City of San Diego Greenhouse Gas Emissions Inventory Methodology and Updates

Supplement to 2023 Climate Action Plan Annual Report

June 2024

Prepared for the City of San Diego

Prepared by the Energy Policy Initiatives Center

About EPIC

The Energy Policy Initiatives Center (EPIC) is a non-profit research center of the University of San Diego School of Law that studies energy policy issues affecting California and the San Diego region. EPIC's mission is to increase awareness and understanding of energy- and climate-related policy issues by conducting research and analysis to inform decision makers and educate law students.

For more information, please visit the EPIC website at www.sandiego.edu/epic.

Disclaimer

The Energy Policy Initiatives Center (EPIC) prepared this report for the City of San Diego. This report represents EPIC's professional judgment based on the data and information available at the time EPIC prepared this report. EPIC relies on data and information from third parties who provide it with no guarantees such as of completeness, accuracy or timeliness. EPIC makes no representations or warranties, whether expressed or implied, and assumes no legal liability for the use of the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. Readers of the report are advised that EPIC may periodically update this report or data, information, findings, and opinions and that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, data, information, findings and opinions contained in the report.

Table of Contents

Tables

Figures

1 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 2019–2022 and the methods used. This is a supplement to the City's Final 2022 Climate Action Plan (CAP) Annual Report and its appendix.

In preparation for this Annual Report and the 2022 GHG emissions inventory, revisions and refinements were made to the 2019 GHG emissions estimates in the previous 2021 Annual Report to reflect updated data supplied by agencies not managed by the City, and to ensure consistency with the 2019–2021 GHG emissions estimates.[1] This follows the approach used by the California Air Resources Board (CARB) when it updates the California statewide inventory, and is based on the Intergovernmental Panel on Climate Change (IPCC) recommendations to maintain a consistent time-series when developing GHG inventories.[2]

This document includes the following sections:

- Section 2 describes the background sources and common assumptions used for the GHG emissions inventory;
- Section 3 provides the 2019–2021 GHG emissions inventory results summary; and
- Section 4 provides the methods used to prepare each category of the inventory.

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.

2 BACKGROUND

2.1 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),[3] provided in Table 1. The GWPs used in this inventory are consistent with the California statewide GHG inventories and the national GHG inventories.[4]

[1] City of San Diego: 2022 Climate Action Plan, Climate Action Plan 2020 Annual Report and Appendix.
[2] California Air Resources Board (CARB): California Greenhouse Gas Emissions for 2000 to 2020. Trends of Emissions and Other Indicators, p. 28 Additional Information (2020).
[3] IPCC Fourth Assessment Report: Climate Change 2007: Direct Global Warming Potentials (2013).
[4] 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.

Table 1 Global Warming Potentials Used in San Diego GHG Emission Inventory & Projections

Greenhouse Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298
IPCC 2013.	

2.2 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.[5]

Table 2 Population, Housing, and Jobs Estimates (San Diego, 2019–2022)

Year	Population Estimates	Housing Estimates (Units)	
		Total	Occupied
2019	1,420,571	545,645	514,548
2020	1,380,448	548,934	515,676
2021	1,371,832	552,410	514,964
2022	1,374,790	571,542	536,856

2019 population and housing estimates are based on the 2010 census benchmark, and 2020 and 2021 population and housing estimates are based on the 2020 census benchmark.
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, 2022.

