 2 shows countywide GDP growth compared to City of San Diego population and GHG emissions changes since 2019. County GDP is used as city-specific GSP data is not available. From 2019 to 2023, the per capita GHG emissions in the city dropped by 19%, while the population remained largely stable.

FIGURE 1: CHANGES IN SAN DIEGO COUNTY GDP COMPARED TO CITY OF SAN DIEGO POPULATION AND GHG EMISSIONS FROM 2019 BASELINE



GDP listed is for San Diego County. Population and Emissions are for the City of San Diego.

CA Dept of Finance, U.S. Bureau of Economic Analysis, Energy Policy Initiatives Center, University of San Diego 2025

B4 METHOD TO CALCULATE GHG EMISSIONS INVENTORY

The CAP inventory follows the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (U.S. Community Protocol),[4] developed by ICLEI USA. It requires a minimum of five basic emissions-generating activities to be included in a Protocol-compliant community-scale GHG inventory. These categories are: electricity, natural gas, on-road transportation, water and wastewater, and solid waste. GHG emissions are calculated by multiplying activity data (e.g., kilowatt-hours of electricity, tons of solid waste) by an emission factor (e.g., pounds of CO_2e per unit of electricity). Off-road emissions from construction equipment were added to the 2022 CAP and subsequent Annual Reports as an optional category to be consistent with the emission categories in the CAP. These emission categories are routinely included in citywide inventories to ensure comparability across jurisdictions. GHG emissions from sources such as air travel, shipping, or other high global warming potential gases used in the City are not included. For these categories, methods based on the U.S. Community Protocol were modified with regional- or City-specific data when available.

The U.S. Community Protocol provides guidance for developing community-scale inventories. Protocols and guidance for reporting GHG emissions for individual entities, such as corporations and public agencies, are different from those for communities. The Local Government Operations Protocol, developed by ICLEI, CARB, and the Climate Registry (TCR), and the General Reporting Protocol, developed by TCR, are widely used to develop GHG inventories for local governments and public agencies.[5] The method to determine boundaries in the U.S. Community Protocol is different from the method in the Local Government Operations Protocol or the General Reporting Protocol, which depends on the entity's financial or operational control. This inventory accounts for the emission generating activities in the City of San Diego, not based on City's financial or operational control.

All activity data and GHG emissions reported in this document are annual values, and all emission factors reported in this document are annual average values, unless stated otherwise.

B4.1 On-Road Transportation

The emissions associated with on-road transportation are calculated by multiplying the estimated City of San Diego annual VMT with the average annual vehicle emission rate in the San Diego region.

B4.1.1 Vehicle Miles Traveled (VMT)

SANDAG uses an activity-based model (ABM) to support development of Regional Transportation Plans and generates outputs related to the transportation system performance, including VMT. Every three to five years, SANDAG produces the Regional Growth Forecast, a long-range forecast of population, housing employment growth, and produces VMT for the San Diego region, and by jurisdiction. As of the Annual Report development, the most recent forecast is the Series 14 Growth Forecast with a base year of 2016. This Forecast was used in SANDAG's Final 2021 Regional Plan with the most recent version of the ABM model, ABM2+. While a draft version of the 2025 Regional Plan[6] has recently been released, jurisdiction-specific VMT estimates are not yet available from the updated travel demand model.

[4] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019).
[5] CARB, ICLEI, and The Climate Registry: Local Government Operations Protocol; the Climate Registry: General Reporting Protocol Version 3.0.
[6] Draft 2025 Regional Plan. SANDAG

SANDAG provided VMT estimates for the City of San Diego for year 2016.[7] However, 2017–2023 VMT data from Series 14 are not available at the jurisdictional level. Therefore, for the City of San Diego, post-2016 VMT data were estimated with the Series 14 2016 VMT adjusted using VMT monitoring data for 2017–2023 from other sources. The public road and freeway data in the San Diego region are from the California Department of Transportation (Caltrans) Highway Performance Monitoring System (HPMS).[8]

SANDAG allocates the VMT derived from ABM2+ to a jurisdiction using the Origin-Destination (O-D) method.[9] The O-D VMT method is the preferred method proposed by the U.S Community Protocol in *"TR.1 Emissions from Passenger Vehicles"* and *"TR.2 Emissions from Freight and Service Trucks"* that estimates miles traveled based on where a trip originates and where it ends to attribute on-road emissions to cities and regions (Figure 2).[10]

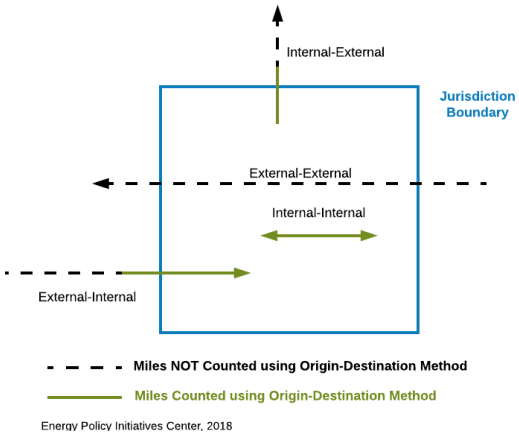


FIGURE 2 COMPONENTS OF O-D METHOD FOR VMT CALCULATION

O-D VMT allocated to San Diego includes all miles traveled for trips that originate and end within San Diego city limits (referred to as Internal-Internal), and half of the miles traveled for trips that either begin within San Diego and end outside the City (referred to as Internal-External), or vice versa (referred to as External-Internal). In accordance with the methodology, VMT from trips that begin and end outside San Diego that only pass through the City limits (referred to as External-External) are not included in the total City VMT. The total average weekday VMT were multiplied by 347 to adjust from average weekday VMT to average annual VMT, which includes weekends.[11]

The average weekday Series 14 O-D VMT estimates for each trip type in 2016 provided by SANDAG and the total VMT allocated to the City based on the ICLEI methodology described above are given in Table 6.[12]

[7] 2016 VMT was provided by SANDAG to City of San Diego (January 2022). SANDAG Activity Based Model 2+ Release v14.2.2, Final 2021 Regional Plan Networks, Policies, and Assumptions, Year 2016, Reference Scenario 458. The forecast in the Final 2021 Regional Plan was based on the Sustainable Communities Strategy land use pattern, which may be different from jurisdictions' general plan land use pattern.
[8] California Department of Transportation: Highway Performance Monitoring System (HPMS) Data.
[9] SANDAG (2013): Vehicle Miles Traveled Calculation Using the SANDAG Regional Travel Demand Model. Technical White Paper.
[10] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019), Appendix D: Transportation and Other Mobile Emission Activities and Sources.
[11] The conversion of 347 weekdays to 365 days per year as used by CARB. CARB: California's 2000–2014 Greenhouse Gas Emission Inventory Technical Support Document (2016 Edition), p. 41 (September 2016).
[12] The 2016 data used here are different from (1-3% lower) the 2016 data used in the San Diego Climate Action Plan update 2022, which were from SANDAG ABM2+ Release v14.2.1, Draft 2021 Regional plan (October 2020).

TABLE 6 2016 O-D VMT ESTIMATES BY TRIP TYPES AND TOTAL VMT PROVIDED BY SANDAG (SAN DIEGO, 2016)					
Year	VMT by Trip Type (Miles/Weekday)			Total City VMT (100% * I-I + 50% * I-E/E-I) (Miles per Weekday)	Total City VMT (Miles per Year)
	Internal-Internal (I-I) Trips	External-Internal/Internal-External (I-E/E-I) Trips	External-External Trips (Information only, excluded from City VMT)*		
2016	22,264,735	28,279,389	32,824,891	36,404,429	12,632,336,902

*Though excluded from this analysis, miles from External-External trips (pass-through trips) shown here are the portion only within the City boundary, not from the entire trip.
Based on SANDAG Series 14 (Final 2021 Regional Plan) and ABM2+ VMT estimates. The conversion factor from miles per weekday to miles per year is 347.

