The City of SAN DIEGO

Climate Action Plan
2019 Annual Report
Appendix

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Introduction

This appendix to the 2019 Annual Report of the City of San Diego's Climate Action Plan (CAP) provides additional information and data in the following four sections:

A. Overview of 2018 Greenhouse Gas (GHG) Emissions;
B. 2018 Climate Action Plan Strategy Updates;
C. Methodology Differences and Data Refinement; and
D. Analysis on Jobs.

The 2018 total GHG emissions in the City of San Diego (the City) were estimated to be 9.8 million metric tons of carbon dioxide equivalent (MMT CO2e) approximately 3% lower than the previous year 2017 GHG emissions estimate (10.2 MMT CO2e).

As detailed in the CAP, this Appendix relates to the second phase (January 1, 2018 - December 31, 2020) of CAP implementation, in which the City focuses on the mid-term actions as identified in the CAP, continued monitoring of the implementation of the CAP strategies as well as the impact of federal and California state policies and mandates to determine whether the City is on track to achieve its emission reduction targets.[1]

In preparation for the 2019 Annual Report and the 2018 GHG emissions inventory, revisions and refinements were made to the 2016 and 2017 citywide GHG emissions, as well as to CAP strategies performance metrics presented in the previous 2018 CAP annual report. These revisions reflect updated data supplied by agencies not managed by the City, and ensures consistency with the 2018 GHG emissions estimates.[2] Revising previous inventories and metrics is consistent with the California Air Resources Board (CARB)'s California statewide inventory method updates to incorporate new methods or reflect updated data, and is based on the Intergovernmental Panel on Climate Change (IPCC) recommendations to maintain a consistent time-series when developing GHG inventories.[3] The updates to 2016 and 2017 citywide emissions are related to revisions in the transportation and energy emissions categories. These revisions are discussed briefly in section C (*Methodology Differences and Data Refinement*) of this Appendix, as well as in Section 5 of the *City of San Diego 2016-2018 Greenhouse Gas Emissions Inventory* supplemental document. The updates to the CAP strategies performance metrics are described in section B (

[1] City of San Diego: Climate Action Plan, adopted December 2015. Chapter 3 – Implementation and Monitoring.

[2] City of San Diego: Climate Action Plan 2018 Annual Report and Appendix (2018), accessed October 21, 2019.

[3] California Air Resources Board (CARB): California Greenhouse Gas Emissions for 2000 to 2017. Trends of Emissions and Other Indicators, p. 16 Additional Information (2019), accessed October 21, 2019.

2018 Climate Action Plan Strategy Updates) of this Appendix..

The five CAP strategies are: 1) energy and water efficient buildings, 2) clean and renewable energy, 3) bicycle, walking, transit and land use 4) zero waste, and 5) climate resilience. Under each strategy, the current state in 2018 is presented first followed by updates of each action. Comparisons of the current status in 2018 to 2017 and the baseline estimates in 2010 are provided where possible.

Overview of 2018 Greenhouse Gas (GHG) Emissions

GHG EMISSIONS INVENTORY

The emissions source categories included in this update have remained consistent with the previous CAP Annual Reports: on-road transportation, electricity, natural gas, water, and, wastewater and solid waste. As in the previous years, these reflect the five categories of emissions that are recommended in the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (U.S. Community Protocol) to be routinely included in a citywide inventory.[4] GHG emissions from sources such as air travel, shipping, off-road vehicle and equipment or other high global warming potential gases in use in the City are not included.

The 2018 and revised 2016 and 2017 GHG emissions inventory results are shown in **Error! Reference source not found.**. The methods, data availability and sources used to calculate GHG emissions have been updated since the development of the 2010 baseline emissions in the CAP. A brief discussion of the differences in methods and data sources is provided in Section 0 of this Appendix.

TABLE 1 CITY OF SAN DIEGO GREENHOUSE GAS EMISSIONS

Emissions Category	2010 Emissions* (Reported in the CAP, MT CO_2e)	2015 Emissions (reported in 2018 annual report, (MT CO_2e)	2016 Emissions Revised* (MT CO_2e)	2017 Emissions Revised* (MT CO_2e)	2018 Emissions (MT CO_2e)	2017 Revised – 2018 % Changes	2010 – 2018 % Changes
On-Road Transportation	7,086,297	5,541,000	5,542,000	5,525,000	5,472,000	-1.0%	-23%
Electricity	3,138,613	2,474,000	2,219,000	2,184,000	2,161,000	-1.1%	-31%
Natural Gas	2,098,983	2,016,000	2,058,000	2,093,000	1,842,000	-12%	-12%
Wastewater & Solid Waste	383,172	286,000	276,000	285,000	295,000	3.5%	-23%

[4] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012).

Water	277,927	75,000	73,000	67,000	79,000	18%	-72%
Total	12,984,993	10,392,000	10,169,000	10,153,000	9,849,000	-3.0%	-24%

*2010 emissions are not rounded and the methods, data availability, and sources used to calculate GHG emissions have been updated since the development of 2010 emissions inventory **Revised values reflect updated data and information. 2015 emissions reported in 2018 annual report were not revised.
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 CO_2e = metric tons of carbon dioxide equivalent.
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The 2016 revised, 2017 revised emissions and 2018 emissions shown in **Error! Reference source not found.** are calculated based on the same methods and data sources, and can be compared directly. The 2018 total GHG emissions are estimated at 9.8 million metric tons CO_2e (MMT CO_2e), approximately 3% lower than 2017 revised total GHG emissions. The natural gas end-use and water related emissions show the largest changes from 2017 compared with the other emission categories.

A 12% decrease in natural gas end-use emissions between the 2017 revised and 2018 value is mainly due to a decrease in natural gas use from industrial customers within the City. The natural gas end-use from industrial customers in 2018 was 26% lower than that in 2017. Residential and commercial natural gas end-use has not changed significantly (less than 4% decrease in each customer class) from 2017 to 2018. An 18% increase in water-related emissions between 2017 revised and 2018 is partially due to higher water use and less local water supply in 2018 compared with 2017. Less local supply means increased imported water and increased energy and GHG emissions associated with imported water. The waste-related emissions in 2018 were 3% higher than in 2017. The City has maintained a 65% waste diversion rate in 2018, similar to the diversion rate in 2017 (66%), however, the waste disposed at landfills in 2018 from the City was 4% higher than in 2017.

LOW CARBON ECONOMY

The GHG intensity is the level of GHGs per unit of economic activity denominated as the Gross Domestic Product (GDP). The GDP is normally a national unit of economic activity, but can also be applied at the state, regional or city level. National GDP is measured as household expenditures on goods and services plus business investment, government expenditures and net exports. State GDP is measured by income (labor and capital minus business taxes) earned and costs of production in that state. The US Bureau of Economic Affairs has developed GDPs for regions such as San Diego County based on local personal income and industry. IMPLAN, an economic impact model, has been used to develop city-level GDPs[5].

[5] Kelly Cunningham (San Diego Institute for Economic Research) developed and provided the estimate based on the IMPLAN model for the City of San Diego using the city's zip code information and the current data available from the U.S. Department of Commerce's Bureau of Economic Analysis (of September 2019). The 2018 GDP data are estimates and subject to revision with new data and information available from the U.S. Department of Commerce.

GHG intensity indicates how dependent economic activity is on GHG producing activities. Economic productivity is said to be more efficient if GHG intensity decreases, as economic growth then consumes less carbon-based fuels. This occurs when GHG emissions remain constant or decrease over time while the GDP increases. As mentioned above, the GHG emissions for the City of San Diego excludes specific emission sources such as emissions from air travel, shipping, off-road vehicles and equipment, or high global warming potential gases in use in the city. Therefore, a limitation of applying this method to community-wide GHG emissions is that not all economic sectors and GHG-emitting categories are included in the inventory, and the GHG intensity is lower than it actually is. However, since the categories inventoried each year are the same, GHG intensities can be compared for the City across the years.

The City of San Diego's GHG intensity was 77 MT CO_2e /$ million in 2017 and 70 MT CO_2e /$ million in 2018.

TABLE 2 2016 AND 2017 GHG INTENSITY (MT CO_2E/$ MILLION GDP)

Year	2017 (reported in 2018 Annual Report)	2017 Revised*	2018	2017 Revised – 2018 % Changes
Total Emissions (Million MT CO_2e)	10.2	10.2	9.8	-3%
GDP ($ billion)	129	132	140	6%
GHG Intensity (MT CO_2e/$million GDP)	79	77	70	-8%

*Revised values reflect updated information.

GDP = city-adjusted gross domestic product, MT CO_2e = metric tons of carbon dioxide equivalent

Sources: GDP estimated by Kelly Cunningham, San Diego Institute for Economic Research, based on Bureau of Economic Analysis, 2019. 2018 GDP data are estimates.

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PER CAPITA GHG EMISSIONS

The 2017 and 2018 per capita GHG emissions in the City of San Diego are given in Table 3. This is based only on the five emission categories analyzed. The 2018 per capital GHG emissions are estimated at 6.9 MT CO_2e per capita, approximately 4% lower than the 2017 per capita GHG emissions.

TABLE 3 2017 AND 2018 PER CAPITA GHG EMISSIONS (MT CO_2E PER CAPITA)					
Year	**2010 Baseline* (reported in the CAP)**	**2017 (reported in 2018 Annual Report)**	**2017 Revised****	**2018**	**2017 Revised – 2018 % Changes**
Total emissions (Million MT CO_2e)	13.0	10.2	10.2	9.8	-3.0%
Total Population	1,301,617	1,399,924	1,399,924	1,419,845	1.4%
Per capita GHG emissions (MT CO_2e per capita)	10.0	7.3	7.3	6.9	-4.4%

*The methods, data availability, and sources used to calculate GHG emissions have been updated since the development of 2010 emissions inventory **Revised values reflect updated information from sources.

MT CO_2e = metric tons of carbon dioxide equivalent

Per capita emissions based on five emission categories only and cannot be compared with California statewide per capita emissions or per capita emissions targets.

2017 revised and 2018 population are based on SANDAG's Demographic & Socio-Economic Estimates (May 25, 2019 version).

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As mentioned above, the GHG emissions categories included and the methods to calculate GHG emissions for the City of San Diego are based on the U.S. Community Protocol. The U.S. Communities Protocol requires five basic emissions-generating activities to be included in a Protocol-compliant community-scale 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 from air travel, shipping, off-road vehicles and equipment, or high global warming potential gases are not considered as such. Therefore allocating emissions from such categories to cities is either not possible due to lack of data or lack of proxy data, is challenging, or is better handled at a higher 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.

2018 Climate Action Plan Strategy Updates

STRATEGY 1: ENERGY AND WATER EFFICIENT BUILDINGS

Energy (fossil-fuel based electricity and natural gas consumption) and water-related emissions account for 41% of 2018 Citywide GHG emissions (**Error! Reference source not found.**). The Energy and Water Efficient Buildings strategy has targets to reduce citywide per capita water use, energy use in residential buildings and energy use in city operations. Water treatment and distribution to residents and businesses in the City require energy; therefore, reducing water use will also have an impact on the associated energy use.

Baseline and Current State of Energy and Water Use in the City of San Diego

The 2017 and 2018 grid supplied electricity is provided in Table 4. For electricity users with on-site electric generation, only the net electricity from the grid has been included.

TABLE 4 GRID SUPPLIED ELECTRICITY USE IN CITY OF SAN DIEGO

Year	2010 (reported in CAP)	2017 (reported in 2017 Annual Report)	2017 Revised*	2018	2010-2018 % Change	2017 Revised – 2018 % Change
Electricity (MWh)	8,572,155	7,738,649	7,753,710	7,626,727	-11%	-1.6%
Emissions from Electricity (MT CO_2e)	3,138,613	2,187,000	2,184,000	2,161,000	-31%	-1.1%

* Revised values reflect updated information from data sources.

MWh = megawatt hour, MT CO_2e = metric tons of carbon dioxide equivalent

The MWhs do not include transmission and distribution losses, or self-serve behind-the-meter electricity generation (i.e., rooftop PV systems). The electricity sales data do not include the electricity sales to San Diego County Regional Airport Authority, San Diego Unified Port District and military.

GHG emissions are rounded to the nearest thousands. The emissions from electricity were calculated based on City of San Diego's grid supply and power mix specifically, which may differ from other jurisdictions in San Diego region.

SDG&E 2019, Energy Policy Initiatives Center 2019

Table 5 provides a breakdown of electricity use by customer class in 2018.

TABLE 5 BREAKDOWN OF ELECTRICITY USE BY CUSTOMER CLASS

Customer Class	Percentage of Electricity Use in 2018
Residential	29%
Commercial	45%
Industrial	25%
Agricultural and Pumping	1.1%
Lighting (traffic lighting and traffic lights)	0.7%
Total	100%

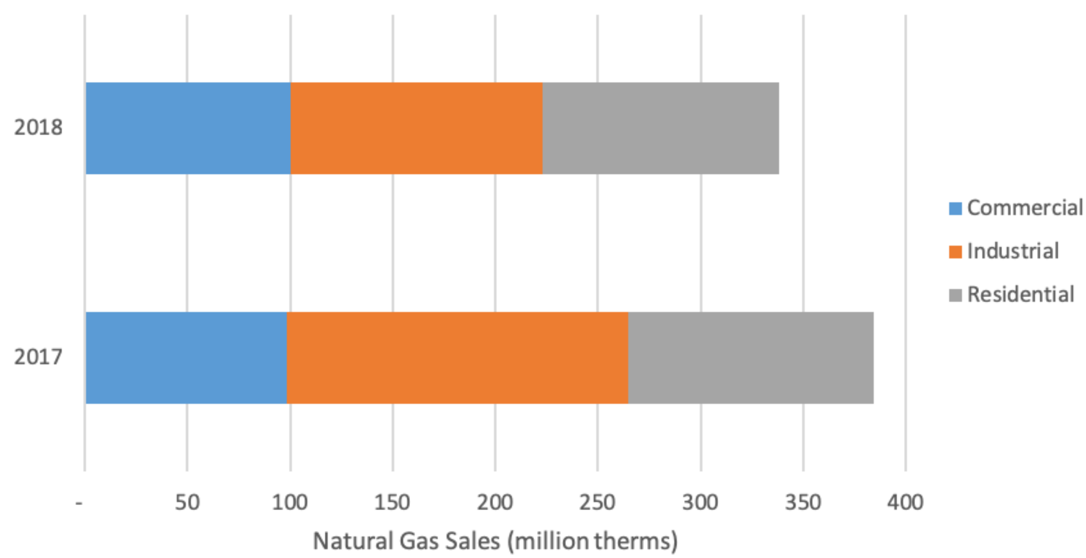
SDG&E 2019

In 2018, 34% of natural gas use was from the residential class, 30% from the commercial class and the rest from the industrial class (including electric generation using natural gas). Table 6 provides natural gas end use in 2017 and 2018.

TABLE 6 TOTAL NATURAL GAS DELIVERED BY SDG&E IN CITY OF SAN DIEGO				
Year	**2017 (reported in 2018 Annual Report)**	**2017 Revised***	**2018**	**2017 Revised – 2018 % Changes**
Natural Gas Use (million therms)	384	384	338	-12%
* Revised values reflect updated information from sources. The natural gas sales data do not include the sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and military. SDG&E 2019 Energy Policy Initiatives Center 2019				

A 12% decrease in natural gas end-use emissions between 2017 and 2018 appears to be related to a decrease in natural gas use from industrial customers within the City. Residential and commercial natural gas end-use has not changed significantly (less than 4% change in each customer class) from 2017 to 2018. A comparison of the natural gas end-use by customer class in 2017 and 2018 is shown in Figure 1.

FIGURE 1 NATURAL GAS END-USE BY CUSTOMER CLASS IN CITY OF SAN DIEGO



SDG&E's electricity sales in City of San Diego, exclude sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and the military.
SDG&E 2019

Table 7 provides the electricity and natural gas end use in million British thermal units (MMBtu). MMBtu is the common unit of energy used to enable comparison of the energy use of different fuel types. In this case, MMBtu is used to convert electricity in kilowatt-hours (kWh) and natural gas in units of therms to the same unit. Natural gas constituted 57% of the total end use energy in 2018.