3 SUMMARY OF 2019–2021 GHG EMISSIONS INVENTORY

GHG emissions by category from San Diego in 2019–2022 are shown in

Emissions Category	2019 Inventory		2020 Inventory		2021 Inventory		2022 Inventory	
	GHG Emissions (MT CO_2e)	(%)	GHG Emissions (MT CO_2e)	(%)	GHG Emissions (MT CO_2e)	(%)	GHG Emissions (MT CO_2e)	(%)
On-Road Transportation*	5,854,000	55%	4,650,000	50%	4,683,000	53%	4,628,000	54%
Electricity	2,398,000	23%	2,368,000	26%	1,725,000	20%	1,661,000	19%
Natural Gas	1,912,000	18%	1,827,000	20%	1,918,000	22%	1,837,000	21%
Solid Waste**	277,000	3%	273,000	3%	288,000	3%	282,000	3%
Offroad Transportation (Construction Equipment Only)	69,000	1%	57,000	1%	57,000	1%	57,000	1%
Water	61,000	1%	70,000	1%	70,000	1%	74,000	1%
Wastewater	26,000	0%	23,000	0%	24,000	0%	13,000	0%
Total	**10,597,000**	**100%**	**9,268,000**	**100%**	**8,765,000**	**100%**	**8,552,000**	**100%**

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.
*Emissions are based on SANDAG's Series 14 modeled vehicle miles traveled (VMT) estimates, and 2019 and 2020 VMT are based on 2016 VMT adjusted to account for regional VMT growth, as reflected in the California Highway Performance Monitoring System

[5] California Department of Finance: E-4 Population Estimates for Cities, Counties, and the State, 2021-2022 with 2020 Census Benchmark (May 2022), accessed January 6, 2023. E-4 Population Estimates for Cities, Counties, and the State, 2011-2020 with 2010 Census Benchmark (May 2021), accessed January 6, 2023.

(HPMS) from 2016 to 2019 and to 2020. 2021 VMT are based on 2019 VMT adjusted to account for regional freeway VMT difference between 2019 and 2020 in the California Performance Measurement System (PeMS), due to a delay in HPMS data. 2016 VMT is the output from SANDAG's Final 2021 Regional Plan and activity-based model (ABM2+).
**2020 waste tonnage was used to calculate 2021 emissions from waste due to a delay in reported waste data
Energy Policy Initiatives Center, University of San Diego 2024

.

Table 3 GHG Emissions by Category from City of San Diego (2019–2021)

Emissions Category	2019 Inventory[6]		2020 Inventory		2021 Inventory		2022 Inventory	
	GHG Emissions (MT CO_2e)	(%)	GHG Emissions (MT CO_2e)	(%)	GHG Emissions (MT CO_2e)	(%)	GHG Emissions (MT CO_2e)	(%)
On-Road Transportation*	5,854,000	55%	4,650,000	50%	4,683,000	53%	4,628,000	54%
Electricity	2,398,000	23%	2,368,000	26%	1,725,000	20%	1,661,000	19%
Natural Gas	1,912,000	18%	1,827,000	20%	1,918,000	22%	1,837,000	21%
Solid Waste**	277,000	3%	273,000	3%	288,000	3%	282,000	3%
Offroad Transportation (Construction Equipment Only)	69,000	1%	57,000	1%	57,000	1%	57,000	1%
Water	61,000	1%	70,000	1%	70,000	1%	74,000	1%
Wastewater	26,000	0%	23,000	0%	24,000	0%	13,000	0%
Total	**10,597,000**	**100%**	**9,268,000**	**100%**	**8,765,000**	**100%**	**8,552,000**	**100%**

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.
*Emissions are based on SANDAG's Series 14 modeled vehicle miles traveled (VMT) estimates, and 2019 and 2020 VMT are based on 2016 VMT adjusted to account for regional VMT growth, as reflected in the California Highway Performance Monitoring System (HPMS) from 2016 to 2019 and to 2020. 2021 VMT are based on 2019 VMT adjusted to account for regional freeway VMT difference between 2019 and 2020 in the California Performance Measurement System (PeMS), due to a delay in HPMS data. 2016 VMT is the output from SANDAG's Final 2021 Regional Plan and activity-based model (ABM2+).
**2020 waste tonnage was used to calculate 2021 emissions from waste due to a delay in reported waste data
Energy Policy Initiatives Center, University of San Diego 2024

In 2022, total emissions were 8.6 MMTCO_2e, a 19% reduction from the 2019 baseline and 2% reduction from 2021. This decrease was mainly due to improvements in the carbon intensity of electricity supplied to the City and increased on-road vehicle efficiency and adoption of electric and hybrid vehicles. Although COVID-19 temporarily reduced on-road transportation emissions by lowering vehicle miles traveled, these miles are now returning to pre-pandemic levels. Despite this, emissions remain lower because the adoption of electric and hybrid vehicles has reduced the carbon intensity of on-road vehicles.