SANDAG 2022, Energy Policy Initiatives Center, University of San Diego 2024

Historical year data from other than the 2016 base year are not available under SANDAG ABM2+. Therefore, to estimate 2023 O-D VMT, the 2016 O-D VMT was adjusted by the annual rates of increase from 2016 to 2023, as indicated by the State public road VMT monitoring system (Caltrans HPMS). Annual Caltrans HPMS VMT was used to estimate annual VMT growth rates for the San Diego region. These growth rates were applied to the City of San Diego's 2016 O-D VMT data (Table 6) as an approximation of VMT growth since 2016. The Caltrans HPMS VMT estimate for the San Diego region is based on daily monitoring on all public roads, including city streets, county roads, state highways, roads maintained by state and federal agencies, freeways, etc. The estimated daily VMT and annual rate of increase or decrease from 2016 to 2023 with Caltrans HPMS data are given in Table 7.[13]

TABLE 7 SAN DIEGO REGION DAILY VMT DERIVED FROM THE CALTRANS HIGHWAY PERFORMANCE MONITORING SYSTEM		
Year	San Diego Region Daily VMT	Annual Rate of Increase
	(thousand miles/day)	(%)
2016	79,622	-
2017	81,253	2.0%
2018	82,618	1.7%
2019	86,136	4.3%
2020	68,650	-20.3%
2021	71,151	3.6%
2022	71,954	1.1%
2023	74,422	3.4%
Caltrans 2024, Energy Policy Initiatives Center, University of San Diego 2025		

The 2020 San Diego regional daily VMT was 20% lower than in 2019, which reflects the travel pattern change due to the COVID-19 pandemic. Statewide, 2020 VMT showed an average decline of 15%

[13] Caltrans: HPMS Data, accessed January 18, 2023.

compared with 2019.[14] In the years since, VMT has been steadily increasing back to close to pre-pandemic levels.

B4.1.2 Average Annual Vehicle Emission Rate

The average annual vehicle emission rate expressed in grams of CO_2e per mile driven (g CO_2e/mile) is derived from the statewide mobile source emissions model EMFAC2021 developed by CARB.[15]

EMFAC2021 was run in the default activity mode to generate the total VMT and total vehicle GHG emissions for the San Diego region, including all vehicle model years, classes, and fuel types.[16] This document assumes that the City of San Diego has the same distribution of vehicle types as the San Diego region.

B4.1.3 Total Emissions from On-Road Transportation

Total estimated VMT, average vehicle emission rates, and corresponding GHG emissions from on-road transportation from 2019–2023 are given in Table 8.

TABLE 8 VMT, EMISSION RATE, AND GHG EMISSIONS FROM ON-ROAD TRANSPORTATION (SAN DIEGO, 2019–2023)

Year	Total VMT (Million Miles/year)	Average Vehicle Emission Rate (g CO_2e/mile)	GHG Emissions (MMT CO_2e)
2019	13,666	428	5.85
2020	10,892	427	4.65
2021	11,288	415	4.68
2022	11,416	405	4.63
2023	11,807	396	4.67

GHG emissions for each category are rounded. Values are not rounded in the intermediary steps in the calculation.
Energy Policy Initiatives Center, University of San Diego 2025

B4.2 Electricity

Emissions from electricity in the City of San Diego were estimated using the Built Environment (BE.2) method from the U.S. Community Protocol, by multiplying electricity use by the annual City-specific electricity emission factor.[17]

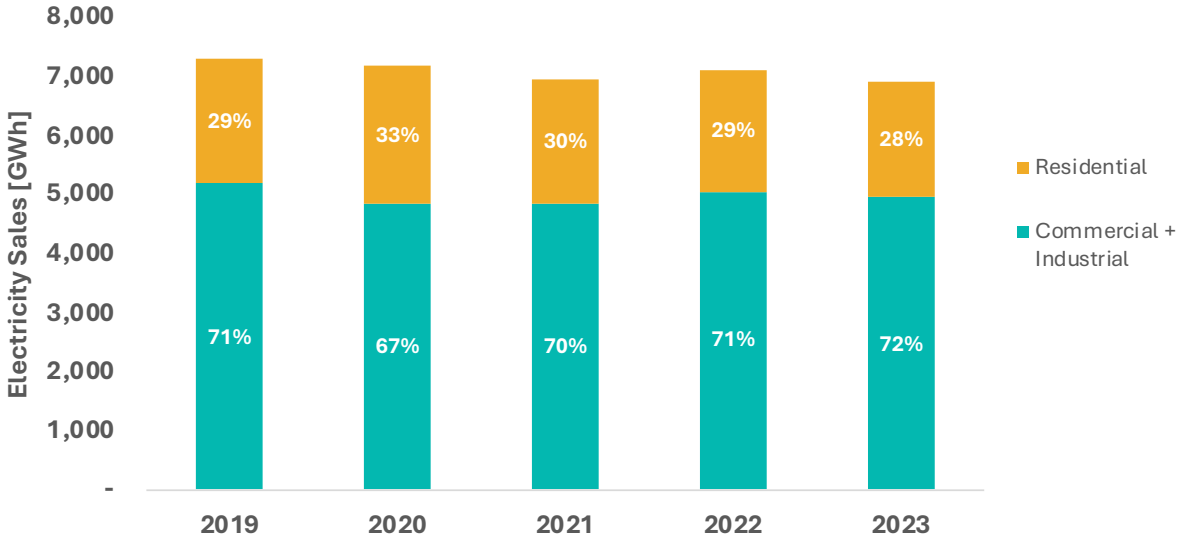
B4.2.1 Electricity Use

Annual metered electricity sales data within the City were provided by the local utility, San Diego Gas & Electric (SDG&E).[18] The electricity sales data do not include the electricity sales to San Diego County

[14] Caltrans: California Public Road Data 2022. Statistical Information Derived from the Highway Performance Monitoring System (Released November 2023).
[15] CARB: EMission FACtors model, EMFAC2021 v1.0.1, released on April 30, 2021, downloaded on August 30, 2021. CARB published an updated version, EMFAC2021 v1.0.2, on May 2, 2022. The updates fixed bugs that were not related to GHG emissions.
[16] *Id.*
[17] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019), Appendix C: Built Environment Emission Activities and Sources.
[18] Electricity sales were provided to EPIC by SDG&E (January 2025)

Regional Airport Authority, San Diego Unified Port District, and the military. The electricity sales from 2019 to 2023 by customer class are shown in Figure 3.

FIGURE 3 SDG&E ELECTRICITY SALES TO CITY OF SAN DIEGO BY CUSTOMER CLASS (2019–2023)



SDG&E's electricity sales in City of San Diego. Sales do not include transmission and distribution losses, and exclude sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and the military.
Percentages may not sum up to totals due to rounding.
SDG&E 2019-2023

The percentage of electricity use from each customer class (residential vs. commercial and industrial) has remained relatively similar each year. Since the 2019 baseline, residential electricity consumption has decreased by 9%, and commercial and industrial electricity consumption has decreased by 4%.

In 2019 and 2020, the electricity sales included the sales to SDG&E bundled customers[19] and Direct Access (DA) customers.[20] In March 2021, San Diego Community Power (SDCP), a community choice energy provider, started serving jurisdictions in the San Diego region, including the City of San Diego. By the end of 2021, eligible SDG&E bundled commercial and industrial customers were enrolled in SDCP automatically with the option to opt-out (return to SDG&E) or opt-up to a SDCP product with higher renewable electricity. In early 2022, residential accounts were automatically enrolled in SDCP with the same options to opt-out or opt-up.

The 2019 and 2020 electricity use per customer class provided by SDG&E have the same format, with bundled and DA customers' electricity use identified separately. For inventory year 2023, SDG&E provided electricity use by customer class and energy provider, matching the 2019 and 2020 format and including additional consumption from CCA customers. In data year 2021, only total electricity use per customer class was provided by SDG&E and in data year 2022 SDG&E provided a breakout for CCA electricity consumption but not for DA electricity consumption. For those years, the 2020 percentage of electricity consumption used by DA customers was used as a proxy to break out DA consumption. In 2021 participation rate provided by the CCA was used to estimate consumption via CCA customers.

The electricity sales were then adjusted by 1) a loss factor[21] of 1.085[22] to account for transmission and distribution losses; and 2) subtracting electricity use associated with moving water within the City limits, which is allocated to the water category emissions.

The adjusted net energy for load (electricity sales + losses) is provided in Table 9.