TABLE 7 TOTAL ELECTRICITY AND NATURAL GAS DELIVERED BY SDG&E IN CITY OF SAN DIEGO

Year	2017 (reported in 2018 Annual Report)	2017 Revised*	2018	2017 Revised – 2018 % Changes
Electricity (million MMBtu)	26.4	26.4	26.0	-2%
Natural Gas (million MMBtu)	38.4	38.4	33.8	-12%
Energy (million MMBtu)	64.8	64.8	59.8	-8%

* Revised values reflect updated information from sources.
MMBtu = million British Thermal Units
Conversion factors are 293 kWh/MMBtu and 10 therms/MMBtu.

SDG&E 2019, Energy Policy Initiatives Center 2019

Table 8 provides the electricity and natural gas saved from utility (SDG&E)'s energy efficiency program from 2016 to 2018.

TABLE 8 ENERGY SAVINGS FROM UTILITY ENERGY EFFICIENCY PROGRAM

Year	2016	2017	2018
Electricity Savings (MWh)	8,220	11,900	10,365
Electricity Savings (MMBtu)	280,275	405,724	353,403
Natural Gas Savings (therms)	1,011,251	382,077	(453,270)
Natural Gas Savings (MMBtu)	101,125	38,208	(45,327)
Net Electricity and Natural Gas Savings (MMBtu)	381,400	443,931	308,076
Net Electricity and Natural Gas Savings as a Percentage of Energy Use (%)	0.6%	0.7%	0.5^

MWh = megawatt hour, MMBtu = million British Thermal Units
KWh and therms are converted to MMBtu using 99,976 btu/therm and 3,412 btu/kWh conversion factors.

The annual data provide the energy efficiency savings credited for that year. The energy savings are from SDG&E energy efficiency program participants only. These includes all customer classes (agricultural, residential, commercial, and industrial). The savings are estimates comparing the energy use with and without the energy efficiency projects. A negative natural gas value means additional natural gas is used. Net energy savings means the net of electricity and natural gas savings.
SDG&E 2019, Energy Policy Initiatives Center 2019

Action & Progress: Reduce Energy Use in Residential Housing Units

Total residential electricity use includes both electricity provided by SDG&E and electricity generated from behind-the-meter PV systems. Residential PV systems increased to 237 megawatts (MW) in 2018. Combining both electricity and natural gas use, energy use per home in 2018 is approximately 3% lower than that in 2017 (Table 9).

TABLE 9 RESIDENTIAL ENERGY (ELECTRICITY + NATURAL GAS) USE

Year	2010 (reported in CAP)	2017 (reported in 2018 Annual Report)	2017 Revised*	2018	2010-2018 % Change	2017 Revised-2018 % Change
Electricity (MWh) - utility	2,498,471	2,281,973	2,282,186	2,227,628	-11%	-2%
Electricity (MW) – PV*	15	193	194	237	1658%	22%
Electricity (MWh) – PV**	26,251	338,589	340,460	414,869	1658%	22%
Total Electricity (sum of utility + estimated PV, MWh)	2,524,722	2,620,562	2,622,646	2,642,497	5%	0.8%
Total Electricity (sum of utility + estimated PV, MMBtu)	8,608,065	8,936,871	8,941,940	9,009,621	5%	0.8%
Natural Gas (million therms)	138	119	119	115	-17%	-3.6%
Natural Gas (MMBtu)	13,781,505	11,910,251	11,909,868	11,476,071	-17%	-3.6%
Total Energy (MMBtu)	22,389,570	20,845,086	20,851,808	20,485,691	-8%	-1.8%
Total # of occupied units***	483,092	505,531	505,531	509,216	8%	0.7%
Energy use per home (MMBtu/home)	46.3	41.2	41.2	40.2	-15%	-2.5%

*Revised values reflect updated information from sources.

MW = megawatt, MWh = megawatt hour, MMBtu = million British Thermal Unit

*Behind-the-meter PV capacity is obtained from the California Distributed Generation Statistics database, net energy metering (NEM) interconnection dataset for SDG&E - City of San Diego residential customers (July 31, 2019 version). It is based on the date of interconnection application approval. **Capacity is converted to electricity using an average PV system capacity factor of 20%. ***Occupied housing units are from SANDAG's Demographic & Socio-Economic Estimates (May 25, 2019 version).

Energy Policy Initiatives Center 2019

In 2018, approximately 7,100 new residential solar PV systems (97% of the total new systems) were approved for interconnection in the City for an additional 42 MW of new behind-the-meter PV capacity.

Action & Progress: Reduce Municipal (City Operations) Energy Use

Municipal operations energy use (grid purchases) in 2018 was 5% higher than in 2017 (Table 10).

TABLE 10 ENERGY (ELECTRICITY + NATURAL GAS) USE FOR MUNICIPAL OPERATIONS (SDG&E ONLY)						
Energy Use	**2010 Baseline**	**2016 (reported in 2018 Annual Report)**	**2017 (reported in 2018 Annual Report)**	**2018**	**2010-2018 (% Change)**	**2017 - 2018 (% Change)**
Electricity (MWh)	205,787	183,873	190,351	180,377	-12%	-5.2%
Electricity (MMBtu)	701,633	626,916	649,004	614,997	-12%	-5.2%
Natural Gas (Million Therms)	3.4	3.6	3.6	4.5	33%	24%
Natural Gas (MMBtu)	335,723	356,384	362,016	448,000	33%	24%
Total energy (MMBtu)	1,037,357	983,300	1,011,019	1,062,997	2.5%	5.1%

Grid purchases only, does not include on-site renewable generation. Natural gas consumption includes gas use for space heating/cooling and electric generation.

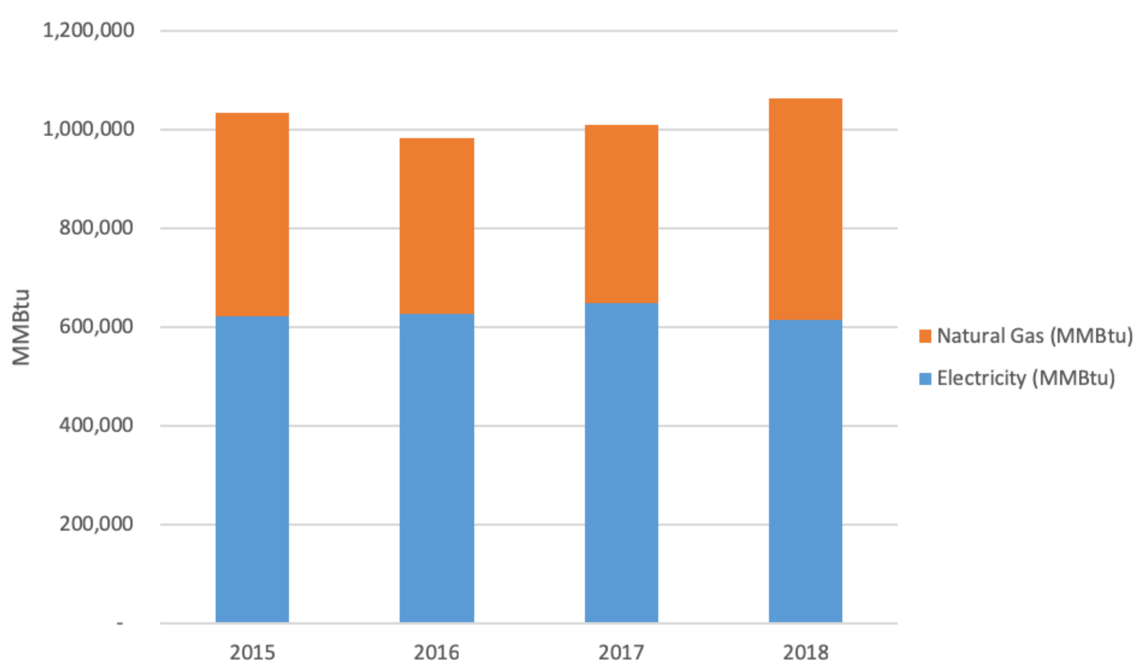
MWh = megawatt hour, MMBtu = million British Thermal Units.

KWh and therms are converted to MMBtu using 99,976 btu/therm and 3,412 btu/kWh factors.

Sources: City of San Diego Sustainability Department 2019

A comparison of energy use for municipal operations from 2015 to 2018 is given in Figure 2 below.

FIGURE 2 MUNICIPAL ENERGY USE (2015-2018)



Source: City of San Diego Sustainability Department
SDG&E grid purchase only. Does not include on-site renewable geneartion.

The City's municipal operations grid supplied electricity consumption declined from 2017 to 2018, which is likely attributed to the following:

- City's deployment of 3.5 MW of solar photovoltaics across City facilities;
- Maintenance projects for reservoirs declined in 2018 and contributed to the decrease of electricity use;
- Many of the City's highest energy consuming facilities consume more or less electricity in any year because of operational changes and decisions on how to best use the equipment to meet the community's needs.
- The replacement of 4,785 light-emitting diode (LED) streetlights throughout the City

However, the municipal operations natural gas consumption increased during 2017 to 2018, which is likely attributed to the following:

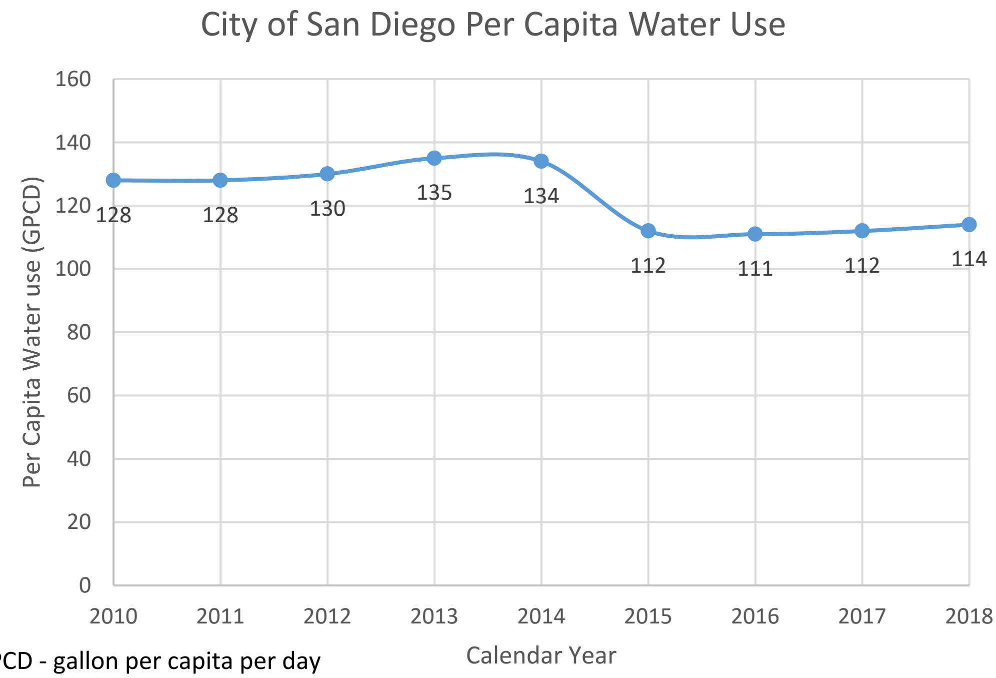
- Changes in consumption from new City assets and added loads;
- Increased consumption from City facilities that were not fully staffed and/or operational in the previous year; and
- Natural gas driven pumps for selected water treatment and wastewater treatment plants were down in 2017 but up and running in 2018 so back-up electric motor driven pumps were not used, increasing natural gas consumption and decreasing electricity consumption.

Action & Progress: Reduce Daily per Capita Water Consumption

Per capita water use (gallons per capita per day – GPCD) decreased substantially from 2010 to 2018 beyond what was projected in the CAP for 2020 (Figure 3). Governor Brown issued Executive Order B-29-2015 imposing a 25% statewide potable water reduction in April 2015. The drought emergency declaration was lifted by the Governor in April 2017, while retaining a prohibition on wasteful practice. The per capita water use in the City of San Diego has remained at a similar level as in 2015, however, the per capita water use has increased slightly from 2016 to 2018.

The GPCD calculation method (volume of water entering City of San Diego's distribution system divided by distribution system population) is consistent with the GPCD definition in SB X7-7 (the Water Conservation Act of 2009) and the City of San Diego 2015 Urban Water Management Plan (June 2016 final version). However, to be consistent with the CAP, the GPCD is reported by calendar year in the CAP Annual Report, while the GPCD in the Urban Water Management Plan and SB X7-7 are by fiscal year. Therefore, the GPCD reported here cannot be directly compared with the SB X7-7 GPCD target for 2020.

FIGURE 3 PER CAPITA WATER USE (2010-2018)



GPCD - gallon per capita per day
Source: City of San Diego Public Utilities Department

The amount of recycled water and water used for irrigation from 2010 to 2018 are provided in Table 11 and Table 12.

TABLE 11 METERED RECYCLED WATER CONSUMPTION

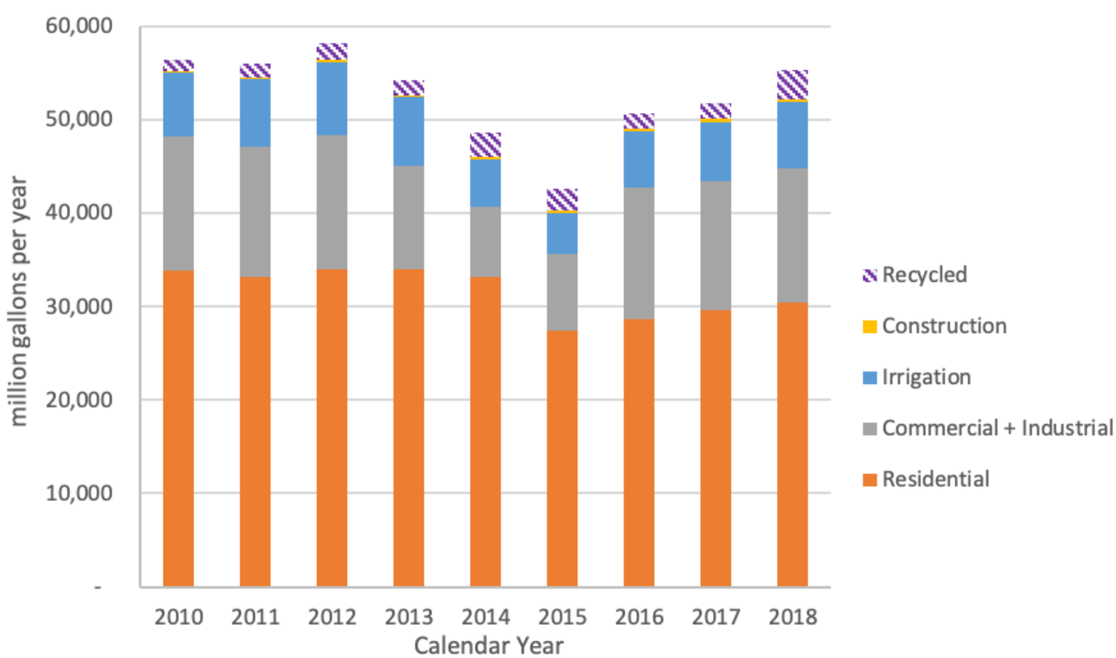
Year	Recycled Water Sales (million gallons)
2010	1,350
2011	1,524
2012	1,867
2013	1,691
2014	2,588
2015	2,370
2016	1,637
2017	1,691
2018	3,265
Sources: City of San Diego Public Utilities Department	

TABLE 12 METERED IRRIGATION WATER USE (AGRICULTURAL AND LANDSCAPE)	
Year	**Metered Irrigation Water Use (million gallons)**
2010	6,923
2011	7,193
2012	7,812
2013	7,336
2014	4,977
2015	4,378
2016	5,943
2017	6,302
2018	7,092
Metered irrigation water, including agricultural and landscape water use. Source: City of San Diego Public Utilities Department	

The recycled water sales in 2018 increased significantly from 2017, almost double the recycled water sales in 2017, mainly due to the weather, increase in new customers and increase in existing customer usage.

The breakdown of City of San Diego's water sales by sector including recycled water is given in Figure 4.