Furthermore, SDG&E has expanded its renewable energy portfolio, and San Diego Community Power, the City's Community Choice Energy provider, now supplies electricity to commercial, industrial, and residential sectors. This shift has decreased the carbon intensity of the City's electricity consumption, further reducing overall emissions.

[6] The 2019 GHG emissions inventory in this document updated from the 2019 inventory in the CAP Annual Report 2020, due to updated data sources after the Annual Report release: (1) 2019 electricity emissions factor became available in December 2020; and (2) new mobile sources emissions inventory (EMFAC2021) became available in 2021; (3) new solid waste data became available in 2022;

4 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),[7] 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. 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.[8] 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.

4.1 On-Road Transportation

The emissions associated with on-road transportation are calculated by multiplying the estimated City of San Diego VMT and the average vehicle emission rate in the San Diego region from 2019 to 2022, from the statewide mobile source emissions model.

4.1.1 Vehicle Miles Traveled (VMT)

SANDAG uses an activity-based model (ABM) to support development of Regional Transportation Plans and generate 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+.

SANDAG provided VMT estimates for the City of San Diego for year 2016.[9] However, 2017–2022 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 using the Series 14 2016 VMT adjusted using VMT monitoring data for 2017–2022 from other sources. The two sources available are public road and freeway data in the San

[7] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019).
[8] CARB, ICLEI, and The Climate Registry: Local Government Operations Protocol; the Climate Registry: General Reporting Protocol Version 3.0.
[9] 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.

Diego region derived from the California Department of Transportation (Caltrans) Highway Performance Monitoring System (HPMS) and Performance Measurement System (PeMS).[10]

SANDAG allocates the VMT derived from ABM2+ to a jurisdiction using the Origin-Destination (O-D) method.[11] 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 1).[12]

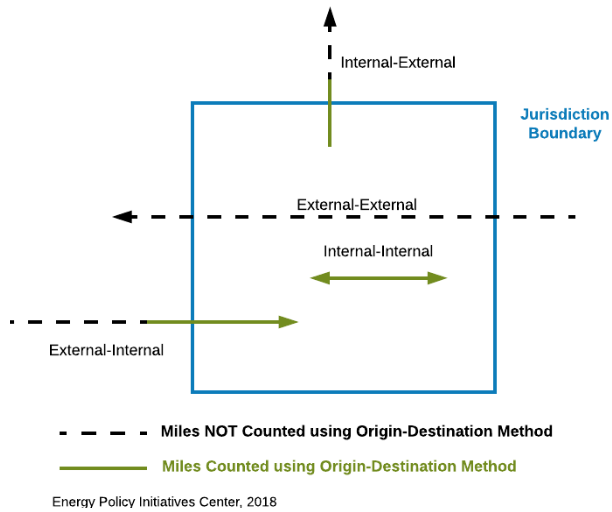


Figure 1 Components of O-D Method for VMT Calculation

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.[13]

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 4.[14]

---

[10] California Department of Transportation: Highway Performance Monitoring System (HPMS) Data.
[11] SANDAG (2013): Vehicle Miles Traveled Calculation Using the SANDAG Regional Travel Demand Model. Technical White Paper.
[12] 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.
[13] 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).
[14] 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 4 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 2020 O-D VMT, the 2016 O-D VMT was adjusted by the annual rates of increase from 2016 to 2020, 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 4) 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 2022 with Caltrans HPMS data are given in Table 5.[15]

Table 5 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%

*Updated to use 2021 Caltrans HPMS data
Caltrans 2022, Energy Policy Initiatives Center, University of San Diego 2024

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% compared with 2019.[16]

[15] Caltrans: HPMS Data, accessed January 18, 2023.
[16] Caltrans: California Public Road Data 2022. Statistical Information Derived from the Highway Performance Monitoring System (Released November 2023).