B4.2.2 City-Specific Electricity Emission Factor

For a given year, the City-specific electricity emission factor, expressed in pounds of CO_2e per Megawatt-hour (lbs CO_2e/MWh), is estimated based on the specific mix of bundled power, DA power, and SDCP power, if any, in the City and their respective emission factors.

The 2019 SDG&E bundled emission factors are calculated using Federal Energy Regulatory Commission (FERC) Form 1[23] data, the California Energy Commission (CEC) Power Source Disclosure (PSD) Program[24] data on SDG&E-owned and purchased power, and U.S. EPA Emissions and Generating Resource Integrated Database (eGRID) 2019 Edition[25] on specific power plant emissions. The 2019 SDG&E bundled emission factor calculated using the sources above is 633 lbs CO_2e/MWh, with 31% eligible renewable.

The CEC PSD Program, under the requirements of Assembly Bill (AB) 1110 (Ting, Chapter 656, Statutes of 2016), requires retail electric providers to disclose GHG emissions intensity (i.e., electricity emission factor) separately from unbundled renewable energy credits, starting in 2021 for 2020 procurements. The SDG&E bundled emission factors are provided directly in the power content labels reported under the CEC PSD Program and listed below in Table 9.

The DA emission factor, 836 lbs CO_2e/MWh, is based on a 2016 California Public Utilities Commission (CPUC) Decision D.14-12-037.[26] The CEC PSD program began publishing emissions intensity data for statewide energy service providers servicing DA customers in data year 2021. This Annual Report updates the Direct Access emission factor to use the statewide average emissions from all DA energy service providers (ESPs) for the available data years, 2021 and 2022. Due to data confidentiality issues, 2023 DA emission factors use 2022 data as a proxy until all ESP data is released by December 2025. A straight-line estimate from the 2016 CPUC emission factor to the calculated 2021 direct access emission factor is used for inventory years 2019 to 2020. The City-specific electricity emission factors are provided in Table 9.

B4.2.3 Total Emissions from Electricity

Emissions are calculated by multiplying the adjusted net energy for load (electricity sales + losses) and the corresponding City-specific electricity emission factor. The net energy for San Diego's load

[21] The transmission and distribution loss factor is used to scale end-use demand or retail sales to produce net energy for load. L. Wong, *A Review of Transmission Losses In Planning Studies*, CEC Staff Paper (August 2011).
[22] California Energy Commission (CEC): *California Energy Demand 2015–2025 Final Forecast Mid-Case Final Baseline Demand Forecast Forms*, SDG&E Mid. The transmission and distribution loss (T&D) factor is calculated based on the ratio of net energy for load (total sales + net losses) and total sales from SDG&E Form 1.2 Mid. While T&D losses fluctuate, 1.085 is used as a constant for all jurisdictions regionally.
[23] FERC: Form 1 – Electric Utility Annual Report.
[24] CEC: Power Source Disclosure Program under Senate Bill 1305. The SDG&E annual power source disclosure reports in 2019 were provided to EPIC by CEC staff. SDG&E 2019 Power Content Label, version October 2020. The CEC PSD Program, under the requirements of Assembly Bill (AB) 1110 (Ting, Chapter 656, Statutes of 2016), requires retail electric providers to disclose GHG emissions intensity (i.e., electricity emission factor) and unbundled renewable energy credits, starting in 2021 for 2020 procurements. Starting in 2021, the GHG emissions intensity reported by retail electric providers for the PSD Program will be used directly to calculate GHG emissions from the electricity category.
[25] U.S. EPA. eGRID 2019 Edition, released on February 23, 2021.
[26] CPUC: Decision 14-12-037, December 18, 2014 in Rulemaking 11-03-012 (filed March 24, 2011). The recommended emission factor is 0.379 MT CO_2e/MWh (836 lbs CO_2e/MWh). The recommended emission factor has not changed since 2014. However, all electric service suppliers must meet the Renewables Portfolio Standards in the target years.

(electricity sales + losses), electricity emission factors, and corresponding GHG emissions from the electricity category for 2019-2023 are shown in Table 9.

TABLE 9 NET ENERGY FOR LOAD, EMISSION FACTOR, AND GHG EMISSIONS FROM ELECTRICITY CATEGORY (SAN DIEGO, 2019–2023)

Year	SDG&E Bundled Emission Factor (lbs CO_2e/ MWh)	SDCP 'Power On' Emission Factor (lbs CO_2e/MWh)	DA Energy Service Provider Emission Factor (lbs CO_2e/MWh)	Net Energy for Load (electricity sales + losses)* (MWh)	City-Specific Emission Factor (lbs CO_2e/MWh)**	GHG Emissions (MT CO_2e)
2019	633	-	735	7,934,303	649	2,336,000
2020	636	-	702	7,810,499	645	2,286,000
2021	504	378	668	7,548,648	472	1,617,000
2022	508	375	641	7,743,740	435	1,527,000
2023***	537	460	641	7,494,342	475	1,615,000

*The net energy for load does not include the net energy for load from San Diego County Regional Airport Authority, San Diego Unified Port District, and the military.
**City-Specific emission factors are for City of San Diego only and do not represent the emission factors of SDG&E bundled electricity or of other jurisdictions in the San Diego region.
***Not all statewide direct energy service provider emission factors are available for 2023. This Annual Report uses 2022 emission factors for DA energy.
GHG emissions for each category are rounded. Values are not rounded in the intermediary steps in the calculation.
Energy Policy Initiatives Center, University of San Diego 2025

B4.3 Natural Gas

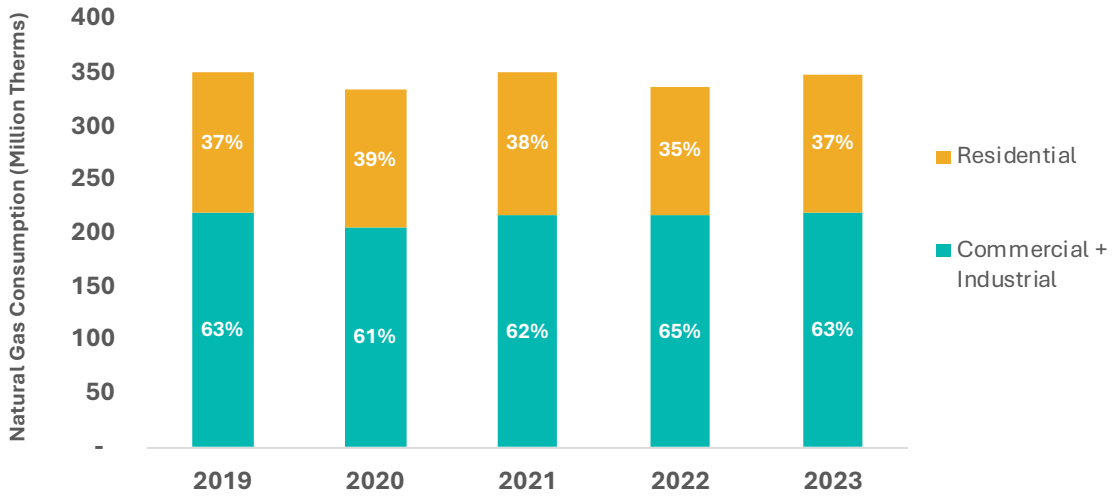
Emissions from natural gas use in San Diego were estimated using method Built Environment (BE.1) from the U.S. Community Protocol, by multiplying the natural gas use (the activity) and the natural gas emission factor each year.[27]

B4.3.1 Natural Gas Use

Annual natural gas sales were provided by SDG&E, broken down by residential, commercial, and industrial customer class.[28] The natural gas sales data do not include the sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and the military. The natural gas sales from 2019 to 2023 by customer class are show in Figure 4.

[27] ICLEI– Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019), Appendix C: Built Environment Emission Activities and Sources.
[28] Natural gas sales were provided to EPIC by SDG&E (January 2025).

FIGURE 4 SDG&E NATURAL GAS SALES TO CITY OF SAN DIEGO BY CUSTOMER CLASS (2019–2023)



SDG&E'S natural gas sales in City of San Diego do not include transmission and distribution losses, and exclude sales to Sa Diego County Regional Airport Authority, San Diego Unified Port District, and the military.
Percentages may not sum up to totals due to rounding.
SDG&E 2019-2023

The natural gas end-use fluctuates annually. In 2023 natural gas emissions have reduced 1% compared to the 2019 baseline but are 3% higher than 2022.