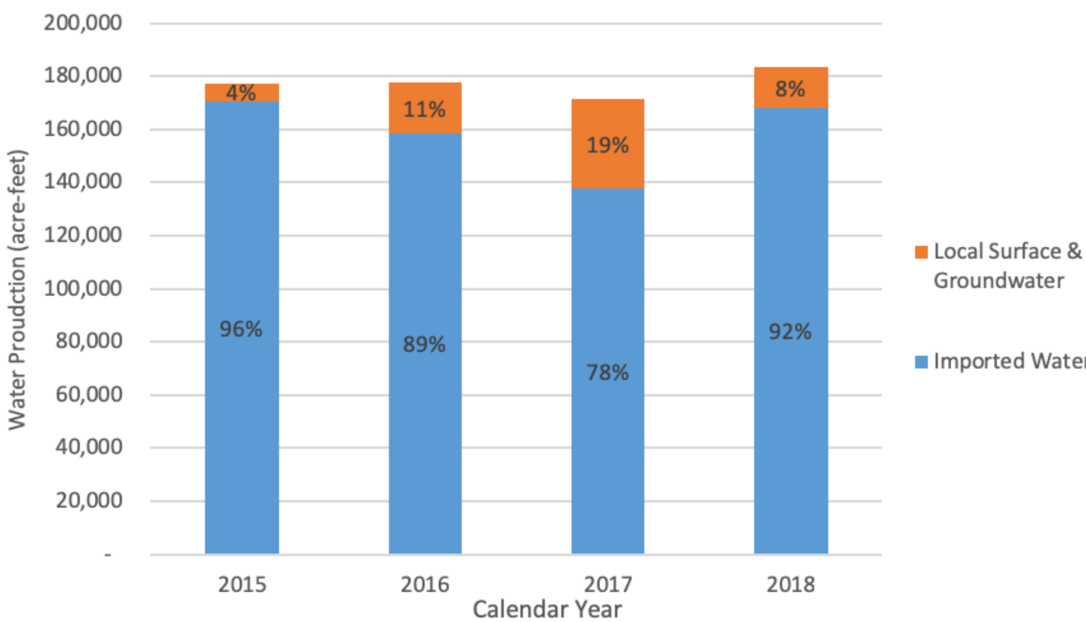
FIGURE 4 WATER SALES BY SECTOR (2010-2018)



Source: City of San Diego Public Utilities Department
Sales within City of San Diego only. Do not include sales to other agencies.

The percentage of local water supply to total water supply increased from 4% in 2015 to 19% in 2017, but decreased to 8% in 2018, as shown in Figure 5. The reduction in local water supply from 2017 to 2018 is mainly due to less local water availability as a result of lower rain and runoff in the City reservoirs in 2018 compared with 2017. A higher percentage of local water supply would reduce the need to import water from SDCWA, and reduce the energy and GHG emissions associated with the imported water.

FIGURE 5 WATER MIX (2015-2018)



Water production include water delivered within City of San Diego and sales to other agencies.
Source: City of San Diego Public Utilities Department

STRATEGY 2: CLEAN AND RENEWABLE ENERGY

The City of San Diego has a long-term goal of reaching 100% renewable electricity supply in 2035. Several key categories contribute to the 100% renewable goal including the renewable content in SDG&E's electricity supply, behind-the-meter renewable supply (including rooftop PV) and the renewable content in a Community Choice Aggregation or similar program. In 2018, SDG&E achieved 43% renewables in its electricity supply, similar to 2016 and 2017 level, and higher than the state Renewable Portfolio Standard target for 2020. The citywide total behind-the-meter PV systems increased to 340 MW 2018.[6]

Baseline and Current State of Clean and Renewable Energy in the City of San Diego

SDG&E's renewable electricity supply increase from 11% in 2010 to 43% in 2018 (Table 13).[7]

TABLE 13 PERCENTAGE OF RENEWABLES IN SDG&E ELECTRICITY SUPPLY

Year	Renewables in SDG&E Electricity Supply
2010	11%
2011	16%
2012	19%
2013	24%
2014	32%
2015	36%
2016	43%
2017	44%
2018	43%

The 2010-2017 percent renewable in SDG&E electricity supply is based on SDG&E's 2010-2017 annual power content label. The 2018 percent renewable is based on SDG&E's 2018 power source disclosure report submitted to the California Energy Commission in June 2019, which may be subject to change and will be finalized in November 2019.

The percent renewable is for the electricity SDG&E supplied to its bundled customers; it does not represent the renewable content of the electricity supplied to SDG&E's Direct Access customers and does not account for behind-the-meter renewable supply.

California Energy Commission 2019

In 2018, approximately 7,100 out of 7,300 new PV systems added (42 MW out of 62 MW) in the City were from residential customers (Table 14). The cumulative net

[6] Only accounts for the behind-the-meter PV systems currently interconnected to the grid and net-metered, with historical installation years. NEM Interconnection Data Set (current as of July 31, 2019), accessed on October 23, 2019. Service cities include San Diego, La Jolla and San Ysidro. Based on the date of NEM interconnection applications approved and the Permission to Operate letters issued to the customers. Solar capacities are reported in direct current (DC).

[7] CEC Power Source Disclosure Program under Senate Bill 1305. The 2018 SDG&E annual power source disclosure report was provided by CEC staff to EPIC on June 25, 2019.

energy metered (NEM) PV capacity from the interconnected systems installed between 1999 and the end of 2018 was 340 MW in the City. Assuming that solar PV systems have a capacity factor of 20% and an annual system degradation rate of 1%, the electricity generated from rooftop solar was estimated at 577,000 MWh in 2018, accounting for approximately 6% of the total electricity consumption.

TABLE 14 NUMBER AND CAPACITY OF INSTALLED BEHIND-THE-METER PHOTOVOLTAIC (PV) SYSTEMS

Year	Number of New PV Systems Approved (reported in 2018 Annual Report)	Number of New PV Systems Approved (Revised)*	New PV System Capacity (kW)
2010	1,054	1,055	10,582
2011	1,159	1,161	16,188
2012	1,562	1,551	14,291
2013	3,210	3,143	21,322
2014	4,469	4,420	28,531
2015	8,406	8,482	55,920
2016	9,271	9,367	61,667
2017	5,920	5,904	47,746
2018	-	7,345	62,440

For 2010-2018, the number of systems and system capacity in the City of San Diego are based on the approved date of interconnection as available in the California Distributed Generation Statistics database. Both the number of systems and capacity in a given year are new, not cumulative. The 2014 and after system capacity is reported as direct current (DC) in kW. The 2010-2013 capacity is converted to DC from alternating current (AC), as the number of systems reported in AC and DC are inconsistent before 2014 in the database.

*Revised values reflect updated information from sources.

Sources:

California Distributed Generation Statistics database, net energy metering (NEM) interconnection dataset, July 31, 2019 version.

Energy Policy Initiatives Center 2019

The City also has numerous facilities with on-site renewable generation, including 1) combined heat and power generation using landfill gas or digester gas at Metropolitan Biosolids Center, Point Loma Wastewater Treatment Plant and North City Water Reclamation Plant; 2) hydroelectric generation at Point Loma Wastewater Treatment Plant ocean outfall; and 3) PV systems at water treatment facilities, libraries, recreation centers and fire stations. Two of the largest PV systems, at the Alvarado Water Treatment Plant and the Otay Water Treatment Plant, produced a combined 2,400 MWh of electricity on-site in 2018. In 2018, the City also deployed 3.5 MW of new solar PV across City facilities.

Electric Vehicles and Infrastructure in the City of San Diego

The impact of zero-emission vehicles policies and programs in reducing GHG emissions is calculated as reductions from State actions, not CAP strategies. However, the impact is reflected at the local level. The estimated electric vehicle (EV) rebates through the Clean Vehicle Rebate Program (CVRP) continues to increase in the City of San Diego. The total number of rebates for EVs since 2010 in the City is estimated at 10,901 EV rebates or 77 EV rebates per 10,000 capita in 2018. The new CVRP rebates saw an increase of 40% from 2017 to 2018, as shown in Table 15.[8]

TABLE 15 ESTIMATED CLEAN VEHICLE REBATE PROGRAM REBATED ELECTRIC VEHICLES

Year	Estimated Clean Vehicle Rebate Program Rebated Electric Vehicles
2010	3
2011	660
2012	386
2013	1,081
2014	1,469
2015	1,476
2016	1,736
2017	1,704
2018	2,386
Total	10,901

Totals may differ from those reported previously due to data settling (e.g., vehicles returned, rebate processing). Rebates are allocated to City of San Diego based on census tract. If a census tract covers more than one jurisdiction, all rebates in the tract are allocated to the jurisdiction that covers a majority of the census tract.

Rebated electric vehicles include plug-in hybrids and battery electric vehicles, excludes electric motorcycles, neighborhood EVs, and commercial EVs. The number of electric vehicles receiving rebates is lower than the actual number of electric vehicle sales.

Center for Sustainable Energy 2019, Energy Policy Initiatives Center 2019

Not all EV buyers apply for or receive rebates from CVRP, the total number of registered EVs citywide, including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), at the beginning of 2018 is show in Table 16. [9]

TABLE 16 NUMBER OF REGISTERED ELECTRIC VEHICLES

Number of Vehicles	As of January 1, 2018
Number of Battery Electric Vehicles (BEVs)	7,712
Number of Plug-in Hybrid Electric Vehicles (PHEVs)	4,701
Total Number of Electric Vehicles (BEVs + PHEVs)	12,413
Total Number of Registered Vehicles	1,100,805
Percent of Electric Vehicles to All Registered Vehicles	1.1%

Department of Motor Vehicles 2019

[8] Center for Sustainable Energy: CVRP Rebate Statistics, current as of February 27, 2019, accessed March 18, 2019.

[9] California Department of Motor Vehicles: Fuel Type by City as of 1/1/2018, accessed March 18, 2019.

At the beginning of 2018, approximately 1% of all registered vehicles in the City were EVs, which is similar to the percentage of San Diego region-wide EVs to all registered vehicles. The percentage does not represent the percentage of new EVs of new vehicles sales. EVs accounted for approximately 5% of new vehicle sales in the state in 2017, and 8% of new vehicle sales in 2018.[10]

The increasing number of EVs leads to increasing demand for EV charging, Table 17 below shows the number of public electric vehicle charging stations (EVCSs) and the number of EVCSs offered through SDG&E's Power Your Drive program at multi-family buildings and workplaces within the City.

TABLE 17 ESTIMATED NUMBER OF ELECTRIC VEHICLE CHARGING STATIONS

Number of Charging Sites or Chargers	At the end of 2018/Early 2019
Number of Sites with Public EVCSs	300
Number of Public Level 2 EVCSs at all Sites	1,052
Number of Public DC Fast EVCSs at all Sites	108
Number of SDG&E Power Your Drive EVCSs	1,755

EVCS = electric vehicle charging station

Number of EVCSs are the number of nozzles or plugs, one site may have more than one nozzle or plug. EVCSs installed through SDG&E's Power Your Drive program are not considered public chargers, they are installed primarily at workplaces (include municipal facilities) and multi-family buildings (apartments and/or condo buildings).
Data do not include other private workplace or in-home (e.g. single-family homes) charging stations.

Alternative Fuels Data Center 2019, SDG&E 2019, Energy Policy Initiatives Center 2019

Action & Progress: Increase Municipal Zero Emissions Vehicles

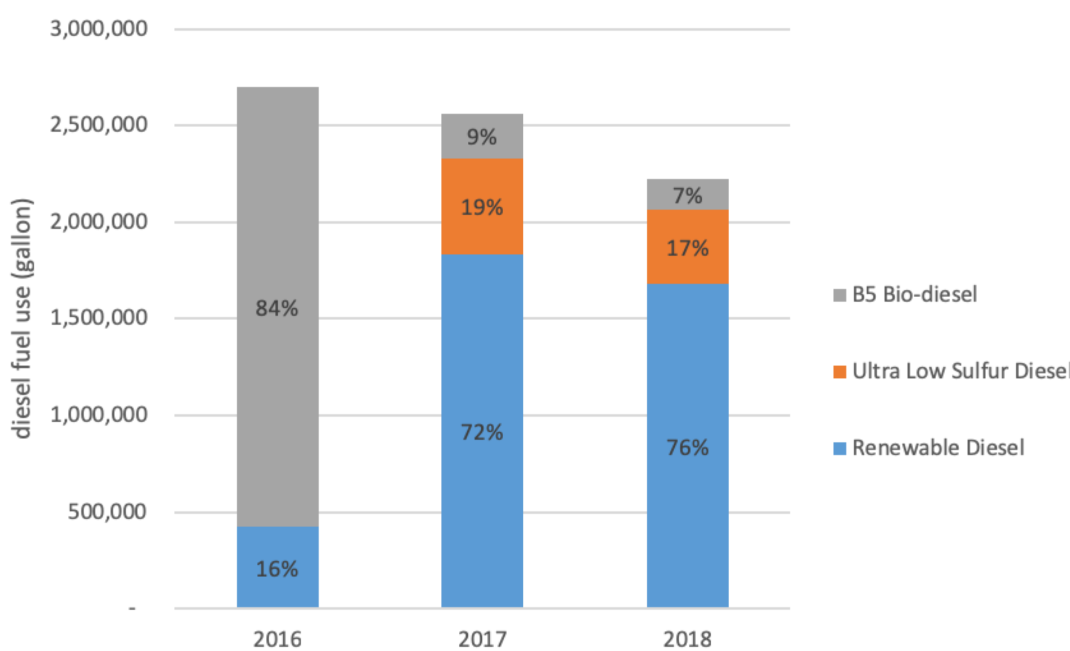
As of 2018, the City operations have 4,370 vehicles, including 41 compressed natural gas (CNG) waste trucks, 87 EVs and 70 hybrid vehicles. The 2010 to 2018 city fleet gasoline consumption is given in Table 18.

[10] Based on CEC IEPR Lead Commissioner July 22, 2019 Workshop Preliminary Transportation Energy Demand Forecast, Presentation: Light-Duty Vehicle Demand Forecast, accessed July 22, 2019.

TABLE 18 CITY FLEET GASOLINE CONSUMPTION	
Year	**Total Gasoline (gallons)**
2010	1,337,869
2011	2,155,962
2012	2,267,693
2013	2,277,559
2014	2,268,104
2015	2,262,114
2016	2,344,552
2017	2,275,635
2018	2,199,146
Source: City of San Diego Fleet Operations Department	

In 2016, the City municipal fleet transitioned to 100% renewable diesel to help meet the CAP goal of reducing municipal fleet GHG emissions. The percentage of renewable diesel in total diesel use increased from 16% in 2016 to 76% in 2018 (Figure 6).

FIGURE 6 MUNICIPAL FLEET DIESEL FUEL USE BY FUEL TYPE (2016 TO 2018)



B5 Bio-diesel also includes off-road equipment fuel use.
Source: City of San Diego Fleet Operations Department

Consistent with the CARB statewide GHG Inventory and the IPCC Guidelines, the CO_2 emissions from biofuel (e.g., ethanol, biodiesel, and renewable diesel) are classified as "biogenic CO_2" and not included in the GHG inventory. Only the CH_4 and N_2O

emissions from biofuel are accounted for in the GHG inventory. For regular diesel, all CO_2 CH_4 and N_2O emissions are accounted for in the GHG inventory. The GHG emissions avoided were calculated based on the difference between the GHG emissions from renewable diesel and GHG emissions if the fuel use were Ultra Low Sulfur (ULS) diesel. The carbon intensities of the diesel fuel reported under CARB's Low Carbon Fuel Standard (LCFS) program were used.

The transition to renewable diesel avoided approximately 14,000 MT CO_2e in 2018, as shown in Table 19.[11]

TABLE 19 GHG EMISSIONS AVOIDED BY TRANSITION FROM ULTRA LOW SURFUR DIESEL TO RENEWABLE DIESEL

Fuel Type	Carbon Intensity* (g CO_2e/gallon)	Fuel Use (gallons)	GHG Emissions (MT CO_2e)
Renewable Diesel	5,252	1,682,192	8,836
Ultra-Low Sulfur Diesel	13,508		22,722
GHG Emissions Avoided by Using Renewable Diesel			13,887

*Based on the certified carbon intensity reported under CARB Low Carbon Fuel Standard, renewable diesel is from Nest Singapore (RDT202), and ultra-low sulfur diesel the California average (ULS000L00072019).
City of San Diego Fleet Operations, CARB 2019, Energy Policy Initiatives Center 2019

Action & Progress: Convert Municipal Waste Collection Trucks to Low-Emissions Fuel

In 2018, the City had 41 CNG waste collection trucks in service versus 25 in 2017, ahead of the scheduled implementation of the measure. The use of CNG trucks displaces diesel trucks and diesel fuel use. The GHG emissions avoided from this conversion were calculated based on the difference between GHG emissions from CNG and GHG emissions if the fuel use were ULS diesel.