2021 HPMS data were not available for the previous Annual Report, therefore, annual San Diego regional freeway VMT from Caltrans freeway monitoring system (Caltrans PeMS) was used to estimate the VMT growth rate for calendar year 2021. To maintain methodological continuity, the 2021 VMT value has been updated in this 2023 Annual Report to use the published HPMS data to estimate growth rate instead of PeMS data.

4.1.2 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.[17]

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.[18] This document assumes that the City of San Diego has the same distribution of vehicle types as the San Diego region.

4.1.3 Total Emissions from On-Road Transportation

Total estimated VMT, average vehicle emission rates, and corresponding GHG emissions from on-road transportation from 2019–2022 are given in Table 6.

Table 6 VMT, Emission Rate, and GHG Emissions from On-Road Transportation (San Diego, 2019–2022)

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

GHG emissions for each category are rounded. Values are not rounded in the intermediary steps in the calculation.
*2021 VMT estimate updated for methodological continuity.
Energy Policy Initiatives Center, University of San Diego 2024

4.2 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 City-specific electricity emission factor in a given year.[19]

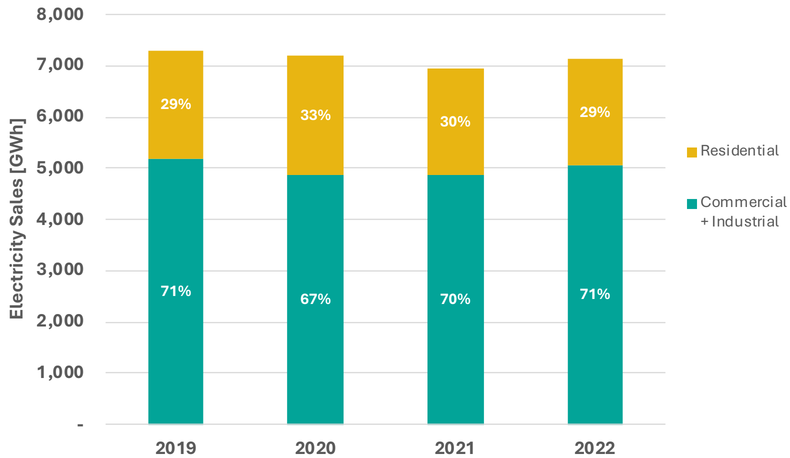
4.2.1 Electricity Use

Annual metered electricity sales data within the City were provided by the local utility, San Diego Gas & Electric (SDG&E).[20] The electricity sales data do not include the electricity sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and the military. The electricity sales from 2019 to 2022 by customer class are shown in Figure 2.

---

[17] 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.
[18] *Id.*
[19] 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.
[20] 2020 and 2021 metered electricity sales were provided to EPIC by SDG&E (March 16, 2021, and October 31, 2022).

Figure 2 SDG&E Electricity Sales to City of San Diego by Customer Class (2019–2022)



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 2019-2022

The percentage of electricity use from each customer class (residential, commercial, and industrial) was similar in each of the three years. In 2020, a higher percentage of electricity use, 33%, was from residential customers, potentially due to the COVID stay-at-home order in 2020.

In 2019 and 2020, the electricity sales included the sales to SDG&E bundled customers[21] and Direct Access (DA) customers.[22] 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. However, for 2021 and 2022, only total electricity use per customer class was provided by SDG&E. To estimate the 2021 electricity use by DA customers in each customer class, the ratio of 2020 DA customers to total electricity use was applied to the total 2021 electricity use in each customer class. Based on the SDCP participation rate, 98% of the remaining 2021 commercial and industrial electricity use was assumed to be from SDCP commercial and industrial customers.[23] The remaining commercial and industrial electricity use, and residential use, were assumed to be from SDG&E customers. Additionally, in 2022, SDCP provided the energy consumption in kWh for commercial/industrial customers and residential customers. In 2022 instead of using participation rates as used in 2021, the actual kWh consumption was attributed to SDG&E (Direct & Bundled) and SDCP. Direct and bundled electricity was then disaggregated using the proportion from the last data year received (2020).