B4.3.2 Natural Gas Emission Factor

The natural gas emission factor is based on the heat content of the fuel and the fuel's CO_2, CH_4, and N_2O emissions. The heat content of fuel and the emissions from CO_2, CH_4, and N_2O were based on the CARB statewide inventory.[29] The natural gas emission factor is given in Table 10.

B4.3.3 Total Emissions from Natural Gas

To estimate emissions from the combustion of natural gas, end-use sales were multiplied by the emission factor. The total natural gas end-use and corresponding GHG emissions from the natural gas category for 2019-2023 are given in Table 10.

[29] CARB: GHG Current California Emission Inventory Data.

TABLE 10 NATURAL GAS END-USE AND GHG EMISSIONS FROM NATURAL GAS CATEGORY (SAN DIEGO, 2019-2023)			
Year	**Natural Gas End-Use (Million Therms)**	**Natural Gas Emission Factor (Million MT CO_2e/Million Therms)**	**GHG Emissions (MT CO_2e)**
2019	351	0.00545	1,912,000
2020	335	0.00545	1,827,000
2021	352	0.00545	1,918,000
2022	337	0.00545	1,837,000
2023	348	0.00545	1,898,000
The natural gas sales do not include the sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and the military. GHG emissions for each category are rounded to the nearest thousand. Values are not rounded in the intermediary steps in the calculation. **SDG&E 2020-2024, Energy Policy Initiatives Center, University of San Diego 2025**			

B4.4 Off-Road Transportation (Construction Equipment Only)

The emissions from off-road transportation in the City, such as gasoline and diesel fuel use for off-road vehicles and equipment, were estimated based on CARB off-road models. The CARB models include many off-road equipment types, only construction related equipment and its emissions are covered here. Common equipment types are excavators, off-highway tractors, paving equipment. OFFROAD2021 is the main model for estimating off-road transportation emissions.[30]

Due to the lack of jurisdiction-specific data from CARB models, the construction emissions from CARB model outputs for the San Diego region were scaled to the City based on the ratio of regional and citywide construction jobs. The ratio and the corresponding GHG emissions from the off-road transportation category for 2019-2023 are given in Table 11.

TABLE 11 GHG EMISSIONS FROM OFF-ROAD TRANSPORTATION (CONSTRUCTION EQUIPMENT ONLY) CATEGORY (SAN DIEGO, 2019 - 2023)			
Year	**GHG Emissions from Construction Equipment in San Diego Region (MT CO_2e)**	**Construction Jobs Ratio (City of San Diego/San Diego Region)**	**GHG Emissions from Construction Equipment in City of San Diego (MT CO_2e)**
2019*	177,000	39%	69,000
2020	145,000	39%	57,000
2021	145,000	39%	57,000
2022	145,000	39%	57,000
2023	145,000	40%	57,000
*Emissions from 2019 have been updated since the 2022 CAP to reflect updates to the underlying CARB model. CARB OFFROAD2021 (v1.0.6), Energy Policy Initiatives Center, University of San Diego 2025			

[30] CARB: OFFROAD2021 (v1.0.6) Emissions Inventory, all adopted rules -exhaust. Downloaded on May 20, 2024.

B4.5 Solid Waste

Emissions from the decomposition of organic material in waste disposed at landfills were estimated using method Solid Waste (SW.4) from the U.S. Community Protocol, by multiplying the amount of waste disposed by the City in 2019 and an emission factor for mixed solid waste. [31] This represents the immediate and all future emissions from decay of this waste.

B4.5.1 Solid Waste Disposal

Solid waste disposal is the waste disposed by the City in landfills, regardless of whether the landfills accepting the waste are located inside or outside of the City boundary. The majority of the waste from the City is disposed at West Miramar Sanitary Landfill, Otay Landfill, and Sycamore Landfill.[32]

The total waste disposal from the City was 1,607,277 short tons (1,458,098 metric tons) in 2023, 2% higher than the waste disposal in 2019. The total and per-capita solid waste disposal are given in Table 13.[33]

B4.5.2 Mixed Solid Waste Emission Factor

The emission factor of mixed solid waste depends on the percentage of each waste type within the waste stream disposed in a landfill. This Annual Report updates inventory years 2021 – 2023 with CalRecycle's statewide waste characterization study[34]. Inventory years previous to CalRecycle's study year of 2021 uses the City of San Diego's 2012–2013 Waste Characterization Study, conducted at Miramar Landfill, which is the most recent waste characterization study done by the City.[35] Only the CH_4 emissions from waste degradation are considered non-biogenic and included in this category. The CO_2 emissions from waste degradation are considered biogenic and not included in this category.

The EPA Waste Reduction Model (WARM) is used to determine the emission factor of each waste type. WARM is a lifecycle GHG model to assess and compare waste management options (e.g., landfilling, recycling, source reduction, composting), through the lifecycle of waste materials (from material extraction to disposal). However, under the U.S Community Protocol, only emissions from the disposal and associated degradation of waste are included. Therefore, only the landfill emission factors in EPA WARM are used in the calculation. WARM reports the landfill CH_4 emission factor of each waste material in MT CO_2e/short ton, with and without Landfill Gas (LFG) recovery.

The mixed solid waste emission factor is given in Table 12. The landfill emission factors without LFG recovery are identified here; the LFG recovery is applied later.

[31] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019), Appendix E: Solid Waste Emission Activities and Sources.
[32] CalRecycle: Disposal Reporting System (DRS): Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility.
[33] 2021 & 2022 waste disposal was provided by City of San Diego to EPIC in January 2023.
[34] CalRecycle: 2021 Disposal-Facility-Based Characterization of Solid Waste in California (DRRR-2024-1737). Published May 30, 2024.
[35] City of San Diego: Waste Characterization Study 2012–2013 Final Report (2014), accessed November 4, 2019.

TABLE 12 MIXED SOLID WASTE EMISSION FACTOR COMPARISON: 2021 STATEWIDE STUDY AND 2013 REGIONAL STUDY			
Waste Component	**CH_4 without Landfill Gas Recovery (WARM v15) (MT CO_2e/short ton disposed)[3]**	**Pre-2021 Waste Distribution (%)[1]**	**2021 – 2023 Waste Distribution (%)[2]**
Paper		16.8%	15.5%
Corrugated Containers/Cardboard	2.36	*5.0%*	7.4%
Newspaper	0.94	*0.8%*	0.3%
Magazine	1.08	*0.6%*	0.4%
Mixed Paper (general)	2.14	*10.4%*	5.7%
Plastic	0	8.9%	13.7%
Glass	0	1.7%	2.3%
Metal	0	3.5%	4.9%
Organics		38.9%	28.9%
Food	*1.62*	*15%*	9.2%
Tree (Branches)	*1.3*	*5.3%*	1%
Leaves and Grass	*0.59 (leaves)*	*6.8%*	2.2%
Trimmings	*0.73*	*3.5%*	2.8%
Mixed Organics	*0.53*	*8.3%*	13.0%
Electronics	0	0.6%	0.9%
Construction & Demolition Inerts	0	24.6%	12.0%
Household Hazardous Waste	0	0.2%	0.3%
Special Waste	0	3.1%	5.2%
Mixed Residue	0	1.6%	16.9%
Mixed Waste Emission Factor (MTCO2e/short ton)		**0.785**	**0.589**
[1] City of San Diego 2014. [2] CalRecycle 2021 Statewide Waste Characterization Study [3]EPA Waste Reduction Model (WARM) Version 15 (May 2019)			

B4.5.3 Total Emissions from Solid Waste Disposed in Landfills

The mixed waste emission factor given in Table 12 is the emission factor without landfill gas collection. The 75% default capture rate of CH_4 emissions from landfills, from the U.S. Community Protocol, is applied in the emissions calculation. The total and per-capita solid waste disposal and the corresponding GHG emissions for 2019 are given in Table 13.