The conversion to CNG avoided approximately 2,300 MT CO_2e in 2018, as shown in Table 20.

[11] CARB: LCFS Pathway Certified Carbon Intensities, last updated July 17, 2019, accessed July 23, 2019.

TABLE 20 GHG EMISSIONS AVOIDED BY CONVERT MUNICIPAL WASTE COLLECTION TRUCKS TO LOW-EMISSIONS FUEL			
Fuel Type	**Compressed Natural Gas (CNG)**	**Ultra-Low Sulfur Diesel**	**Units**
Fuel use	506,992	----	Therms
	48,937,452	----	Scf
	50,699	50,699	MMBtu
	----	367,386	Gallons
Fuel Carbon Intensity*	54.5	----	Grams per scf
	----	13,508	Grams per gallon
GHG Emissions	2,669	4,962	MT CO_2e
	GHG Emissions Avoided by Using CNG	2,293	MT CO_2e

MMBtu = million British Thermal Unit, scf = standard cubic foot

*Based on the certified carbon intensity reported under CARB Low Carbon Fuel Standard, ultra-low sulfur diesel the California average (ULS000L00072019), and CARB statewide GHG inventory, fuel heat content, 1035 Btu per scf for CNG and 138,000 Btu per gallon for diesel.

City of San Diego Sustainability Department 2019, CARB 2019, Energy Policy Initiatives Center 2019

STRATEGY 3: BICYCLING, WALKING, TRANSIT AND LAND USE

In 2018, transportation accounted for 55% of all GHG emissions within the City of San Diego. This strategy aims at reducing commuter vehicle driving by increasing the use of mass transit, bicycling and walking in the city's Transit Priority Areas (TPA). TPAs are defined as the areas within half a mile of existing or planned major transit stops.

State of and current state of transportation in the City of San Diego

The 2018 vehicle miles travelled (VMT) and on-road transportation emissions in the City of San Diego are shown in Table 21. The data sources and method to calculate on-road transportation emissions are provided in a supplement document of the Appendix, *City of San Diego 2016-2018 Greenhouse Gas Emissions Inventory.*

TABLE 21 2018 VEHICLE MILES TRAVELLED (VMT)	
Total VMT (million miles/year)	13,199
San Diego Regional Average Vehicle Emission Rate (g CO_2e/mile)	415
GHG Emission (MT CO_2e)	5,472,000

The 2018 VMT are estimates based on 2016 City of San Diego VMT estimates from SANDAG's Travel Demand Model (Series 14, version 14.0.1) and adjusted by the 2016-2018 San Diego regional VMT annual rates of growth as shown in the California Department of Transportation (CalTrans) Highway Performance Monitoring System public road data.

Sources: SANDAG 2019, CalTrans 2019, CARB 2018, Energy Policy Initiatives Center 2019

Action & Progress: Walking, Biking, Transit and Vehicle Commute Distance

Since the adoption of the CAP in 2015 the availability and type of data for tracking progress on mode shares and commute trip length have evolved. Baseline mode shares were determined through multiple sources of data as listed below in Table 22. To provide a more consistent evaluation of progress and ensure the utilization of the best available data, the City of San Diego worked with a transportation consulting firm, Fehr & Peers to present updated mode share results comprised of the most up-to-date techniques and information at the time. This information was originally reported in the 2018 CAP Appendix. There is no new data available to update what was presented in last year's report. SANDAG is currently preparing the 2021 Regional Plan which, upon adoption, will enable updating future mode shares.

SANDAG, the regional transportation agency, is currently the best source for transportation data in the region. SANDAG has transitioned from an enhanced four-step transportation model to an activity-based model (ABM). ABMs allow for a more nuanced analysis of complex policies and projects and strive to be as behaviorally realistic as possible by simulating individual and household transportation decisions that compose their daily travel itinerary. The ABM is based on empirical data collected by SANDAG, California Department of Transportation (Caltrans), and the federal government.

The results presented below in Table 22 utilize the SANDAG Series 13 ABM, which is different from the ABM used to develop the VMT data used for the GHG inventory (Series 14 ABM version 14.0.1). SANDAG no longer maintains or allows modification to prior data series (e.g. Series 12) or the previously used four-step transportation model. The following model years and scenarios were used:

- Series 13 Base Year (2012) Model Run: The base year model run represents the land use and transportation network for year 2012. The full model output was provided by SANDAG and post processed to obtain 2012 mode share and commute trip length information. No land use or transportation network adjustments were made to the base year model run.

- Series 13 2035 with community plan updates (CPU) Model Run: The 2035 model run was developed before several community plan updates (CPUs) were completed, the unadjusted 2035 model run from SANDAG does not include land use from the recently approved CPUs. The 2035 model was adjusted to reflect the CPU land use for Uptown, North Park, Golden Hill, Navajo, San Ysidro, Southeastern, and Encanto. The full model output was post processed by Fehr & Peers to obtain forecasts for 2035 mode share and commute trip length information.

TABLE 22 SUMMARY OF 2010 (CAP BASELINE YEAR) MODESHARE ESTIMATES AND VEHICLE COMMUTE DISTANCE		
Mode	**Baseline Mode Share (%) 2010**	**Baseline Source Data**
Transit	4%	American Community Survey Briefs 2008 and 2009 (Table 2), for San Diego-Carlsbad-San Marcos area
Walking	3.5%	City of San Diego Pedestrian Master Plan of 2006, Appendix D
Bicycling	2%	City of San Diego Bicycle Master Plan, Table 5.12
Vehicle Commute Distance	25 miles per day (Regional)	SANDAG, 2010

TABLE 23 SUMMARY OF BASELINE MODESHARES AND VEHICLE COMMUTE DISTANCE				
Mode	**2012 Base Year Modeshare (%)**	**Modeled Modeshare (%) 2017**[12]	**2035 with CPUs Modeshare (%)**	**Modeled Source Data**
Transit	5.9%	7.6%	12.7%	SANDAG series 13 regional travel demand model base year (2012) run and SANDAG Series 13 regional travel demand model run 2035 with community plan updates.
Walking	2.7%	3.0%	4.0%	
Bicycling	1.6%	1.8%	2.3%	
Drive	89.8%	87.6%	81.0%	
Drive Alone	80.4%	78.1%	71.3%	
Regional Vehicle Commute Distance (miles)	20.11	19.95	19.41	
City Vehicle Commute Distance (miles)	17.05	16.97	16.71	
Source: Fehr & Peers, 2018				

This analysis does not account for citywide regulations, programs and policies that would be implemented throughout the life of the community plans, such as additional bicycle and pedestrian improvements whenever street resurfacing occurs, as feasible; highest priority bicycle and pedestrian improvements that align with "Vision Zero"; regional improvements that promote alternative modes of transportation, such as mobility hubs; innovative mobility options (e.g., dockless vehicles, micro transit, etc.), bicycle and car sharing programs; the CAP consistency checklist for new development; and, improvements to enhance transit accessibility. the mode share information provided in this annual report reflect the land use contribution to shift the citywide mode share in continued progress of achieving the CAP goals.

[12] The 2017 modeshare values were calculated using a straight-line interpolation between the 2012 SANDAG series 13 base year and the 2035 SANDAG series 13 with CPUs mode share values.

As transportation modeling efforts continue to improve the information presented in this and future CAP annual reports will reflect results based on the best available data.

In terms of pedestrian infrastructure improvement, in 2018, the City constructed 8,800 linear feet of new sidewalk, approximately 15 city blocks (one city block is about 600 ft.), and improved 54,000 linear feet of sidewalk.

The bicycle facility improvements are shown in Table 24.

TABLE 24 BICYCLE FACILITIES IMPROVEMENTS SINCE 2013

Year	2013	2014	2015	2016	2017	2018	Since 2013
New Class I Bike Lane Miles Added					2.1	0	2.1
New Class II Bike Lane Miles Added	6.9	10.5	14.6	12.7	7.9	11.5	64.1
Existing Bike Lane Miles Improved	35.7	51.7	42.2	43.6	21.4	2.3	196.9
Existing Bike Lane Miles Replaced	1.3	1.6	-	-	-	27.9	30.8
Total Added or Improved Miles	43.9	63.8	56.8	56.8	31.4	41.7	294.4
Source: City of San Diego Transportation & Storm Water Department							

Action & Progress: Roundabouts and Traffic Signal Re-timing

The city re-timed 52 traffic signals in 2018 that led to reduced emissions from improvements to traffic flow and subsequent fuel reductions, as shown in Table 25.

TABLE 25 ROUNDABOUTS INSTALLED AND TRAFFIC SIGNALS RETIMED

Year	2016	2017	2018
Roundabouts Installed	2	0	0
52 Traffic Signals Retimed	60	70	52
City of San Diego Transportation & Storm Water Department			

STRATEGY 4: ZERO WASTE

In 2018, solid waste and wastewater emissions accounted for about 3% of the total citywide emissions. The City has a Zero Waste strategy with actions to divert waste from landfills and capture and utilize the methane from wastewater treatment.

Action & Progress: Enact Zero Waste and Divert Trash and Capture GHG Emissions from Landfills

The 2015-2018 waste disposed and diversion rates in the City are shown in Table 26. The waste diversion rate in 2018 was similar to the diversion rate in 2017, however, the waste disposal increased by 4%.

TABLE 26 WASTE DIVERSION RATE AND DISPOSED TONNAGE				
Year	**2015**	**2016**	**2017**	**2018**
Waste Disposed in Landfills (tons)	1,583,833	1,521,363	1,576,105	1,639,817
Waste Diversion Rate (%)	64%	66%	66%	65%
Tonnages were adjusted/corrected from tonnages reported in the CalRecycle database based on City information City of San Diego Environmental Service Department				

Action & Progress: Capture Methane from Wastewater Treatment

The City of San Diego's Point Loma Wastewater Treatment Plant (Point Loma WWTP) is self-sufficient with on-site renewable electricity production using biogas (captured methane from wastewater treatment) and hydropower. The excess renewable electricity generated at the Point Loma WWTP is exported back to the grid. The digester capture rate at Point Loma WWTP is now 99.9%.

STRATEGY 5: CLIMATE RESILIENCE

Increasing urban tree canopy coverage in the city contributes to the capture and storage of carbon, as well as other benefits including storm water management, improved air quality, increased property values, etc.

Action & Progress: Increase Urban Tree Canopy Coverage

The updated urban tree canopy coverage in 2015 was 13% in the City of San Diego, based on the Urban Tree Canopy Assessment preliminary results developed by the University of Vermont and the USDA Forest Service, funded by California Department of Forestry and the FITURE Protection (CalFire) for the City of San Diego. The City is tracking the number of new trees planted and tree maintenance (trimmed, pruned and or removed) by City departments (Table 27).

TABLE 27 TREE PLANTING AND MAINTENANCE	
Tree Planting and Maintenance Year	2018
Trees Planted*	1,798
Trees Trimmed (Palms Trees and Shade Trees)*	32,377
Shade Trees Pruned or Removed	8,011
*Planted by the Transportation Street Division and Parks and Recreation Department Data are for fiscal year 2018. Source: City of San Diego Transportation & Storm Water Department and Planning Department	

In addition, City also inventoried 100,000 trees and potential tree locations in 2018. Results are being evaluated for future reporting.

METHODOLOGY DIFFERENCES AND DATA REFINEMENT

The method differences and data refinements between the previous and current GHG inventory calculations are given in Table 28. The differences are primarily from updated and more accurate data sources. "No change" means no method differences or data refinements since the 2018 Annual Report.

TABLE 28 METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF GHG INVENTORY

Category	Category Detail	2017 Inventory (Published in 2018 Annual Report)	2017 Revised Inventory	2018 Inventory
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	No change	
	Emission Factor (lbs CO_2e/MWh)	Created a weighted average emission factor based on 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 eGRID2016 database specific plant level emission factor)	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 eGRID2016 database specific plant level emission factor) for SDG&E's purchased power, and b) fuel consumption (FERC Form 1 Electric Utility Annual Report) at SDG&E's owned power plants	
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	No change	
	Emission Factor (MT CO_2e/therm)	Natural gas emission factor in California based on California Air Resources Board statewide inventory	No change	

TABLE 28 METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF GHG INVENTORY				
Category	**Category Detail**	**2017 Inventory (Published in 2018 Annual Report)**	**2017 Revised Inventory**	**2018 Inventory**
Transportation	Activity (VMT)	Applied 2012-2017 annual average VMT rate of increase from CalTrans Highway Performances Monitoring System (HPMS) data to 2012 VMT estimates provided by SANDAG using Series 13 Activity Based Model 13.3.0	Applied 2016-2018 annual average VMT rate of increase from HPMS data to 2016 VMT estimates provided by SANDAG using Series 14 Activity Based Model 14.0.1	
Transportation	Emission Factor (g CO_2e/mile)	San Diego region emission rate per vehicle class from EMFAC2017 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 as not in the City	No change	
Water	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; eGRID2016 California average (CAMX)	No change	
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)	No change	

TABLE 28 METHODOLOGY DIFFERENCES AND DATA REFINEMENTS OF GHG INVENTORY

Category	Category Detail	2017 Inventory (Published in 2018 Annual Report)	2017 Revised Inventory	2018 Inventory
	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 2015 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	No change	
	Emission Factor ($MT\ CH_4$/tons)	Emission factor for each waste component from EPA WARM Model 2016 version and waste components from City of San Diego waste characterization study 2012-2013	No change	

Analysis on Jobs

To objectively identify a baseline of jobs and trends associated with these five strategies, a qualitative review of industry reports associated with these sectors was conducted, as well as a quantitative analysis of job growth within associated industry sectors. Our quantitative analysis also included additional data due to the discrepancy in the number of industries included in each sector.

Utilizing data from the Bureau of Labor Statistics (BLS), 74 industries in San Diego County were categorized into the five CAP strategies. These results are presented in Figure 7, showing the total jobs for each group by year.

The BLS estimates San Diego's jobs in the industry groups related to the CAP grew 17.6 percent from 2010 to 2018 (Figure 7). Energy and Water Efficient Buildings contributed more than 70 percent of that growth. Between 2017 and 2018, the five CAP-related industry groups added more than 5,800 jobs, an increase of 4.3 percent. Nearly four out of five new jobs came from the Energy and Water Efficient Buildings group, which grew by 6.1 percent in 2018. This job growth more than offsets the job declines seen in 2017.