[21] SDG&E bundled power includes the electricity from SDG&E-owned power plants and the electricity from its net procurements.
[22] Direct Access refers to electricity that customers purchase from non-SDG&E electric service providers (ESPs), but SDG&E still provides transmission and distribution services. See SDG&E Direct Access Program.
[23] The participation rate is the rate by number of accounts, not by electricity use. Due to lack of data, the number of accounts is used as a proxy to estimate the SDCP commercial and industrial electricity use.

The electricity sales were then adjusted by 1) a loss factor[24] of 1.082[25] 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 6.

4.2.2 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[26] data, the California Energy Commission (CEC) Power Source Disclosure (PSD) Program[27] data on SDG&E-owned and purchased power, and U.S. EPA Emissions and Generating Resource Integrated Database (eGRID) 2019 Edition[28] 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. So 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 6.

The DA emission factor, 836 lbs CO_2e/MWh, is based on California Public Utilities Commission (CPUC) Decision D.14-12-037.[29] The City-specific electricity emission factors are provided in Table 6.

4.2.3 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 (electricity sales + losses), electricity emission factors, and corresponding GHG emissions from the electricity category for 2019-2022 are shown in Table 6.

---

[24] 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).
[25] 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 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.
[26] FERC: Form 1 – Electric Utility Annual Report.
[27] 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.
[28] U.S. EPA. eGRID 2019 Edition, released on February 23, 2021.
[29] 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.

Table 6 Net Energy for Load, Emission Factor, and GHG Emissions from Electricity Category (San Diego, 2019–2022)

Year	SDG&E Bundled Emission Factor (lbs CO_2e/ MWh)	SDCP 'Power On' Emission Factor (lbs CO_2e/MWh)	Net Energy for Load (electricity sales + losses)[1] (MWh)	City-Specific Emission Factor (lbs CO_2e/MWh)[2]	GHG Emissions (MT CO_2e)
2019	633	-	7,912,365	668	2,398,000
2020	636	-	7,788,903	670	2,368,000
2021	504	378	7,527,776	505	1,725,000
2022	508	375	7,722,329	474	1,661,000

[1]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.
[2]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.
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 2024

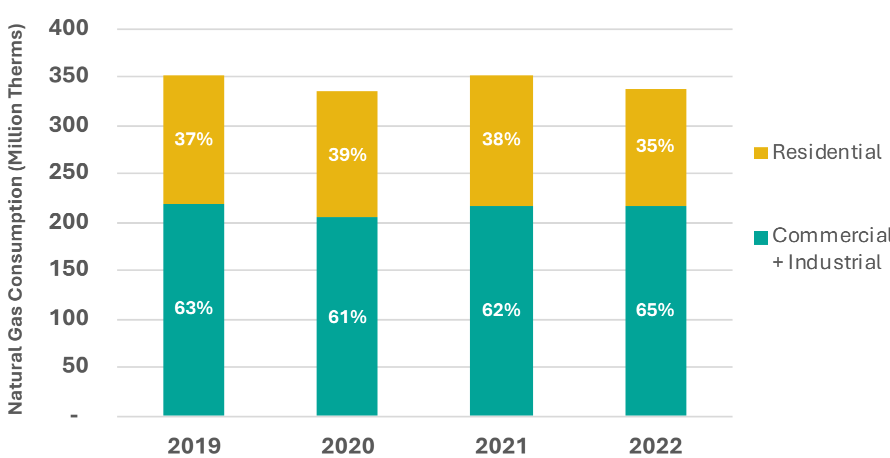
4.3 Natural Gas

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.[30]

4.3.1 Natural Gas Use

Annual natural gas sales were provided by SDG&E, broken down by residential, commercial and industrial customer class.[31] 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 2022 by customer class are show in Figure 3.

Figure 3 SDG&E Natural Gas Sales to City of San Diego by Customer Class (2019–2022)



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.

[30] 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.
[31] 2020 and 2021 metered electricity sales were provided to EPIC by SDG&E (March 16, 2021, and October 31, 2022).