TABLE 13 SOLID WASTE DISPOSAL INTO LANDFILLS AND ASSOCIATED GHG EMISSIONS (SAN DIEGO, 2019–2023)								
Year	Solid Waste Disposed			GHG Emission Factor (MT CO_2e/Short Ton)*	Oxidation Rate[2]	Total GHG Emissions (MT CO_2e)	Default CH_4 Capture Rate	Remaining Emissions (MT CO_2e)
	Citywide (Short Tons/Year)	Citywide (MT/Year)	Per Capita Solid Waste Disposal (kg/person/day)[1]					
2019	1,569,447	1,423,779	2.8	0.785	10%	1,108,000	75%	277,000
2020	1,543,627	1,400,355	2.8	0.785	10%	1,090,000	75%	273,000
2021	1,631,802	1,400,355	2.9	0.589	10%	1,152,000	75%	216,000
2022	1,596,546	1,449,270	2.9	0.589	10%	1,128,000	75%	212,000
2023	1,607,277	1,458,098	2.9	0.589	10%	851,000	75%	213,000

GHG emissions for each category are rounded. Values are not rounded in the intermediary steps in the calculation.
[1] Informational, based on total waste disposal and population estimates. 2019 population is based on 2010 census benchmark, and 2020 - 2023 population are based on the 2020 census benchmark.
[2] The oxidation rate is a default estimate of methane that is oxidized and not emitted, therefore only 90% of total methane emissions are produced per the ICLEI Community Protocol.
*Historical inventory years 2021 and 2022 have been updated in this Annual Report to incorporate results of the statewide waste composition study.
Energy Policy Initiatives Center, University of San Diego 2025

B4.5.4 Estimating Emissions from Previously Disposed Solid Waste (Not Reported in Inventory)

The Community Protocol recognizes that there are emissions from waste previously disposed in landfills located within the City boundary. The emissions from waste-in-place can be reported optionally in additional to waste disposal. The Protocol provides a separate method to estimate emissions from past disposal. The City of San Diego has two active landfills and four closed landfills within its boundary. Emissions from waste already in place in City landfills are tracked separately here and are not included in the reported value for solid waste emissions in the City GHG emissions total.

For landfills that are required to report GHG emissions through the Environmental Protection Agency's Mandatory Greenhouse Gas Reporting Program (EPA MRR), the reported values are used directly.[36] For the landfills not subject to EPA MRR, emissions were calculated based on the Landfill Emissions Tool developed by CARB using the first order decay model recommended by the IPCC.[37]

Emissions from in-boundary landfills cannot be directly added to emissions from solid waste disposed in the current year. This is because emissions from solid waste disposal (method provided in Section B4.5.3) are calculated to include the projected future GHG emissions from the waste disposed in the current year, regardless of disposal location, while emissions from in-boundary landfills are emissions in the current year from waste that has already been in place at the landfills, regardless of where the waste was generated.

The emissions from San Diego landfills are given in Table 14.

[36] EPA: 2019 Greenhouse Gas Emissions from Large Facilities, accessed November 10, 2020.
[37] CARB: Landfill gas tool, released September 24, 2021, download date: January 9, 2023. Results may differ from the previous v1.3 tool released in 2011. tool reports CO_2e of CH_4 using 21 as CH_4 GWP, recalculated using 25 as CH_4 GWP.

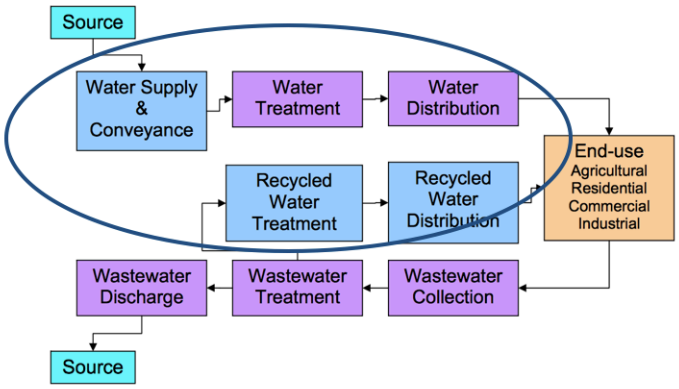
TABLE 14 EMISSIONS FROM IN-BOUNDARY LANDFILLS (INFORMATION ONLY, NOT REPORTED IN GHG INVENTORY)							
Landfill	**Status**	**2019 Landfill Emissions (MT CO_2e)**	**2020 Landfill Emissions (MT CO_2e)**	**2021 Landfill Emissions (MT CO_2e)**	**2022 Landfill Emissions (MT CO_2e)**	**2023 Landfill Emissions (MT CO_2e)**	**Source**
West Miramar Sanitary Landfill	Active	154,932	198,685	152,566	141,544	115,295	EPA MRR
Sycamore Landfill	Active	86,057	87,168	107,175	155,748	105,269	EPA MRR
North Miramar Sanitary Landfill	Closed in 1983	2,974	2,211	3,420	3,210	3,564	EPA MRR
South Chollas Sanitary Landfill	Closed in 1981	n/a	n/a	n/a	n/a	n/a	Discontinued reporting to EPA MRR in 2015
Arizona Street Landfill	Closed in 1974	9,598	9,408	9,222	9,039	8,860	CARB Landfill Emission Tool (CARB LET) result using waste received before closing
Mission Bay Landfill #1	Closed in 1959	5,530	5,420	5,313	5,104	5,104	CARB LET result using operational period 1952-1959 and waste-in-place at the end of 1990
Total	-----	259,091	302,892	277,696	314,645	238,092	-

n/a = not available
Landfill emissions reported in EPA MRR were estimated from methane recovery, destruction and other factors. The emissions may differ from modeled methane generation and from previous versions.
CARB 2024, EPA 2024, Energy Policy Initiatives Center 2025

B4.6 Water

Emissions from water use in a jurisdiction result from the energy required to move water from origin sources to end-use customers, including upstream supply and conveyance, water treatment, and water distribution, as circled in Figure 5. The energy required to move water is primarily electricity but may include natural gas or other fuels.

FIGURE 5 SEGMENTS OF THE WATER CYCLE



California Energy Commission, 2005

Emissions from water were estimated using the method Wastewater and Water (WW.14) from the U.S. Community Protocol.[38] Emissions associated with water end-use, such as water heating and cooling, are included in the electricity and natural gas categories, not in this water category, as data are not available to separate out those values.

Water agencies developing their own GHG inventories would not follow the U.S. Community Protocol because the U.S. Community Protocol is specifically for community-wide inventories, not for other types of entities. Therefore, the scope and boundary of emissions included in this sector are different from those of a water agency's GHG inventory. For example, the water agencies may account only the emission generating activities within their operational or financial control in their GHG inventories.

B4.6.1 Water Use

The City of San Diego is a member agency of the water wholesaler in the San Diego region, the San Diego County Water Authority (SDCWA). The City of San Diego delivers potable and recycled water within the City boundary, and also sells water to or treats water for neighboring water agencies and cities, such as the City of Del Mar, South Bay Irrigation Water District, and the California American Water Company (CalAm).[39]

The potable water supply sources for the City of San Diego include: (1) imported untreated water from SDCWA; (2) imported treated water from SDCWA; (3) surface water from local reservoirs; and (4) groundwater from the Santee-El Monte Basin.[40] Recycled water is produced at the City's North City Water Reclamation Plant (North City WRP) and South Bay Water Reclamation Plant (South Bay WRP) and is used for non-potable use, such as landscape irrigation.

The potable water supplied within City of San Diego (excluding sales to other water agencies) and the percentage of water from each source, and the recycled water are given in Table 15.[41]

[38] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019), Appendix F: Wastewater and Water Emission Activities and Sources.
[39] California American Water Company (CalAm)'s service area in San Diego region includes Cities of Imperial Beach and Coronado, and portions of the City of Chula Vista. California American Water: 2020 Urban Water Management Plan, Southern Division – San Diego County District (2021).
[40] City of San Diego, 2020 Urban Water Management Plan, Section 6 System Water Supplies (2021).
[41] Recycled water sales, water production at each of City's water treatment plants (WTPs) from each water source and sales to other agencies (City of Del Mar and CalAm) were provided by City of San Diego from 2017 to 2019. Water sale to City of Del Mar is from the imported raw

TABLE 15 WATER SUPPLIED AND SUPPLY SOURCE (SAN DIEGO, 2019–2023)						
Year	Potable Water Supply					Recycled Water Supply (Acre-Feet)
	Imported SDCWA Treated	Imported SDCWA Untreated	Local Surface Reservoir	Local Groundwater Basin	Potable Water Supplied (Acre-Feet)	
2019	10%	77%	14%	0.1%	161,472	7,999
2020	12%	73%	14%	0.1%	166,742	8,842
2021	8%	84%	7%	0.3%	161,995	8,586
2022*	6%	86%	8%	0.3%	171,984	10,012
2023	10%	66%	23%	0.3%	155,215	8,675
Percentages may not add up to totals due to rounding. Potable water supplied (acre-feet) is the City of San Diego's water production excluding sales to other water agencies. * 2022 water supply has been updated from the previous Annual Report as water sales to other agencies were incorrectly not removed. This Annual Report corrects that error. **City of San Diego 2024, Energy Policy Initiatives Center, University of San Diego 2025**						

B4.6.2 Energy Intensity of Water

The energy used to produce and distribute water from each source is different due to the different raw source type and its location. The energy intensity of water, or the energy needed to move one unit of water through each segment of the water-use cycle (water supply and conveyance, water treatment, and water distribution) individually, expressed in kWh per acre foot (kWh/Acre-foot), are described below.