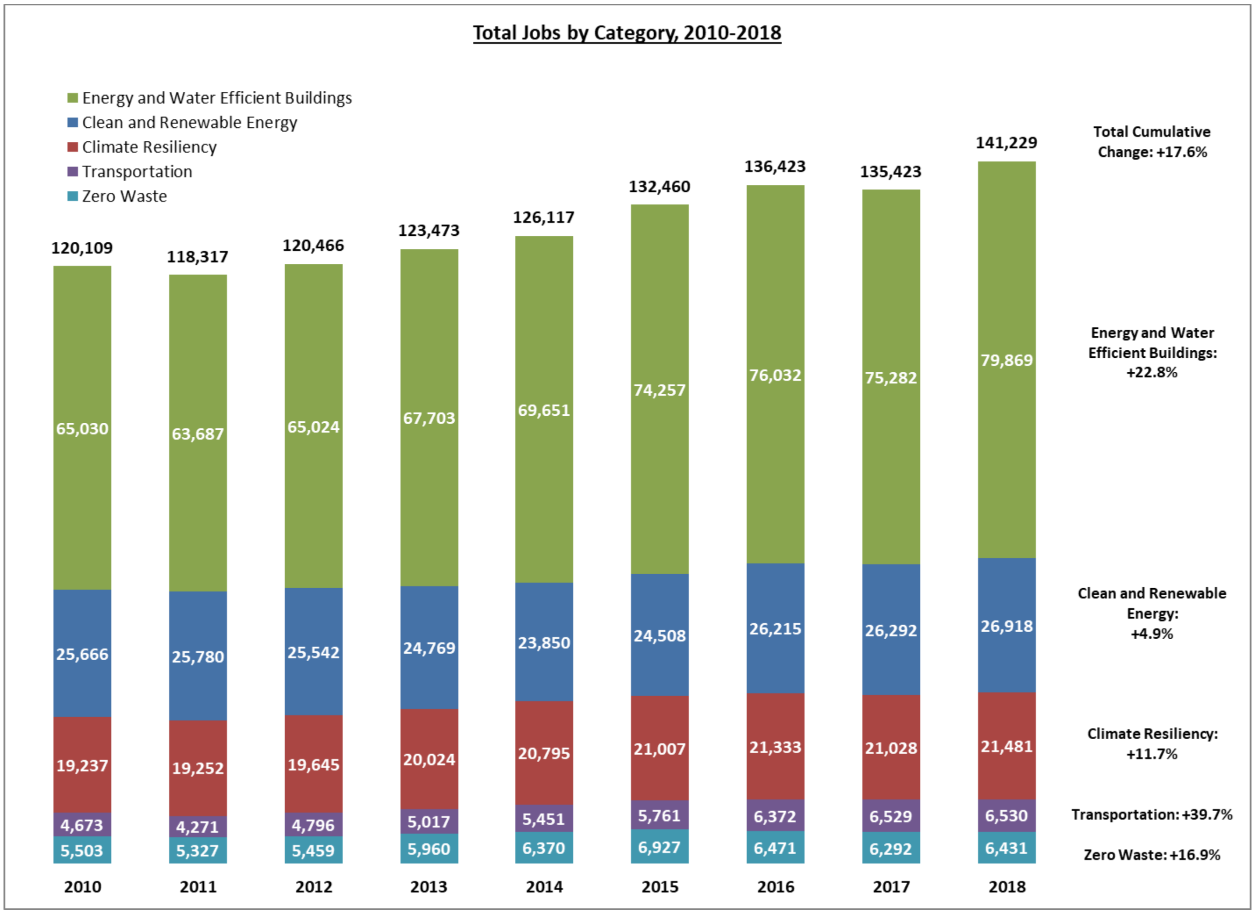
Conversely, industry reports show San Diego, and California as a whole, is experiencing job declines in Solar and Cleantech industries. According to the Cleantech Industry Cluster Economic Impact Analysis conducted by the San Diego Regional Economic Development Corporation, employment in the San Diego region's Cleantech Industry Cluster job declining by nearly 1,000 jobs. However, regional employment in the cluster remains more than twice as concentrated as the national average. In addition, the number of business establishments and average earnings both increased in 2018. [13]

According to a separate report by The Solar Foundation's 2018 National Solar Jobs Census, total employment in the solar industry declined again in 2018 both in California and in San Diego. [14] These jobs include the installation and project development, wholesale trade and distribution, operations and maintenance, as well as manufacturing.

[13] The San Diego Regional Economic Development Corporation's Cleantech Industry Cluster Economic Impact Analysis, November 2019

[14] The Solar Foundation's 2018 National Solar Jobs Census

FIGURE 7 ESTIMATED TOTAL SAN DIEGO JOBS BY CAP SECTOR BETWEEN 2010 AND 2018.



QUALITATIVE SOURCES

The San Diego Regional Economic Development Corporation's Cleantech Industry Economic Impact Analysis

- The Solar Foundation's 2018 National Solar Jobs Census
- This is Advanced Energy
- California's Golden Energy Efficiency Opportunity: Ramping up Success to Save Billions and Meet Climate Goals
- Regional Planning Unit Summary: Southern Border
- Small Businesses: Workforce Needs of Small Businesses in San Diego
- Priority Sectors: Workforce Initiatives in San Diego County
- City of San Diego Zero Waste Plan

QUANTITATIVE METHODS

Data source: Economic Modeling Specialists International (Emsi, 2019.3) www.economicmodeling.com

Summary: Emsi identifies 1,000+ industries within the San Diego Region. Seventy-four industries were categorized into five CAP industry groups and grouped within

Emsi. From those groups, Emsi output the jobs per occupations in the total of all the industries identified per CAP industry group during 2010-18. These job totals were then used to identify the growth per CAP industry group between 2010 and 2018.

To identify a baseline of total jobs within the CAP strategies over the past five years, first the industries that corresponded with each CAP industry group were identified (Table 29). No one industry was categorized into multiple CAP industry groups. Overall, 74 industries were categorized into the five industry groups; 20 industries in Energy and Water Efficient Buildings, 21 industries in Clean and Renewable Energy, eight industries in Climate Resiliency, 13 industries in Transportation and 12 industries in Zero Waste. The occupations within the corresponding CAP industry groups were identified and then the individual jobs within these occupations were totaled for each year between 2010 and 2018.

Industry Data: Emsi industry data have various sources depending on the class of worker. (1) For QCEW Employees, Emsi primarily uses the QCEW (Quarterly Census of Employment and Wages), with supplemental estimates from County Business Patterns. (2) Non-QCEW employees data are based on a number of sources including QCEW, Current Employment Statistics, County Business Patterns, BEA State and Local Personal Income reports, the National Industry-Occupation Employment Matrix (NIOEM), the American Community Survey, and Railroad Retirement Board statistics. (3) Self-Employed and Extended Proprietor classes of worker data are primarily based on the American Community Survey, Nonemployer Statistics, and BEA State and Local Personal Income Reports. Projections for QCEW and Non-QCEW Employees are informed by NIOEM and long-term industry projections published by individual states.

This report uses state data from the following agencies: California Labor Market Information Department, U.S. Bureau of Labor Statistics. This report uses state data from the following agencies: California Labor Market Information Department.

TABLE 29 INDUSTIES WITHIN EACH CAP SECTOR				
Energy and Water Efficient Buildings	**Clean and Renewable Energy**	**Climate Resiliency**	**Transportation**	**Zero Waste**
Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	Biomass Electric Power Generation	Environment, Conservation and Wildlife Organizations	All Other Transit and Ground Passenger Transportation	All Other Miscellaneous Waste Management Services
Architectural Services	Commercial, Industrial, and Institutional Electric Lighting Fixture Manufacturing	Forest Nurseries and Gathering of Forest Products	Bus and Other Motor Vehicle Transit Systems	Hazardous Waste Collection
Automatic Environmental Control Manufacturing for Residential, Commercial and Appliance Use	Electric Bulk Power Transmission and Control	Landscape Architectural Services	Commuter Rail Systems	Hazardous Waste Treatment and Disposal
Building Inspection Services	Electric Power Distribution	Landscaping Services	Highway, Street and Bridge Construction	Materials Recovery Facilities
Commercial and Institutional Building Construction	Electrical Contractors and Other Wiring Installation Contractors	Sewage Treatment Facilities	Interurban and Rural Bus Transportation	Other Nonhazardous Waste Treatment and Disposal
Engineering Services	Environmental Consulting Services	Soil Preparation, Planting and Cultivating	Mixed Mode Transit Systems	Other Waste Collection
Industrial and Commercial Fan and Blower and Air Purification Equipment Manufacturing	Geothermal Electric Power Generation	Water and Sewer Line and Related	Other Support Activities for Road Transportation	Recyclable Material

		Structures Construction		Merchant Wholesalers
Industrial Building Construction	Hydroelectric Power Generation	Water Supply and Irrigation Systems	Other Urban Transit Systems	Remediation Services
Industrial Design Services	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals		Rail transportation	Solid Waste Collection
New Housing For-Sale Builders	Mechanical Power Transmission Equipment Manufacturing		School and Employee Bus Transportation	Solid Waste Combustors and Incinerators
New Multifamily Housing Construction (except For-Sale Builders)	Natural Gas Distribution		Support Activities for Rail Transportation	Solid Waste Landfill
New Single-family Housing Construction (except For-Sale Builders)	Nuclear Electric Power Generation		Taxi Service	Used Merchandise Stores
Plumbing and Heating Equipment and Supplies (Hydronics) Merchant Wholesalers	Other Electric Power Generation		Transportation Equipment and Supplies (except Motor Vehicle) Merchant Wholesalers	
Plumbing, Heating and Air-Conditioning Contractors	Pipeline Transportation of Natural Gas			
Relay and Industrial Control Manufacturing	Power and Communication Line and Related Structures Construction			
Research and Development in the Physical, Engineering and Life Sciences (except Biotechnology)	Power, Distribution and Specialty Transformer Manufacturing			

Residential Electric Lighting Fixture Manufacturing	Semiconductor and Related Device Manufacturing			
Residential Remodelers	Solar Electric Power Generation			
Steam and Air-Conditioning Supply	Storage Battery Manufacturing			
Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers	Turbine and Turbine Generator Set Units Manufacturing			
	Wind Electric Power Generation			

TABLE 30 NUMBER OF JOBS/INDUSTRY PER CAP INDUSTRY GROUP 2010 TO 2018					
	Energy and Water Efficient Buildings	**Clean and Renewable Energy**	**Climate Resiliency**	**Transportation**	**Zero Waste**
2010	65,030	25,666	19,237	4,673	5,503
2011	63,687	25,780	19,252	4,271	5,327
2012	65,024	25,542	19,645	4,796	5,459
2013	67,703	24,769	20,024	5,017	5,960
2014	69,651	23,850	20,795	5,451	6,370
2015	74,257	24,508	21,007	5,761	6,927
2016	76,032	26,215	21,333	6,372	6,471
2017	75,282	26,292	21,028	6,529	6,292
2018	79,869	26,918	21,481	6,530	6,431

TABLE 31 NUMBER OF INDUSTRIES AND OCCUPATIONS (WITH EMPLOYMENT) PER CAP INDUSTRY GROUP					
	Energy and Water Efficient Buildings	**Clean and Renewable Energy**	**Climate Resiliency**	**Transportation**	**Zero Waste**
Industries	20	21	8	13	12
Occupations	570	443	436	245	310

TABLE 32 PERCENT CHANGE IN JOBS FROM 2010 TO 2018					
	Energy and Water Efficient Buildings	**Clean and Renewable Energy**	**Climate Resiliency**	**Transportation**	**Zero Waste**
2010-11	-2.1	0.4	0.1	-8.6	-3.2
2011-12	2.1	-0.9	2.0	12.3	2.5
2012-13	4.1	-3.0	1.9	4.6	9.2
2013-14	2.9	-3.7	3.9	8.7	6.9

2014-15	6.6	2.8	1.0	5.7	8.7
2015-16	2.4	7.0	1.6	10.6	-6.6
2016-17	-1.0	0.3	-1.4	2.5	-2.8
2017-18	6.1	2.4	2.2	0.0	2.2
2010-18	**22.8**	**4.9**	**11.7**	**39.7**	**16.9**

City of San Diego's Climate Equity Index Report

2019

Climate Equity Index Report

CONTENTS

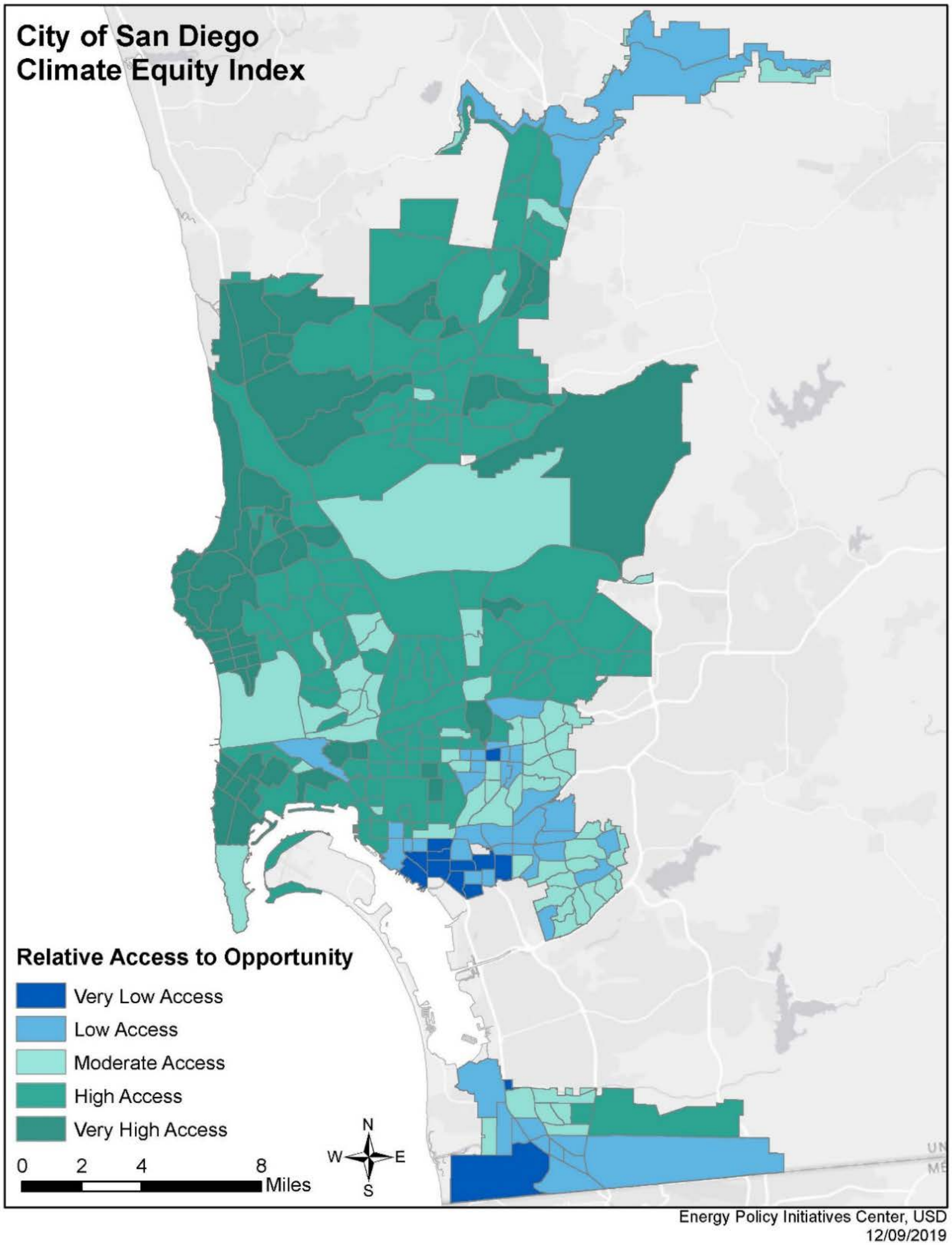
EXECUTIVE SUMMARY

Historically in San Diego, as in most cities, some communities have been afforded greater access to opportunity than others over many years of growth and development. The City of San Diego's 2015 Climate Action Plan (CAP) established an opportunity to address environmental justice and social equity concerns - collectively referred to as climate equity – when addressing climate change. This direction, and the CAP overall, supports the City's General Plan which provides policies to pursue environmental justice in the planning process through greater community participation. It also establishes the need to prioritize and allocate citywide resources which provide public facilities and services to communities in need, and to improve mobility options and accessibility for the non-driving elderly, disabled, low-income, and other members of the population. The City has identified these communities as Communities of Concern.

To better understand our Communities of Concern, and to establish benchmarks and metrics to serve as a citywide assessment of climate equity, the City's Sustainability Department and the University of San Diego Energy Policy Initiatives Center (EPIC) created the first-of-its-kind Climate Equity Index (CEI). San Diego's CEI assessed all 297 census tracts that intersect with the City and developed standardized indicators to calculate a CEI score from 0-100 for each tract that can be compared to the score of other tracts.