SDG&E 2019-2022

The natural gas end-use in 2020 was approximately 4% lower than the end-use in 2019 but has fluctuated in recent years.

4.3.2 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.[32] The natural gas emission factor is given in Table 7.

4.3.3 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 2019-2022 are given in Table 7.

Table 7 Natural Gas End-Use and GHG Emissions from Natural Gas Category (San Diego, 2019-2022)

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

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 2020-2022, Energy Policy Initiatives Center, University of San Diego 2024

4.4 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.[33]

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 2019-2022 are given in Table 8.

[32] CARB: GHG Current California Emission Inventory Data.
[33] CARB: OFFROAD2021 (v1.0.6) Emissions Inventory, all adopted rules -exhaust. Downloaded on May 20, 2024.

Table 8 GHG Emissions from Off-Road Transportation (Construction Equipment Only) Category (San Diego, 2019 - 2022)

Year	GHG Emissions from Construction Equipment in San Diego Region (MMT CO2e)	Construction Jobs Ratio (City of San Diego/San Diego Region)	GHG Emissions from Construction Equipment in City of San Diego (MT CO2e)
2019*	177	39%	69,000
2020	145	39%	57,000
2021	145	39%	57,000
2022	145	39%	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 2024

4.5 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. [34] This represents the immediate and all future emissions from decay of this waste.

4.5.1 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.[35]

The total waste disposal from the City was 1,597,546 short tons (1,449,270 metric tons) in 2022, 2% lower than the waste disposal in 2019. The total waste disposal from the City in 2021 was not available for the previously published Annual Report, so the 2021 waste disposal figure has been updated in this report now that data is available. The total and per-capita solid waste disposal are given in Table 10 below.[36]

4.5.2 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. The City of San Diego's 2012–2013 Waste Characterization Study, conducted at Miramar Landfill, is the most recent waste characterization study done by the City and was used as a proxy for San Diego's solid waste composition.[37] 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 life-cycle GHG model to assess and compare waste management options (e.g., landfilling, recycling, source reduction, composting), through the life-cycle of waste materials (from material extraction to disposal). However, under the U.S Community Protocol, only emissions from the disposal

[34] 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.
[35] CalRecycle: Disposal Reporting System (DRS): Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility.
[36] 2021 & 2022 waste disposal was provided by City of San Diego to EPIC in January 2023.
[37] City of San Diego: Waste Characterization Study 2012–2013 Final Report (2014), accessed November 4, 2019.

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 9. The landfill emission factors without LFG recovery are identified here; the LFG recovery is applied later.

Table 9 Mixed Solid Waste Emission Factor

Waste Component	**Waste Distribution (%)[1]**	**Landfill Gas Emission Factors**	
		CH_4 without Landfill Gas Recovery (MT CO_2e/short ton disposed)	**Source[2]**
Paper	16.8%		
Corrugated Containers/Cardboard	*5.0%*	2.36	Exhibit 3-27, WARM v15 Containers /Packaging
Newspaper	*0.8%*	0.94	Exhibit 3-27, WARM v15 Containers /Packaging
Magazine	*0.6%*	1.08	Exhibit 3-27, WARM v15 Containers /Packaging
Mixed Paper (general)	*10.4%*	2.14	Exhibit 3-27, WARM v15 Containers /Packaging
Plastic	8.9%	0	-
Glass	1.7%	0	-
Metal	3.5%	0	-
Organics	38.9%		
Food	*15%*	1.62	Exhibit 1-49, WARM V15 Organic Materials
Tree (Branches)	*5.3%*	1.3	Exhibit 2-13 WARM V15 Organic Materials
Leaves and Grass	*6.8%*	0.59 (leaves)	Exhibit 2-13 WARM V15 Organic Materials
Trimmings	*3.5%*	0.73	Exhibit 2-13 WARM V15 Organic Materials
Mixed Organics	*8.3%*	0.53	Exhibit 1-48 WARM V15 Organic Materials
Electronics	0.6%	0	-
Construction & Demolition	24.6%	0	-
Household Hazardous Waste	0.2%	0	-
Special Waste	3.1%	0	-
Mixed Residue	1.6%	0.53	
Mixed Waste Emission Factor		**0.785**	
[1] **City of San Diego 2014**. [2]**EPA Waste Reduction Model (WARM) Version 15 (May 2019)**			

4.5.3 Total Emissions from Solid Waste Disposed in Landfills

The mixed waste emission factor given in Table 9 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 10.