Upstream Supply and Conveyance – This is defined as supply and conveyance of water from the raw sources to the local service area. The upstream supply and conveyance energy use for SDCWA untreated water consists of conveyance of water from the State Water Project and the Colorado River through Metropolitan Water District's (MWD) and SDCWA's service area. The energy use associated with upstream supply and conveyance for SDCWA treated water consists of that associated with SDCWA untreated water and water treatment before the water is delivered to City of San Diego's service area. The water may be treated at MWD or SDCWA's water treatment plants (WTPs).[42] The City does not have operational control over the upstream supply and conveyance.

Water suppliers have begun to voluntarily report the energy intensity in their service areas in Urban Water Management Plans (UWMPs). SDCWA's and MWD's reported 2020 UWMP energy intensities are used to calculate the upstream supply energy intensity for SDCWA's member agencies. The energy intensity is based on the average of fiscal years 2018 and 2019 is shown in Table 16.

water treated in City of San Diego's WTPs. The water sale to CalAm (excluding CalAm's service area in City of San Diego's South Bay area) is from local water treated in WTPs. Starting in 2021, water sales to South Bay Irrigation District is from a mixture of local supply and imported water treated in Otay WTP. Recycled water was produced at the City's North City Water Reclamation Plant and provided to City customers only.

[42] SDCWA 2016: Urban Water Management Plan 2015, Metropolitan Water District of Southern California, Urban Water Management Plan 2015.

TABLE 16 COMPONENTS OF AVERAGE UPSTREAM ENERGY INTENSITY FOR SDCWA MEMBER AGENCIES		
Water System Segment	**FY 2018 and 2019 Average Energy Intensity (kWh/Acre-Foot)**	**Data Source**
MWD delivered untreated*	1,767	MWD UWMP 2020 Appendix 10
SDCWA conveyance**	-33.4	SDCWA UWMP 2020 Appendix I
SDCWA Untreated Subtotal	**1,733**	
SDCWA treatment	110.0	SDCWA UWMP 2020 Appendix I
SDCWA distribution***	9.4	SDCWA UWMP 2020 Appendix I
SDCWA Treated Total	**1,853**	

MWD - Metropolitan Water District, SDCWA – San Diego County Water Authority, UWMP - Urban Water Management Plan.
*Includes conveyance from the State Water Project & Colorado River water to MWD's distribution system, and distribution from MWD to MWD's member agencies.
**Conveyance of raw water supplies to the water treatment plants or to member agency connections (negative value means hydro-electric generation by SDCWA).
*** Distribution of treated water from SDCWA's Twin Oaks Water Treatment Plant to SDCWA's member agencies.
"Upstream" refers to moving water from the original source to SDCWA's member agency's service area or first connection point
MWD 2021, SDCWA 2021, Energy Policy Initiatives Center, University of San Diego 2025

Local Supply and Conveyance – This is defined as supply and conveyance of local surface and groundwater within the water agency service area to water treatment plants, such as pumping water from local surface water reservoirs to nearby water treatment plants. Due to the way data is provided, the local supply and conveyance energy intensity is combined with local water treatment energy intensity.

Local Potable Water Treatment – This is the energy used for water treatment plant operations. The energy intensity depends on the source water quality, the treatment level, and capacity and efficiency of the associated WTP. The City of San Diego owns three WTPs: Alvarado, Miramar, and Otay WTP that treat raw water to potable levels. The WTPs treat both imported untreated SDCWA water and local water. Both Alvarado and Otay WTP have on-site behind-the-meter PV systems. The PV systems are connected to the raw water pump stations at Alvarado and Otay WTP that pump water to and from the WTPs to the nearby reservoirs. Because the water conveyance and treatment operations are connected, the local water conveyance and treatment energy intensity are combined and given in Table 17.

TABLE 17 LOCAL WATER CONVEYANCE AND TREATMENT ENERGY INTENSITY (SAN DIEGO, 2019–2023)						
Combined Miramar, Otay and Alvarado WTPs	**2019**	**2020**	**2021**	**2022**	**2023**	**Description**
Water Treated (Acre-Feet)	152,586	153,389	No data	169,185	146,273	Total water treated at three WTPs
Total Treatment + Conveyance Energy Use (kWh)	11,519,163	7,747,558	No data	15,297,562	15,975,577	Total electricity consumption including treatment plant operation, lake pump stations and electricity generated at Alvarado and Otay on-site PV systems
Total Treatment + Conveyance Energy Intensity (kWh/Acre-Foot)	75	51	No data	90	112	Total Energy Intensity (total electricity divided by water treated)
Solar Production (kWh)	2,272,785	2,172,498	No data	2,138,351	1,588,996	Annual electricity generated Alvarado and Otay on-site PV systems
Net Treatment + Conveyance Energy Use (kWh)	9,255,955	9,279,866	No data	13,159,211	14,386,581	Net electricity purchase from the grid (SDG&E). Total electricity consumption minus solar production.
Net Treatment + Conveyance Energy Intensity (kWh/Acre-Foot)	**61**	**60**	**No data**	**78**	**98**	**Net Energy Intensity (net energy divided by water treated)**
City of San Diego 2024, Energy Policy Initiatives Center, University of San Diego 2025						

Starting in March 2019, not all the solar generated at Otay Lake Pump Station (OLPS) is used solely by the pump station anymore. The excess solar generation goes to the grid and is shared with other City accounts. The solar generation share allocated to the OLPS was available for 2020 but not for 2021, therefore, the 2020 energy intensity was used as a proxy for 2021-2023.

Local Potable Water Distribution – This is defined as the energy required to move treated water from water treatment plants to end-use customers. Distribution energy use includes energy use for water pump stations and/or pressure reduction stations, water storage tanks, etc. Local distribution energy intensity depends on the service area's geological conditions, such as the elevation the water is pumped to/from, the pump station's energy efficiency, and whether a pump station is offline for maintenance or repair, which would cause water to be pumped to other pressure zones and rerouted back. The City of San Diego's water service area has some areas with gravity-fed system (no energy needed) and some areas that need water pumping. The citywide water distribution energy intensity is given in Table 18.

TABLE 18 LOCAL WATER DISTRIBUTION ENERGY INTENSITY (SAN DIEGO, 2019–2023)						
Citywide Water Distribution	**2019**	**2020**	**2021**	**2022**	**2023**	**Description**
Total Water Moved (Acre-Feet)	168,014	173,787	174,952	179,695	162,145	Total City of San Diego water production from all water sources (including sales to other water agencies)
Distribution Pump Stations Energy Use (kWh)	25,340,506	26,614,233	27,273,076	27,185,368	25,969,218	Electricity use at water pump stations excluding lake pump stations
Water Distribution Energy Intensity (kWh/Acre-Foot)	**151**	**153**	**156**	**151**	**160**	**Citywide water distribution energy intensity**
The energy intensities are the citywide water distribution system energy intensities, do not represent the energy intensity of a specific area or pressure zone within the City. **City of San Diego 2024, Energy Policy Initiatives Center, University of San Diego 2025**						

Local Recycled Treatment and Distribution – This is energy required to treat recycled water (tertiary treatment, in addition to conventional wastewater treatment) and deliver it to end-use customers. In the City, the recycled water is delivered to customers in purple pipes, separated from the potable water distribution system. The recycled water energy intensity from the City's 2015 UWMP voluntary reporting, 38 kWh/Acre-Foot, is used for all years.[43] The intensity includes energy use for tertiary treatment at WTPs and for recycled water distribution.