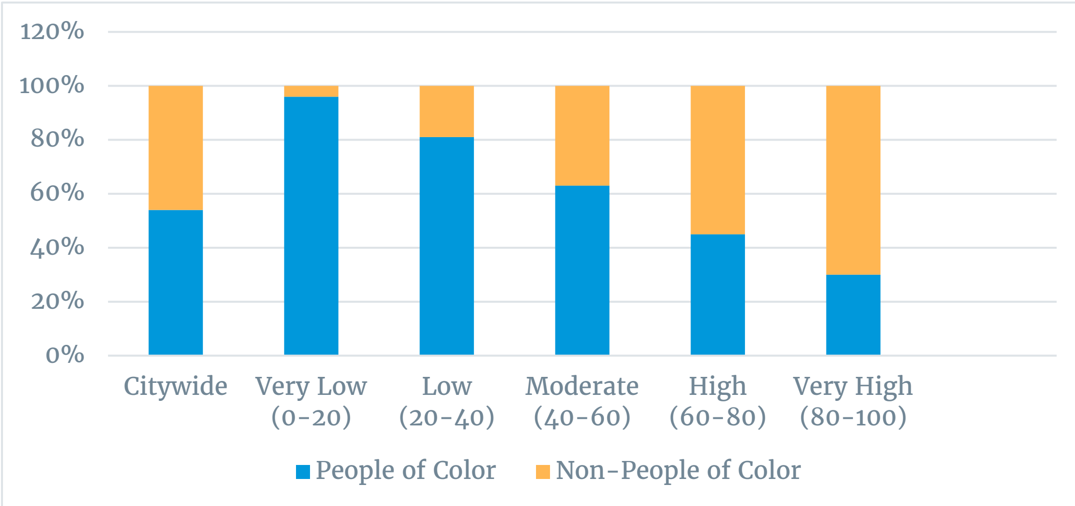
Critical to this effort was collaboration with community stakeholders. To this end, the City worked with community-based organizations to form an Equity Stakeholder Working Group. Thirty-five (35) indicators were selected to measure equity across the City based on input from the Work Group and research on nationwide best practices. Based on this assessment, the average CEI score for the City was determined to be 61. Census tracts that scored below the average are considered to have less access to opportunity than the tracts that scored above the average. In total, 172 census tracts scored at or above the average, indicating high to very high access to opportunity, while 125 tracts scored below average with very low, low or moderate access to opportunity. This is represented in Figure 1 below.

Figure 1. Climate Equity Index Scores Across the City of San Diego



The CEI also highlights racial inequities within the City as a disproportionate number of people of color are concentrated in census tracts with very low to moderate access to opportunity. Seventy three percent (73%) of residents within these census tracts identify as people of color, compared to 40% of residents in tracts with high to very high access to opportunity. Overall 54% of the population of the City identify as people of color. Figure 2 shows the percentage of people of color per census tract category as identified in the CEI.

Figure 2. Percent of People of Color by Census Tract Performance



Thirteen (13) census tracts were identified as having very low access to opportunity, in which 96% identify as people of color. These tracts are in the neighborhoods of Barrio Logan, Lincoln Park, Nestor, the Tijuana River Valley, Logan Heights, Palm City, Mountain View, Stockton, Grant Hill, Southcrest, Teralta East and Shelltown.

Forty-eight (48) census tracts were identified as having low access to opportunity, with an average of 81% identifying as people of color. Sixty-four (64) tracts were identified as having moderate access to opportunity, with an average of 63% of their population identifying as people of color.

While race was not identified as an indicator within the CEI, the index highlights racial inequities the City can address through our climate actions and efforts to address climate equity.

After analyzing the results of the CEI assessment, including feedback from the Equity Stakeholder Working Group, City staff recommends the following actions:

RECOMMENDATION 1: Seek grant funding opportunities to support community engagement and invest in areas with very low to moderate access to opportunity.

RECOMMENDATION 2: Conduct public engagement efforts, in partnership with community-based organizations, in census tracts with very low access to opportunity.

RECOMMENDATION 3: Explore the feasibility of establishing a sustainability ambassador program in areas with a very low to moderate access to opportunity to improve participation in City planning.

RECOMMENDATION 4: Determine mechanisms to incorporate climate equity into City programs and projects.

RECOMMENDATION 5: Refresh data within San Diego's Climate Equity Index every five years.

Taking these recommended actions ensures the City is moving in the right direction to address climate equity when implementing the CAP and that the City is a world leader when planning for our City’s future.

BACKGROUND

THE CLIMATE ACTION PLAN AND COMMUNITIES OF CONCERN

On December 15, 2015, the City of San Diego adopted its Climate Action Plan (CAP), setting forth five strategies that could achieve the goal of reducing greenhouse gas (GHG) emissions 50% by 2035. As stated within the document, "the benefits of the CAP are intended to be shared equally, fairly and with lack of prejudice among all persons citywide." The City recognizes the importance of ensuring all San Diegans receive the opportunities associated with the implementation of the CAP.

The CAP used the term "disadvantaged communities" to describe what the City now refers to as Communities of Concern, to be within census tracts in the top 30th percentile of the California Office of Environmental Health Hazard Assessment's CalEnviroScreen 3.0 (CalEnviroScreen) tool, census blocks eligible for Community Development Block Grants, and areas within a half-mile radius of affordable housing. A map of San Diego's Communities of Concern is included in Appendix A.

Additionally, the City's General Plan, which the CAP serves as mitigation to, includes policies that prioritize and allocate citywide resources to provide public facilities and services to communities - including those in need that improve mobility options and accessibility for the non-driving elderly, disabled, low-income, and other members of the population. City staff takes this as a directive to ensure we prioritize Communities of Concern when looking at investing in CAP projects and programs.

CLIMATE EQUITY

To address environmental justice and social equity, the City recognizes these two concepts are incorporated in the term "climate equity". The City worked with community-based organizations (CBOs) to define climate equity as efforts addressing historical inequities suffered by people of color, allowing everyone to fairly share the same benefits and burdens from climate solutions and attain full and equal access to opportunities regardless of one's background and identity.

CLIMATE EQUITY

Addressing historical inequities suffered by people of color, allowing everyone to fairly share the same benefits and burdens from climate solutions and attain full and equal access to opportunities regardless of one's background and identity.

Throughout the nation, vulnerable populations are hit hardest by climate change.[15] As the City continues to plan to address those impacts it is imperative that decision-making tools are created and utilized to better understand how to respond more effectively in communities that need it most.

To attain climate equity, the City recognizes the need to acknowledge where disparities exist and identify ways to redress those disparities. The City developed the CEI, along with stakeholders representing San Diego's Communities of Concern, to provide a data-backed method to understand the inequities experienced by these communities.

STAKEHOLDER ENGAGEMENT

The first step to addressing climate equity is to include Communities of Concern in the decision-making process. To do so, the City has established an informal Climate Equity Stakeholder Working Group to provide feedback and input on decisions for how the CEI was developed. This group may reconvene beyond the completion of the CEI to provide input on overall CAP implementation. The stakeholder group was integral in advising the City on the working definition of climate equity and provided input on how to measure climate equity in the City and the recommendations of this report.

The Equity Stakeholder Working Group is comprised of 34 CBOs that serve San Diego's identified Communities of Concern. A list of the Equity Stakeholder Working Group members is available in the Acknowledgements section of this report.

CLIMATE EQUITY INDEX

San Diego's Climate Equity Index (CEI) was developed to measure the level of access to opportunity residents have within a census tract, and assess the degree of potential impact from climate change to these areas. For example, some census tracts have a higher level of access to opportunity as a result of greater access to public transit stops and pedestrian amenities, such as sidewalks and streetlights, or they spend a lower percentage of their income on housing, energy, and transportation costs. These populations face relatively fewer barriers to commute to school or work or to invest in newer energy conservation technologies.

The City's CAP committed staff to develop the methodology for reporting on equity related to the CAP[16]. To fulfill that commitment, the CEI identifies the level of access to opportunity for residents and provides the City with a tool to measure inequity. With the development of the CEI, the City can prioritize the areas with the least access to opportunity and begin dismantling the historic barriers that have caused the disparities in the City's Communities of Concern. The CEI can also be a tool to identify other areas that should be included in the Communities of Concern definition.

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[15] Making Equity Real in Climate Adaption and Community Resilience Policies and Programs: A Guidebook (2019)
[16] City of San Diego Climate Action Plan (2015), Pg. 43

METHODOLOGY

INDICATORS

City staff researched nationwide best practices, reviewed available sources of data, and obtained input from the Equity Stakeholder Working Group to measure equity across the City. A total of 35 indicators were selected for the CEI. In deciding on the final list of indicators, the City worked with the Equity Stakeholder Working Group and assessed each indicator with the following guidelines:

- **Equity Focus –** data identifies and represents equity issues within the City
- **Climate Focus –** data has a close connection to the City's Climate Action Plan
- **Clear Connection –** the relationship between the indicator and climate equity is clearly understood
- **Data Integrity –** quality data is available from reliable and trustworthy sources
- **Data Update Frequency –** the frequency of data updates should permit regular, future updates to the CEI and allow for indicator(s) to be tracked over time

All indicators fall into one of five broader categories: environmental, socioeconomic, housing, mobility and health. The indicators that pertain to each category are identified in Table 1, in no particular order, along with a description of what was measured for each. For further discussion of individual indicators, refer to Appendix **B**.

Table 1. Climate Equity Index Indicators

#	Indicator	Description
Environmental Indicators		
	Flood Risk*	Percent of census tract within the 100-year flood plain and/or predicted to experience inundation during a 100-year storm surge event given a 2-meter rise in sea level
	Fire Risk*	Percent of the census tract classified under the very high fire hazard severity zone
	Tree Coverage*	Percent of tree canopy coverage
	Urban Heat Island Index	Increase in temperature due to urban heat island (UHI) effect
	Proximity to Community Recreation Areas*	Number of recreation areas (parks, open space, beaches, libraries, and recreation centers) within 1/2 mile of populated neighborhoods
	Proximity to Waste Sites*	Average distance to the nearest waste site (includes hazardous waste generators and facilities, facilities with documented toxic releases, solid waste sites and facilities, and cleanup sites)

Pesticide Use	Total pounds of selected pesticides used in production-agriculture per square mile as calculated by CalEnviroScreen 3.0
Drinking Water Contaminants	Average concentration of contaminants within drinking water systems as calculated by CalEnviroScreen 3.0
Groundwater Threats	CalEnviroScreen 3.0 groundwater threat scores for census tracts based on type of pollution site and location to populated neighborhoods
Impaired Water Bodies	Number of pollutants across all water bodies designated as impaired within the census tract as calculated by CalEnviroScreen
Socioeconomic Indicators	
Unemployment	Unemployment rate (percent of population unemployed)
Educational Attainment	Percent of population over age 25 with less than a high school education
Linguistic Isolation	Percent of households that are limited English-speaking households
Digital Access	Percent of households without internet access
Median Income	Estimated median household income in the past 12 months
Poverty Rate	Percent of population with income below 300% of the federal poverty level
Change in Income*	Five-year annual percent change in median household income
Energy Cost Burden*	Three-year average annual cost of energy as a percent of the median household income
Solar Photovoltaic Systems*	Number of solar photovoltaic systems per capita
Housing Indicators	
Housing Cost Burden	Median housing cost as a percent of median income
Overcrowdedness	Percent of housing units with greater than 1.00 occupants per room
Mobility Indicators	
Pedestrian Access*	A combination of average Walk Score, miles of sidewalk, number of streetlights, and pedestrian-vehicle collisions
Commute Burden*	Percent of population with commute time over the regional average (30 minutes for commuting by car and 45 minutes for commuting by mass transit)
Transportation Cost Burden	Median household transportation cost as a percentage of median household income
Disability	Percent of population with a disability
Street conditions*	Weighted average Overall Condition Index (OCI) score

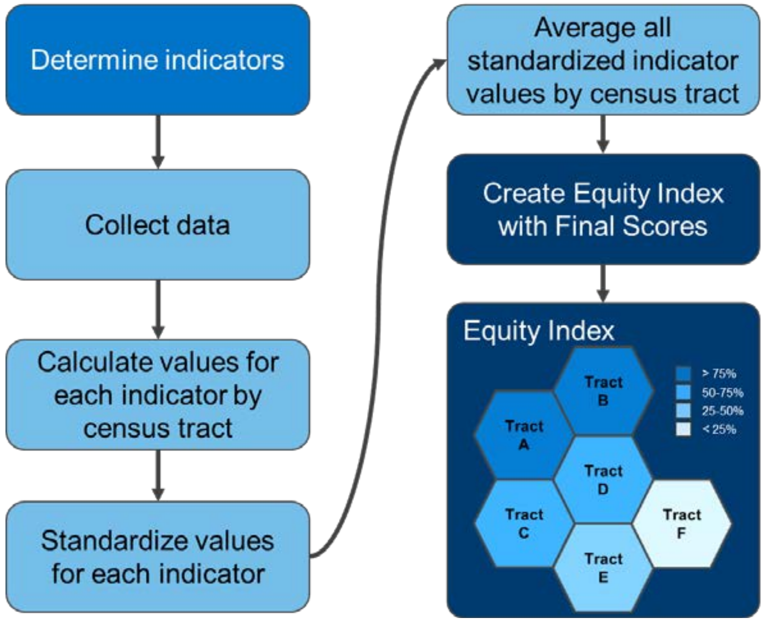
Bikeability*	Weighted average Bike Score
Access to Public Transit*	Average distance to the nearest transit stop
Traffic Density	Traffic volume divided by total road length as calculated by CalEnviroScreen 3.0
Electric Vehicle Charging Infrastructure*	Number of publicly available charging stations (includes Level 2 and DC fast chargers)
Health Indicators	
Asthma Rates*	Rate of emergency department visits due to asthma
Cancer Fatalities*	Percent of total deaths that are cancer related
Healthy Food Access*	Percent of population with low access to healthy food (> 1/2 mile for urban census tracts and >10 miles for rural census tracts)
Low Infant Birth Weight	Percent of full term births (37 weeks of gestation) with a birthweight less than 2,500 grams
Heart Attack Fatalities*	Percent of total deaths that are heart attack-related

**Denotes data needing additional calculation to aggregate at the census tract level.*

INDEX CALCULATION

The CEI is based on census tracts, the smallest geographical area for which most indicator data is available or can be reasonably derived from a larger area. Every tract receives a value for each of the 35 indicators and these values are then used to determine its CEI score. General methods for this process are identified in Figure 3 and are further detailed in Appendix B.

Figure 3. General Climate Equity Index Methods



Data was collected at the census tract level, where available. Data not aggregated at the census tract level required additional calculations (see Appendix B for further details) and are noted in Table 1 above with an asterisk (*).

Next, all indicator values were standardized into z-scores, maintaining the relative difference in scores across census tracts while allowing for calculations across indicators. Final CEI scores were obtained by averaging all z-scores for a particular census tract and then indexing those scores to a value between 0-100 for easier interpretation of the results.

LIMITATIONS

While the CEI highlights areas of concern for the City to focus on when addressing climate equity, there are some limitations that need to be acknowledged when taking the CEI into consideration.

GEOPOLITICAL BOUNDARIES

Ideally, CEI scores would be calculated at the smaller, more localized census block level. Census tracts contain multiple census blocks. However, currently available data restricts the geographic scale to the census tract level, therefore, the CEI scores represent data at the census tract level. Assigning fixed geographic boundaries permits CEI scores to be compared to the demographics of each tract; however, the benefits and/or burdens experienced are not always bound to these specific geographic areas. For instance, facilities and amenities offered in one census tract may be easily accessible to residents in neighboring census tracts, as well. Conversely, if a hazardous waste site is located on the border of one tract, the potential pollution burden will be shared with the other tracts it borders even if the facility does not operate within them.

Census tract boundaries do not adhere to jurisdictional boundaries or other planning boundaries used by the City, as in Community Plan Areas for example. There are also multiple census tracts shared between the City of San Diego and one or more neighboring jurisdictions. Since most data were collected at the census tract level, CEI scores for these tracts reflect conditions across the entire tract, not just the portion located within the City.

DATA AVAILABILITY

There are several limitations that involve data availability that either restrict the potential for regular updates going forward or prevented the inclusion of certain indicators into the CEI. In assessing the City's tree canopy coverage, for example, there is currently no planned update to the 2014 data used to calculate CEI scores. Still, the stakeholder group felt this was an extremely important indicator since it is directly tied to the CAP. The CEI relies on other indicators that receive updates irregularly and may cause some uncertainty. This can potentially limit the ability of regular CEI updates to track how indicators, like tree canopy, change over time.