Table 10 Solid Waste Disposal into Landfills and Associated GHG Emissions (San Diego, 2019–2022)

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	2.7	0.785	10%	1,108,249	75%	277,000
2020	1,543,627	1,400,355	2.8	0.785	10%	1,090,017	75%	273,000
2021*	1,631,802	1,400,355	3.0	0.785	10%	1,152,281	75%	288,000
2022	1,596,546	1,449,270	2.9	0.785	10%	1,128,091	75%	282,000

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, 2021, & 2022 population are based on 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.
*The total waste disposal from the City in 2021 was not available for the previous Annual Report, so this figure has been updated to reflect the corrected data once available.
Energy Policy Initiatives Center, University of San Diego 2024

4.5.4 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.[38] 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.[39]

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 4.5.3) 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.

[38] EPA: 2019 Greenhouse Gas Emissions from Large Facilities, accessed November 10, 2020.
[39] 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.

The emissions from San Diego landfills are given in Table 11.

Table 11 Emissions from In-boundary Landfills (Information Only, Not Reported in GHG Inventory)

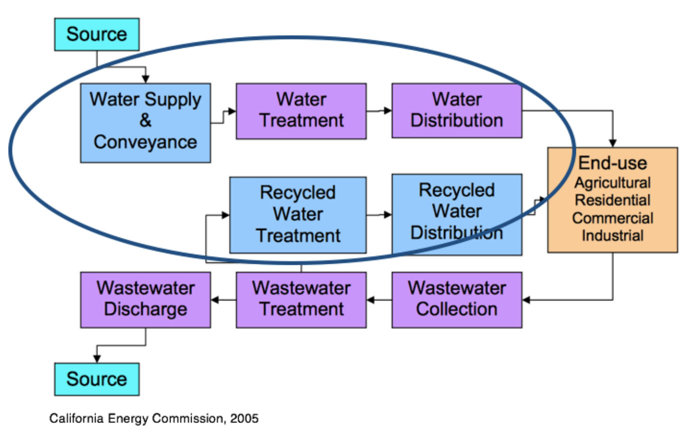
Landfill	Status	2019 Landfill Emissions (MT CO_2e)	2020 Landfill Emissions (MT CO_2e)	2021 Landfill Emissions (MT CO_2e)	2022 Landfill Emissions (MT CO_2e)	Source
West Miramar Sanitary Landfill	Active	154,932	198,685	152,566	141,544	EPA MRR
Sycamore Landfill	Active	86,057	87,168	107,175	155,748	EPA MRR
North Miramar Sanitary Landfill	Closed in 1983	2,974	2,211	3,420	3,210	EPA MRR
South Chollas Sanitary Landfill	Closed in 1981	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	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	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	-

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 2024

4.6 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 4. The energy required to move water is primarily electricity but may include natural gas or other fuels.

Figure 4 Segments of the Water Cycle



Emissions from water were estimated using the method Wastewater and Water (WW.14) from the U.S. Community Protocol.[40] 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.

4.6.1 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).[41]

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.[42] 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 12.[43]

[40] 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.

[41] 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: 2015 Urban Water Management Plan, Southern Division – San Diego County District (2016).

[42] City of San Diego, 2015 Urban Water Management Plan, Section 6 System Water Supplies (2016).

[43] 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 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.

Table 12 Water Supplied and Supply Source (San Diego, 2019–2022)

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%	179,695	10.012

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.
City of San Diego 2024, Energy Policy Initiatives Center, University of San Diego 2024

4.6.2 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).[44] 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 2015 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 2013 and 2014 is shown in Table 13.