B4.6.3 Total Emissions from Water

To convert the energy intensity of water to GHG emissions per unit of water, the electricity emission factor associated with the energy use is applied. For upstream energy use, a California-wide average emission factor from EPA eGRID is applied.[44] For local energy use, including potable water conveyance and treatment, distribution, and recycled water treatment and distribution, SDG&E's bundled electricity emission factor is applied for 2019 and 2020 because SDG&E was the electricity supplier. SDCP's default electricity emission factor is applied for 2021 through 2023 because the municipal accounts were switched to SDCP. The electricity emission factors are given in Table 19.

TABLE 19 ELECTRICITY EMISSION FACTORS FOR WATER-ENERGY INTENSITIES (2019–2023)		
Year	**Electricity Emission Factors for Water-Energy Intensities (lbs CO_2e/MWh)**	
	Upstream (WECC-California from eGRID)	**Local (SDG&E or SDCP)***
2019	455	633 (SDG&E bundled)
2020	515	636 (SDG&E bundled)

[43] City of San Diego, 2015 Urban Water Management Plan, Table 10-4 Energy Intensity for Wastewater and Recycled Water.
[44] The Western Electricity Coordinating Council (WECC) CAMX (eGRID Subregion) emission rates from eGRID were used as representative of the average California electricity emission rate for upstream electricity. U.S. EPA. eGRID2019, released February 23, 2021; eGRID2020, re-released January 30, 2023; eGRID2021, released January 30, 2023; eGRID2022 released Feb 26, 2024.

2021	534	378 (SDCP)
2022	499	375 (SDCP)
2023	438	460 (SDCP)
*SDG&E bundled emission factor is different from City-specific electricity emission factor, which is based on percentages of electricity sales to SDG&E bundled and DA customers, SDG&E and DA emission factors. **EPA 2024, Energy Policy Initiatives Center, University of San Diego 2025**		

For upstream supply and conveyance emissions, the volume of water from SDCWA (treated and untreated) was multiplied by the upstream energy intensities (Table 16) and the upstream electricity emission factor (Table 19). Because the electricity use and GHG emissions associated with upstream supply and conveyance are outside the City boundary and would not be included in the electricity category, they are accounted for in the water category.

For local conveyance and treatment emissions, the volume of water treated at three WTPs and delivered within the City (excluding sales to other agencies) was multiplied by the net water treatment energy intensity (Table 17) and local grid electricity emission factor (Table 19). Because WTPs are located within San Diego, the electricity use associated with water treatment is included in the electricity category for San Diego. Therefore, electricity and GHG emissions associated with water treatment occur within the City boundary and have been subtracted from the electricity category, as they are accounted for in the water category.

For local water distribution emissions, total water within the City (excluding sales to other agencies) was multiplied by the water distribution energy intensity (Table 18) and local grid electricity emission factor (Table 19). Electricity and GHG emissions associated with water distribution occur within the City boundary and have been subtracted from the electricity category, as they are accounted for in the water category.

For recycled water treatment and distribution emissions, total recycled water supplied was multiplied by the recycled water energy intensity (38 kWh/Acre-Foot, Table 18) and local grid electricity emission factor (Table 19). Electricity and GHG emissions associated with recycled water treatment and distribution occur within the City boundary and have been subtracted from the electricity category, as they are accounted for in the water category.

The total potable and recycled water supplied and the corresponding GHG emissions from the water category are given in Table 20.

TABLE 20 WATER SUPPLIED AND GHG EMISSIONS FROM THE WATER CATEGORY (SAN DIEGO, 2019–2023)					
Year	Potable Water Supplied (Acre-Feet)	Recycled Water Supplied (Acre-Feet)	Upstream GHG Emissions (MT CO_2e)	Local GHG Emissions (MT CO_2e)	Total GHG Emissions (MT CO_2e)
2019	161,472	7,999	51,000	10,000	61,000
2020	166,742	8,842	59,000	11,000	70,000
2021	161,995	8,586	64,000	6,000	70,000
2022*	171,984	10,012	65,000	8,000	73,000
2023	155,215	8,675	41,000	9,000	50,000
GHG emissions for each category are rounded to the nearest thousands. Values are not rounded in the intermediary steps in the calculation. * 2022 water supply has been updated from the previous Annual Report as water sales to other agencies were incorrectly not removed. This Annual Report corrects that error. **Energy Policy Initiatives Center, University of San Diego 2025**					

B4.7 Wastewater

The emissions from wastewater generated by San Diego were estimated by multiplying the total amount of wastewater generated in 2019 and the emission factor of the wastewater treatment processes. Unlike the water category, in which the GHG emissions result from the energy used to move and treat water, wastewater-related GHG emissions include only "*process, stationary and fugitive GHG emissions,*" as described in U.S Community Protocol "WW.1 – WW.14."[45]

B4.7.1 Wastewater Generation

Wastewater generated in the City of San Diego is conveyed to the City of San Diego Metropolitan Sewerage System (Metro System). The Metro System collects and treats wastewater from 12 partner agencies. Wastewater collected by the Metro System is treated at one of the three wastewater treatment plants (WWTPs): Point Loma WWTP, North City WRP, and South Bay WRP.[46]

It is assumed the percentage of City of San Diego's wastewater treated at each WWTP is the same as that of the entire Metro System. The City's wastewater generation and the percentage treated at each WWTP are given in Table 21.

TABLE 21 CITY OF SAN DIEGO WASTEWATER GENERATION (SAN DIEGO, 2019–2023)					
Year	% of Wastewater Treated at Each WWTP			Wastewater Flow to Metro System	
	Point Loma WWTP	South Bay WRP	North City WRP	Average Million Gallons per Day (MGD)	Million Gallons per Year
2019	86%	4%	10%	105	38,241
2020	86%	4%	10%	105	38,192
2021	87%	4%	9%	103	37,591
2022	88%	4%	8%	101	36,865
2023	93%	4%	3%	107	39,143

[45] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019), Appendix F: Wastewater and Water Emission Activities and Sources.

[46] City of San Diego, 2015 Urban Water Management Plan, Section 3 Description of Existing Water System. Some of the North City WRP's flow (non-tertiary flow) is conveyed to Point Loma WWTP for discharge.

Sum may not add up to totals due to rounding.
WWTP – wastewater treatment plant; WRP – water reclamation plant.
City of San Diego 2024, Energy Policy Initiatives Center, University of San Diego 2025

B4.7.2 Wastewater Emission Factor

Point Loma WWTP and North City WRP both report plant operation GHG emissions to CARB under the Mandatory GHG Reporting Regulation (MRR) program.[47] The reported GHG emissions include three components: (1) direct CO_2 from combustion of anaerobic digester gas; (2) CH_4 and N_2O emissions from digester gas combustion; and (3) operational fossil fuel emissions assuming complete combustion. The direct CO_2 from combustion of anaerobic digester gas is considered biogenic, while the other two components of CO_2 emissions are considered non-biogenic emissions.

The wastewater treatment emission factor (MT CO_2e/million gallons) at Point Loma WWTP and North City WRP are calculated by dividing the reported GHG emissions by the plants' wastewater flows, as shown in Table 22.[48]

TABLE 22 EMISSION FACTORS AT WASTEWATER TREATMENT PLANT (SAN DIEGO, 2019–2023)

Year	Point Loma WWTP			North City WRP		
	Annual Flow (million gallons)	GHG Emissions (MT CO_2e)	Wastewater Emission Factor (MT CO_2e/million gallon)	Annual Flow (million gallons)	GHG Emissions (MT CO_2e)	Wastewater Emission Factor (MT CO_2e/million gallon)
2019	52,571	15,955	0.30	5,905	17,733	3.0
2020	52,122	17,403	0.33	5,858	13,503	2.3
2021	51,556	17,289	0.34	5,074	13,503	2.7
2022	53,546	15,072	0.28	4,873	3,815	0.8
2023	55,060	21,450	0.39	5,170	72	0.01

WWTP – wastewater treatment plant; WRP – water reclamation plant.
On average 99% of the emissions from Point Loma WWTP and 98% of emissions from North City WRP are biogenic.
City of San Diego 2024, Energy Policy Initiatives Center, University of San Diego 2025

B4.7.3 Total Emissions from Wastewater

For the GHG emissions calculation, the wastewater emission factor derived from Point Loma WWTP was applied to the wastewater flow into Point Loma WWTP and the emission factor derived from North City WRP was applied to the flow into both North City WRP and South Bay WRP. The total wastewater flow, the citywide weighted average wastewater emission factors, as well as the corresponding GHG emissions are given in Table 23. In 2022, there was a sharp decrease in emissions associated with wastewater treatment. This is because the on-site generation facilities, power plants using landfill gas, at the North City Water Reclamation Plant were decommissioned that year.