Some indicators proposed in discussion with the Equity Stakeholder Working Group were not included in this analysis due to a lack of data. For instance, air quality was suggested as a health indicator. While some regional data are available, there is currently no accurate way to assess air quality on a census tract level across the City. While the City acknowledges the importance of monitoring air quality, the current data available does not lend itself to be used for a citywide assessment and therefore was not included in the CEI.

While the City acknowledges these limitations, it maintains confidence in the CEI to accurately measure climate equity within the City of San Diego. As better data becomes available for our citywide assessment, City staff will work with the Equity Stakeholder Working Group to determine if additional indicators should be included in the CEI and assess any future need to adapt methods.

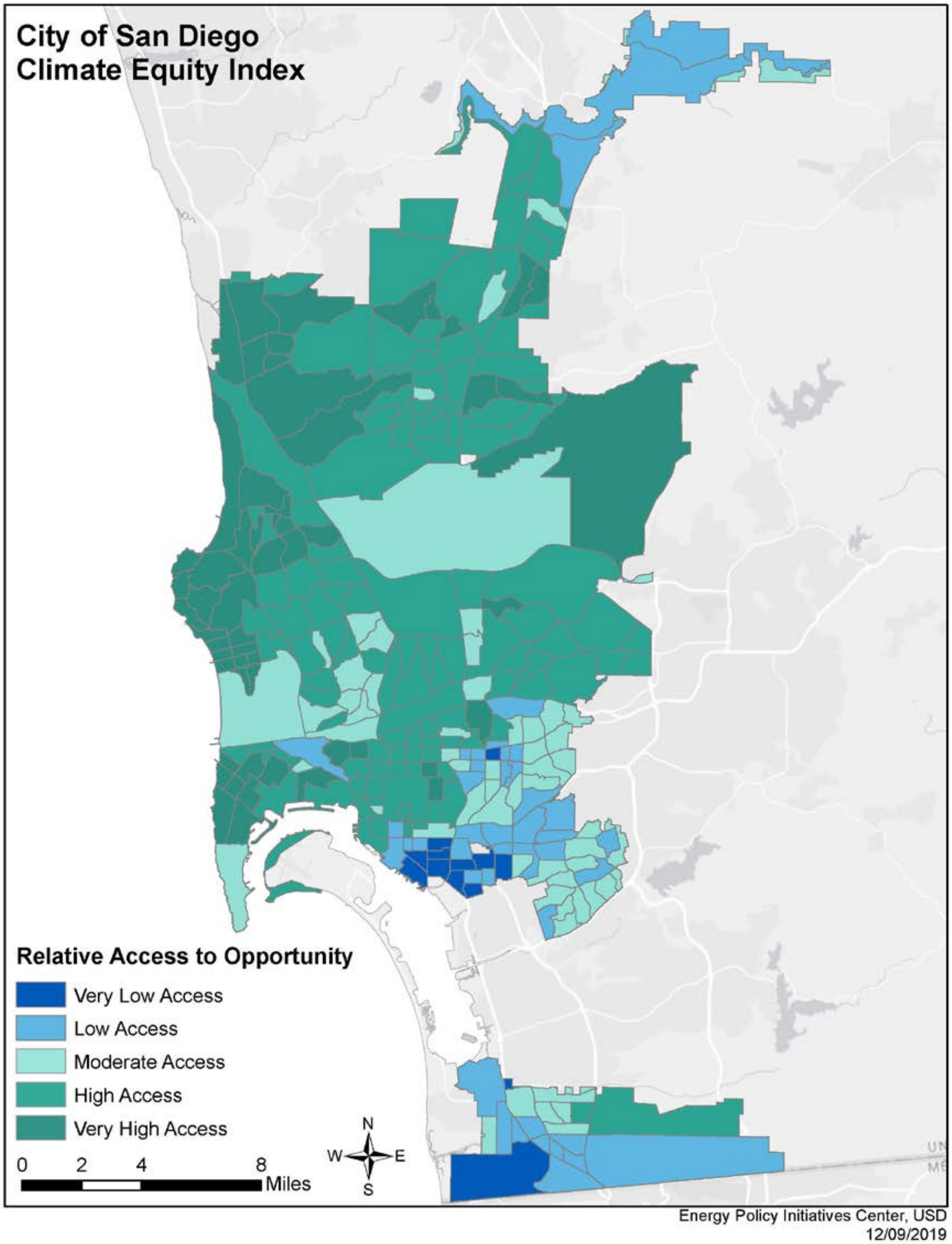
FINDINGS

Figure 1 highlights the results of the CEI. Each of the 297 census tracts within the City has been assigned a score between 0 and 100, based on how each tract scores across all indicators. Scores illustrate the relative difference between census tracts, with the census tract performing the best across all indicators scoring the highest (100) and the tract performing least best across all indicators, the lowest (0). Scores for other census tracts are scaled to demonstrate their performance relative to the highest and lowest scoring tracts.

Five categories were developed to represent CEI scores and better identify the relative differences in access to opportunities among census tracts.

- CEI score of 0-20: very low access to opportunity;
- CEI score of 20-40: low access to opportunity;
- CEI score of 40-60: moderate access to opportunity;
- CEI score of 60-80: high access to opportunity; and
- CEI score of 80-100: very high access to opportunity.

Figure 1. Climate Equity Index Scores Across the City of San Diego

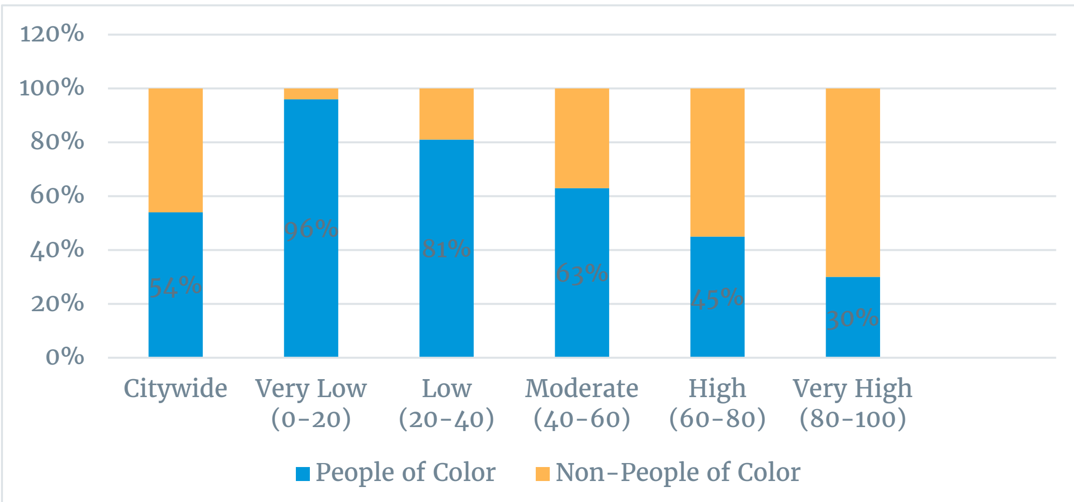


The average CEI score across the City is 61, with a standard deviation of 21. A majority of the City's tracts (171 or 58%) scored at or above the average, demonstrating high to very high access to opportunity. Relative to other tracts in the City, San Diegans living within these tracts face fewer barriers to improve their quality of life and enjoy a higher access to opportunities to improve their lifestyle. However, this still leaves many San Diegans facing higher barriers and with less opportunity.

Meanwhile, 125 census tracts within the City that show very low to moderate access to opportunity. Below are a few demographic key points.[17]

- Census tracts with a below average CEI score represent 42% of the total population in all census tracts included in the analysis.
- The 13 census tracts with the least access to opportunity are in the neighborhoods of Barrio Logan, Lincoln Park, Nestor, the Tijuana River Valley, Logan Heights, Palm City, Mountain View, Stockton, Grant Hill, Southcrest, Teralta East and Shelltown.
- The data shows that there is a disproportionate amount of people of color in our below average tracts, as shown in Figure 2.

Figure 2. Percent of People of Color by Census Tract Performance



  - The average percent of people of color in all the San Diego census tracts is 54%. In census tracts below average, the percent of people of color is 73%.
  - Within the 13 census tracts with very low access to opportunity, 96% of residents identify as people of color.
  - Within the 48 census tracts with low access to opportunity, 81% identifying as people of color.
  - Within the 64 tracts with moderate access to opportunity, 63% identifying as people of color.
  - Within the 116 tracts with high access to opportunity, 45% identify as people of color.
  - Within the 56 tracts with very high access to opportunity, 31% identify as people of color.

[17] Demographic data is based on the U.S. Census Bureau's 2017 American Community Survey 5-year estimate. For census tracts that are shared between the City and another jurisdiction, demographic data represents the entire census tract, not just the portion within the City of San Diego.

RECOMMENDATIONS

Implementation of the CAP affords the City of San Diego the chance to increase access to opportunity in Communities of Concern and become a leader in addressing climate equity. Progress is possible and the City is taking its first major step in acknowledging concerns and moving forward with bold actions to address climate equity.

Addressing climate equity is a multi-faceted task and a relatively new discipline for municipalities and governments to tackle. While there are some examples of success across the nation, due to the diverse nature of our communities, any approach the City takes to address climate equity will require unique solutions developed in close coordination with our communities. Staff recommends the following actions to begin addressing climate equity in the City.

RECOMMENDATION 1: SEEK GRANT FUNDING OPPORTUNITIES TO SUPPORT COMMUNITY ENGAGEMENT AND INVEST IN AREAS WITH VERY LOW TO MODERATE ACCESS TO OPPORTUNITY

Effective outreach and engagement in our Communities of Concern require resources and innovative, non-traditional methods. The City should seek out grants and other funding opportunities that support our efforts, as well as those by stakeholder organizations, that focus on activating, organizing and engaging residents within the communities with very low to moderate access to opportunities. The City can partner with community groups to identify and apply for grants that support our mission of engaging communities and empowering them when it comes to CAP projects and programs that could benefit our Communities of Concern.

RECOMMENDATION 2: CONDUCT PUBLIC ENGAGEMENT EFFORTS, IN PARTNERSHIP WITH COMMUNITY-BASED ORGANIZATIONS, IN CENSUS TRACTS WITH VERY LOW ACCESS TO OPPORTUNITY

The solutions to reducing the City's GHG emissions in Communities of Concern should be done in consultation with stakeholders. Steps should be taken by City staff to prioritize public engagement activities in census tracts with very low access to opportunity. Due to the diversity of backgrounds and demographics, the City should consider partnering with CBOs that currently work in and have relationships with community members that reside in these census tracts.

Engagement should center around education on the City's CAP goals and climate equity, and seek input from residents on projects that help address climate change and reduce GHG emissions.

RECOMMENDATION 3: EXPLORE THE FEASIBILITY OF ESTABLISHING A SUSTAINABILITY AMBASSADOR PROGRAM IN AREAS WITH VERY LOW TO MODERATE ACCESS TO OPPORTUNITY

One way to strengthen our communities and provide equal access is to invest in cultivating community leaders and empowering them to become sustainability ambassadors. Partnering with CBOs and local universities, the City can look to establish a Sustainability Ambassador program, empowering residents by demonstrating the importance of sustainability and climate equity, and providing them with the tools to effect change and educate their fellow community members. This would also improve the relationship between the City and our diverse communities.

RECOMMENDATION 4: DETERMINE MECHANISMS TO INCORPORATE CLIMATE EQUITY INTO CITY PROGRAMS AND PROJECTS

The City should move forward in a coordinated effort to address climate equity, as it intersects with various City Departments. A policy can be developed to provide guidance on how best to incorporate climate equity into City operations and ensure every department is prioritizing Communities of Concern.

The City can also assess other mechanisms to help dismantle barriers our communities face to become more civically engaged and to become a part of the decision-making process, internally and, where applicable, with other agencies within the City. This process should also identify and include specific mechanisms to intergrate climate equity into resiliency and adaptation plans and future climate action planning updates.

RECOMMENDATION 5: REFRESH DATA WITHIN SAN DIEGO'S CLIMATE EQUITY INDEX EVERY FIVE YEARS

The City continues its commitment to include a progress report on the CAP to update the public on the actions taken to address climate equity. To ensure the City is moving in the right direction, a data refresh of the CEI should also be done every five years to measure progress in achieving climate equity goals and potentially revisit based on new information.

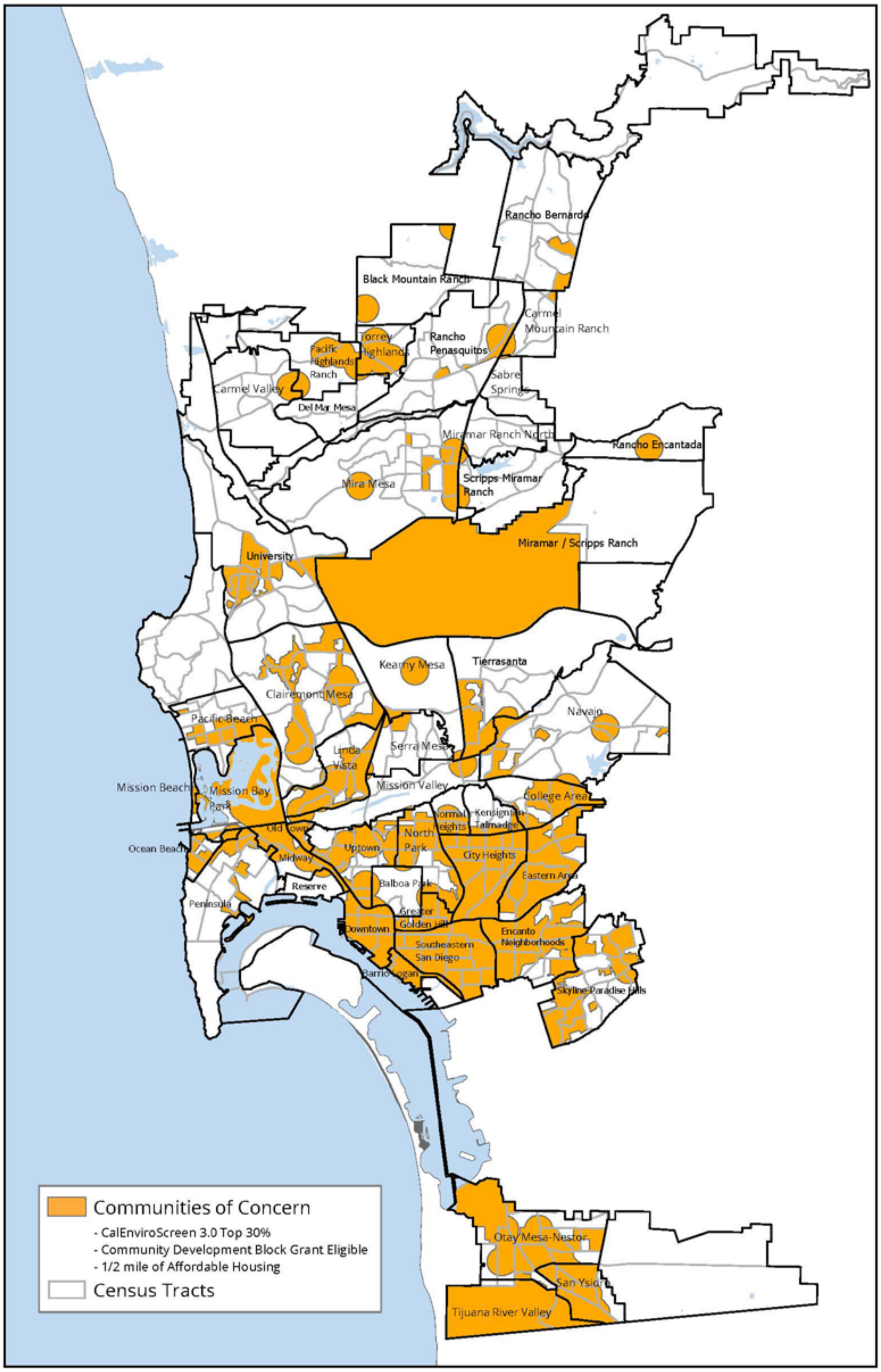
ACKNOWLEDGEMENTS

The following organizations comprised the City's informal Equity Stakeholder Working Group. We thank every organization for their involvement and contribution of time and input in establishing the City's Climate Equity Index.