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

Table 13 Components of Average Upstream Energy Intensity for SDCWA Member Agencies

Water System Segment	FY 2013 and 2014 Average Energy Intensity (kWh/Acre-Foot)	Data Source
MWD delivered untreated*	1,817	MWD UWMP 2015 Appendix 9
SDCWA conveyance**	-62	SDCWA UWMP 2015 Appendix K
SDCWA Untreated Subtotal	**1,755**	
SDCWA treatment	60	SDCWA UWMP 2015 Appendix K
SDCWA distribution***	1.1	SDCWA UWMP 2015 Appendix K
SDCWA Treated Total	**1,816**	

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 2016, SDCWA 2016, Energy Policy Initiatives Center, University of San Diego 2018

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 14.

Table 14 Local Water Conveyance and Treatment Energy Intensity (San Diego, 2019–2022)

Combined Miramar, Otay and Alvarado WTPs	2019	2020	2021	2022	Description
Water Treated (Acre-Feet)	152,586	153,389	No data	169,185	Total water treated at three WTPs
Total Treatment + Conveyance Energy Use (kWh)	11,519,163	7,747,558	No data	15,297,562	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	Total Energy Intensity (total electricity divided by water treated)
Solar Production (kWh)	2,272,785	2,172,498	No data	2,138,351	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	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**	**Net Energy Intensity (net energy divided by water treated)**
City of San Diego 2024, Energy Policy Initiatives Center, University of San Diego 2024					

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 Otay 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.

<u>Local Potable Water Distribution</u> – 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 15.

Table 15 Local Water Distribution Energy Intensity (San Diego, 2019–2022)

Citywide Water Distribution	2019	2020	2021	2022	Description
Total Water Moved (Acre-Feet)	168,014	173,787	174,952	179,695	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	Electricity use at water pump stations excluding lake pump stations
Water Distribution Energy Intensity (kWh/Acre-Foot)	**151**	**153**	**156**	**151**	**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 2024**					

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.[45] The intensity includes energy use for tertiary treatment at WTPs and for recycled water distribution.

4.6.3 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.[46] 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 and 2022 because the municipal accounts were switched to SDCP. The electricity emission factors are given in Table 16.

Table 16 Electricity Emission Factors for Water-Energy Intensities (2019–2022)

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)
2021	534	378 (SDCP)

[45] City of San Diego, 2015 Urban Water Management Plan, Table 10-4 Energy Intensity for Wastewater and Recycled Water.

[46] 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.

2022	499	375 (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. SDCP **EPA 2024, Energy Policy Initiatives Center, University of San Diego 2024**		

For upstream supply and conveyance emissions, the volume of water from SDCWA (treated and untreated) was multiplied by the upstream energy intensities (Table 13) and the upstream electricity emission factor (Table 16). 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 14) and local grid electricity emission factor (Table 16). 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 15) and local grid electricity emission factor (Table 16). 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 15) and local grid electricity emission factor (Table 16). 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 in 2019 are given in Table 17.

Table 17 Water Supplied and GHG Emissions from the Water Category (San Diego, 2019–2022)

Year	Potable Water Supplied (Acre-Feet)	Recycled Water Supplied (Acre-Feet)	GHG Emissions (MT CO_2e)
2019	161,472	7,999	61,000
2020	166,742	8,842	70,000
2021	161,995	8,586	70,000
2022	179,695	10,012	74,000

GHG emissions for each category are rounded to the nearest thousands. Values are not rounded in the intermediary steps in the calculation.
Energy Policy Initiatives Center, University of San Diego 2024

4.7 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."[47]

4.7.1 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.[48]

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 18.

Table 18 City of San Diego Wastewater Generation (San Diego, 2019–2022)

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

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 2024

[47] 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.
[48] 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.

4.7.2 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.[49] 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 19.[50]

Table 19 Emission Factors at Wastewater Treatment Plant (San Diego, 2019–2022)

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

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

4.7.3 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 20. 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.

[49] 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.
[50] 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 20 Wastewater Generated and GHG Emissions from Wastewater Category (San Diego, 2019–2022)

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

[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 2024