[47] CARB: Mandatory GHG Reporting – Reported Emissions. 2020 and 2021 GHG emissions data, current as of November 4, 2022. CARB MRR uses 21 as the CH_4 GWP, therefore the CO_2e for CH_4 in this report is recalculated using 25 as the CH_4 GWP to be consistent with other categories in the inventory.
[48] Point Loma WWTP and North City WRP GHG Reports are from CARB Mandatory GHG Reporting. Wastewater flow into each facility was provided by City of San Diego to EPIC in November 2022.

TABLE 23 WASTEWATER GENERATED AND GHG EMISSIONS FROM WASTEWATER CATEGORY (SAN DIEGO, 2019–2023)			
Year	**Total Wastewater Generated (Million Gallons/year)**	**Wastewater Emission Factor[1] (MT CO_2e/ Million Gallon)**	**GHG Emissions (MT CO_2e)**
2019	38,241	0.67	26,000
2020	38,192	0.60	23,000
2021	37,591	0.63	24,000
2022	38,865	0.34	13,000
2023	39,143	0.34	13,000

[1]Weighted average emission factor of wastewater treated at three wastewater treatment plants in City of San Diego.
GHG emissions for each category are rounded to the nearest thousand. Values are not rounded in the intermediary steps in the calculation.
Energy Policy Initiatives Center, University of San Diego 2025

B5 METHODOLOGY DIFFERENCES AND DATA REFINEMENT

In preparing this report and the latest 2023 GHG emissions inventory, revisions and refinements were made to the 2019–2022 GHG emissions estimates from previous Annual Reports and the 2022 CAP to reflect more appropriate data or methods that were not available at the time of the previous Annual Reports. These revisions and refinements are presented in Table 24. "No change" indicates that no method or data changes occurred since the 2022 CAP. This approach to revise historical inventories follows the approach used by the California Air Resources Board (CARB) when updating the California statewide GHG inventory, and is based on the Intergovernmental Panel on Climate Change (IPCC) recommendation to maintain a consistent time-series when developing GHG inventories.[49]

TABLE 24: METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF ANNUAL GHG INVENTORY

Category	Category Detail	2019 Inventory (Used for 2022 CAP)	2019–2023 Inventory (This Annual Report)
Electricity	Activity (kWh)	Requested data from SDG&E by customer class, service provider, and rate schedule for customers with City of San Diego town code	2019–2020: No change 2021: Data requested from SDG&E by customer class within City of San Diego town code. No service provider or rate schedule available. Direct access and San Diego Community Power customer electricity use were estimated. 2022: Data requested from SDG&E by customer class within City of San Diego town code. No service provider or rate schedule available. Direct access customer electricity use was estimated based on previous year's data. SDCP consumption data provided. 2023: Data requested from SDG&E by customer class within City of San Diego town code. Received data disaggregated by service provider (SDG&E, SDCP, Direct Access)

[49] California Air Resources Board (CARB): California Greenhouse Gas Emissions for 2000 to 2022. Trends of Emissions and Other Indicators.

TABLE 24: METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF ANNUAL GHG INVENTORY			
Category	**Category Detail**	**2019 Inventory (Used for 2022 CAP)**	**2019–2023 Inventory (This Annual Report)**
	Emission Factor (lbs CO2e/MWh)	Created a weighted average emission factor based on a) SDG&E kWh procured from each fuel type at each facility/power plant and the emission factor of electricity generation at each facility/power plant (EPA eGRID2019 database specific plant level emission factor) for SDG&E's purchased power.	2020-2022: Used the SDG&E and San Diego Community Power emission factors reported under CEC's power source disclosure program. 2023: Updated the Direct Access emission factor using newly publicly provided statewide emissions factor for all direct Energy Service Providers throughout the state. Previously used a 2016 CPUC default factor for all direct access energy. Updated past years with newly available data.
Natural Gas	Activity (Therms)	Requested data from SDG&E by customer class, service provider, and rate schedule for customers with City of San Diego town code	2020: No change 2021-2022: Data requested from SDG&E by customer class within City of San Diego town code. No service provider or rate schedule available. 2023: Data requested from SDG&E by customer class within City of San Diego town code. Received data disaggregated by service provider (SDG&E, On-Site Generation, Direct Access)
	Emission Factor (MT CO2e / Therm)	Natural gas emission factor in California based on California Air Resources Board statewide inventory	No change
Transportation	Activity (VMT)	Applied annual average VMT rate of increase from 2016-2019 HPMS data to 2016 VMT estimates. 2016 VMT estimates were provided by SANDAG using Series 14 Forecast and ABM2+ from the Draft 2021 Regional Plan	2020: Applied annual average VMT rate of increase from 2016–2019 HPMS data to 2016 VMT estimates provided by SANDAG using Series 14 Forecast and ABM2+ from the Final 2021 Regional Plan 2021: Applied the VMT 2019 to 2021 percent increase from PeMS data to 2019 VMT estimates, due to a delay in HPMS data

TABLE 24: METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF ANNUAL GHG INVENTORY			
Category	**Category Detail**	**2019 Inventory (Used for 2022 CAP)**	**2019–2023 Inventory (This Annual Report)**
			2022: Applied HPMS data to 2016 VMT estimates to years 2021 and 2022 2023: No change
	Emission Factor (g CO2e/mile)	San Diego region emission rate per vehicle class from EMFAC2021 with model default assumptions on vehicle mix, travel activities, etc.	No change
Water	Activity (acre-feet)	Potable and recycled water supplied to City of San Diego (water production) separated into wholesale water (from San Diego County Water Authority) and local water (surface and groundwater) Removed water purchased by Del Mar and CalAm service area not in the City	No change

TABLE 24: METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF ANNUAL GHG INVENTORY			
Category	**Category Detail**	**2019 Inventory (Used for 2022 CAP)**	**2019–2023 Inventory (This Annual Report)**
	Emission Factor (energy intensity - kWh/acre-foot)	Local energy intensity based on water treatment plants and lake pump stations electricity consumption, all other water pump stations and facilities electricity consumption Upstream supply energy intensity calculated based on Metropolitan Water District and SDCWA 2015 Urban Water Management Plan	No change
	Electricity Emission Factor (lbs CO2e/MWh)	Upstream: eGRID 2016	2019: eGRID2019 2020: eGRID2020 2021: eGRID2021 2022: eGRID2022 2023: eGRID2023
Wastewater	Activity (gallons)	City of San Diego's annual average flow (MGD) entering into Metropolitan Sewerage System (include Point Loma WWTP, South Bay WRP and North City WRP)	2020-2023: No change
	Emission Factor (MT CO_2/gallon)	Calculated by dividing Point Loma WWTP and North City WRP GHG Emission reported in CARB Mandatory GHG Reporting by Point Loma WWTP and North City WRP total flow	No change
Solid Waste	Activity (tons)	Annual waste disposed tonnage provided by City of San Diego Environmental Services Department	2019–2020: No change 2021: Used 2020 waste tonnage due to a delay in reported data

TABLE 24: METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF ANNUAL GHG INVENTORY			
Category	**Category Detail**	**2019 Inventory (Used for 2022 CAP)**	**2019–2023 Inventory (This Annual Report)**
			2022: Updated 2021 waste tonnage with City's primary data. No other change 2023: No change
	Emission Factor (MT CH4/tons)	Emission factor for each waste component from EPA WARM Model Version 15 (2019 version) and waste components from City of San Diego waste characterization study 2012–2013	2019 – 2021: No change 2021-2023: Updated post-2021 data with 2021 statewide waste characterization study.