- Alliance San Diego
- Bayside Community Center
- Business For Good
- Casa Familiar
- Center for Sustainable Energy
- Circulate San Diego
- City Heights CDC
- Climate Action Campaign
- Environmental Health Coalition
- GRID Alternatives
- Groundworks San Diego
- I Am My Brother's Keeper CDC
- Mid-City CAN
- Nile Sisters Development Initiative
- Partnership for the Advancement of New Americans (PANA)
- Project New Village
- RISE San Diego
- San Diego 350
- San Diego EDC
- San Diego Housing Federation
- The Greenlining Institute
- The San Diego Foundation
- Urban Collaborative Project

City of San Diego's Climate Action Plan Identified

Communities of Concern



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SD sustainability

City of San Diego
Climate Equity Index Methods

November 2019

Prepared for the City of San Diego

Prepared by the Energy Policy Initiatives Center

ENERGY POLICY INITIATIVES CENTER
UNIVERSITY OF SAN DIEGO SCHOOL OF LAW

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About EPIC

The Energy Policy Initiatives Center (EPIC) is a non-profit research center of the USD 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 educating law students.

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

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TABLE OF CONTENTS

Introduction

This report provides a summary of the methods and indicators used to calculate the Climate Equity Index (CEI) for the City of San Diego (City).

Section 2 provides discussion on the methods used for the analysis. Section 3 provides discussion on each of the 35 indicators used in the analysis including: what was measured, data source(s) used, indicator specific methods, and potential limitations.

General Methods

The CEI is based at the census tract level, where each tract receives a value for each indicator and its 35 indicator values are then used to determine its CEI score. General methods for this process are identified in Figure 8.

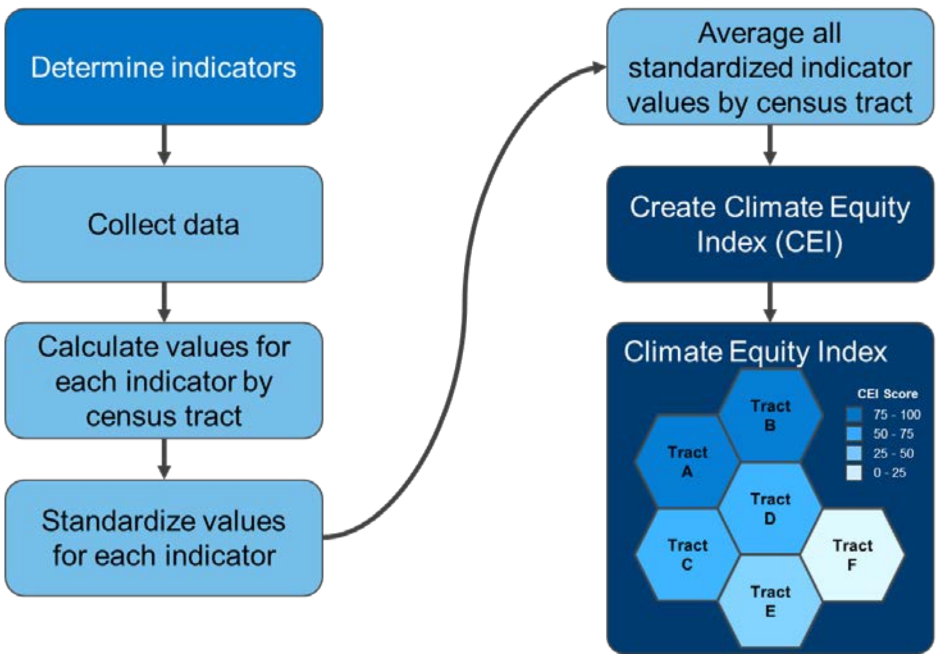

Figure 8. General Climate Equity Index Methods

Indicators were identified through discussion with City staff and the Equity Stakeholder Working Group (ESWG). The following sections detail the methods identified in Figure 8 to calculate CEI scores.

Data Collection

Data were collected for all indicators based on certain criteria to maintain the integrity of the CEI. Key criteria include:

- Data should be available at the census tract level for the entire City of San Diego or in a manner that can be transformed to the census tract level;
- Data should meaningfully represent its corresponding indicator in the context of the CEI; and
- Data should be current with an emphasis on sources that are frequently updated or planned to be updated.

Some indicators were identified by the City and ESWG that did not meet one or more of the criteria above (e.g., air quality); these indicators were not included in the CEI with the understanding that they may be included at a later date should better data become available.

Calculating Individual Indicator Values

Once data were collected for indicators, aggregate indicator values were calculated for each census tract. For some indicators, the data collected were available at the census tract level and required few or no further modifications. For instance, data collected from the U.S. Census Bureau's American Community Survey (ACS) is provided at the census tract level. This includes many of the socioeconomic indicators such as median income, unemployment rate, and digital access. For indicators where data was not available by census tract, additional calculations were necessary to determine values for each tract. More details on indicator specific calculations are provided in Section 3 of this report.

Standardizing Indicators

Once values were calculated for each indicator at the census tract level, they were standardized so that indicators could be compared to one another. The reason for standardizing the indicators is that they are each measured in different units. For instance, median income is measured in dollars per household and fire risk is measured in percent area. By standardizing, the indicators are converted to a common scoring system that allows for an "apples to apples" comparison and permits calculations necessary to aggregate indicators into an overall CEI score (Figure 9).

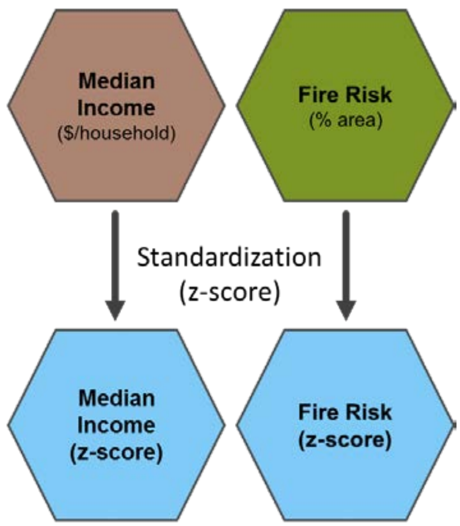

Figure 9. Standardization of Indicators

Indicators were standardized using z-scores. A z-score is a statistical measure that identifies how many standard deviations a value is from the mean. In other words, how far a given value is from the average. Z-scores maintain the magnitude in differences between values and acts as a common metric between datasets with different units. Z-scores were calculated for each census tract indicator value using Equation 1.

Equation 1. Z-score Formula

$$z_{ij} = \frac{x_{ij} - \mu_i}{\sigma_i}$$

Where,

x_{ij} = value for indicator i for census tract j

μ_i = average for indicator i

σ_i = standard deviation for indicator i

Calculating CEI Scores

Once z-scores were calculated for all census tracts across all indicators, indicators could be combined into a single census tract value. This was done by averaging all z-scores for each census tract (**Figure 10**). Z-scores were averaged instead of summed to avoid penalizing census tracts that may have had data missing for one or more indicator.

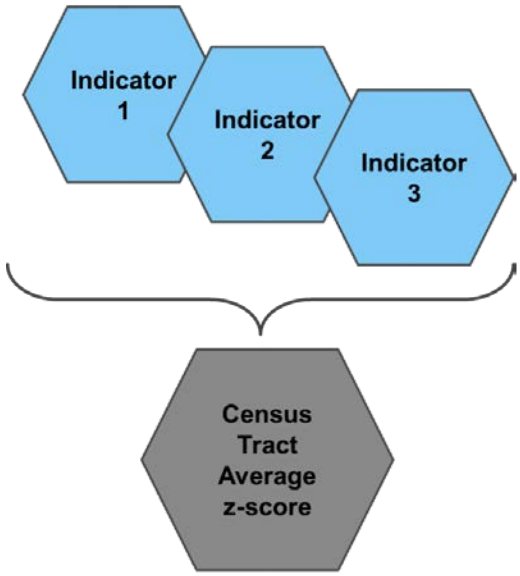

Figure 10. Average Census Tract Z-score

Average z-scores were indexed to a scale of 0-100 (the Climate Equity Index) for easier interpretation. This indexing was done using **Equation 2**.

Equation 2. Z-score Formula

$$Score_j = \frac{(index_{max} - index_{min})}{(z_{max} - z_{min})} * (z_j - z_{min}) + index_{min}$$

Where,

$Score_j$ = CEI score for census tract j
$index_{max}$ = maximum possible index value (100)
$index_{min}$ = minimum possible index value (0)
z_{max} = maximum value for all average z-scores
z_{min} = minimum value for all average z-scores
z_j = mean z-score for census tract j

To prevent outliers from skewing results, average z-scores greater than three standard deviations from the mean were removed from indexing calculations and automatically assigned either the highest (100) or lowest (0) index value depending on its relationship to the mean.

Indexed scores illustrate the relative difference between census tracts, with the census tract performing the best across all indicators scoring the highest (100) and the tract performing the lowest, the worst (0). Scores for other census tracts are scaled to demonstrate their performance relative to the highest and lowest scoring tracts. **Figure 11** is an illustrative example of how CEI scores can be mapped across census tracts.

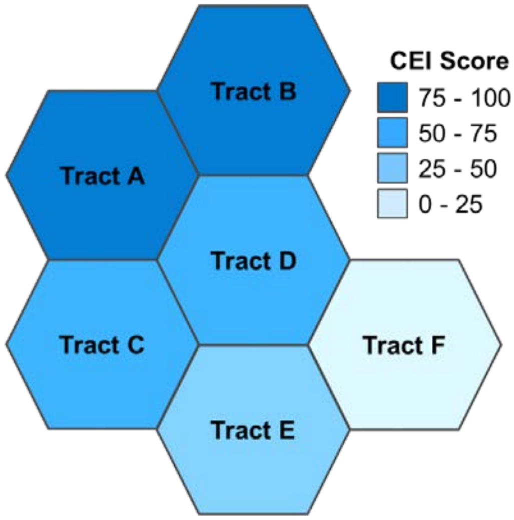

Figure 11. Illustration of CEI Scored Census Tracts

INDICATORS

Environmental Indicators

The following sections detail the data sources and indicator-specific methods used in calculating CEI scores for the following ten (10) environmental indicators:

- Flood Risk;
- Fire Risk;
- Tree Coverage;
- Urban Heat Island Index;
- Proximity to Community Recreation Areas;
- Proximity to Waste Sites;
- Pesticide Use;
- Drinking Water Contaminants;
- Groundwater Threats; and
- Impaired Water Bodies.

Flood Risk

The flood risk indicator measures the percent area of each census tract that falls within the 100-year flood plain and/or is predicted to experience inundation during a 100-year storm surge event given a 2 meter rise in sea level. The floodplain dataset was last updated in June of 2019 and the sea level rise (SLR) dataset was updated in May of 2018. While both datasets are expected to be updated in the future, it is unclear when those updates will occur.

Indicator Specific Methods

The floodplain and sea level rise shapefiles were combined using ArcGIS software to determine all areas across the City that are within the 100-year flood plain and/or are expected to experience inundation during a 100-year storm event given a 2 meter rise in sea level. This new shapefile was intersected with a census tract boundary layer to identify those same areas by census tract. ArcGIS was then used to calculate the total area within each census tract with a qualifying flood risk as a percent of the total census tract area.

Data Source(s)

SanGIS, Federal Emergency Management Agency (FEMA), County of San Diego, Dept. of Public Works, Flood Control Engineering (2019). *Flood_Plain*. Shapefile

Barnard PL., Erikson LH, Foxgrover AC, Limber PW, O'Neill AC, and Vitousek S. (2018). *Coastal Storm Modeling System (CoSMoS) for Southern California, v3.0, Phase 2 (ver. 1g, May 2018)*. U.S. Geological Survey data release. Shapefile

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Fire Risk

The fire risk indicator measures the percent area of each census tract that falls within zones identified as very high fire severity by the California Department of Forestry and Fire Prevention (CAL FIRE). While the fire hazard severity zone (FHSZ) shapefile provided by the City is the current map being utilized by the City, it is unclear when it was most recently updated and no future update date was provided. FHSZs are not expected to significantly change in the near term and using the same data for CEI updates may be acceptable. This assumption will need to be reevaluated with any future CEI update.

Indicator Specific Methods

The FHSZ shapefile was intersected with a census tract boundary layer to identify those areas in each census tract that are within a very high fire severity zone. Calculations were then done to determine the percent of each census tract that falls within these zones.

Data Source(s)

City of San Diego, CAL FIRE (n.d.). *Fire Hazard Severity Zone Local Responsibility Area (FHSZ LRA)*. Shapefile. Provided by City staff.

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Tree Coverage

The tree coverage indicator measures the percent tree canopy coverage for each census tract across all land use categories identified in a 2014 Light Detection and Ranging (LiDAR) analysis for the City of San Diego. Results of the 2014 LiDAR analysis were made available in 2017. Currently, there is no plan to update the data with a second LiDAR study. This may limit the ability of future CEI updates to track progress for this indicator and updated CEI scores may not accurately capture City efforts to increase tree canopy within census tracts.

Indicator Specific Methods

The tree canopy raster dataset contains grid cells that cover the City of San Diego, with each identified as one of seven different land cover categories (tree canopy, bush/shrub, buildings, roads, bare earth, other paved surfaces, or water). The raster file was converted to a shapefile and intersected with the census tract boundary layer with individual polygons representing each land cover category for each census tract. Consistent with how the University of Vermont estimated tree coverage for the entire City, the total coverage for each census tract was derived by dividing the area of each tract categorized as tree canopy by the total area for all land cover types less water.

Data Source(s)

University of Vermont Spatial Analysis Laboratory, City of San Diego (2017). *TreeCanopy_2014_SanDiego*. Raster Dataset

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Urban Heat Island Index

The urban heat island index indicator measures the positive temperature differential (in degree hours per day) between urban census tracts and reference points in rural, upwind reference points. The indicator uses results from the California Environmental Protection Agency's (CalEPA) Urban Heat Island Index (UHII), which measures temperature at two meters above ground level, where people experience heat. The UHII was last updated in 2015 and it is uncertain if and when the data will be updated. This may limit the ability of future CEI updates to include any increases and/or decreases in urban heat island impacts across City census tracts.

Indicator Specific Methods

Data for this indicator were provided at the census tract level through the UHII. No additional calculations or adjustments outside of what was done for the UHII were done for purposes of the CEI.

Data Source(s)

CA Environmental Protection Agency (2015). *Urban Heat Island Index for California*. Shapefile

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Proximity to Community Recreation Areas

The proximity to community recreation areas indicator measures the number of recreation areas (parks, open space, beaches, libraries, and recreation centers) within ½ mile of populated neighborhoods. Location data for this indicator were provided by City staff or collected from SanGIS. For all community recreation area datasets, the most recent year of data is 2018. It is expected that all will undergo frequent updates; however, it is unclear how often and when those updates will occur. Each of these datasets are not expected to significantly change in the near term and using the same data for CEI updates may be acceptable. This assumption will need to be reevaluated with any future CEI update. Future updates may involve working with City staff to identify changes and make necessary updates to the original datasets used here.

Indicator Specific Methods

Multiple shapefiles were collected for this indicator either from the City or downloaded directly from SanGIS, SANDAG's online data portal. All layers were combined into a single shapefile and a ½ mile buffer was applied to each recreation area (park, open space, public beach, library, and recreation centers). This buffered layer was spatially joined with a census tract boundary layer and the number of buffered community recreation areas that overlap (either wholly or partially) with each census tract were summed to estimate the indicator value.

Data Source(s)

City of San Diego (2019). *Recreation Center Locations*. Shapefile

City of San Diego (2019). *Library Locations*. Shapefile

SANDAG, County of San Diego, City of San Diego, City of Carlsbad, City of Chula Vista, City of Coronado, City of Del Mar, City of El Cajon, City of Encinitas, City of Escondido, City of Imperial Beach, City of La Mesa, City of Lemon Grove, National City, City of Oceanside, City of Poway, City of San Marcos, City of Santee, City of Vista, San Diego Port District, State Parks (2019). *Parks*. Shapefile

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Total Population (B01003). CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Proximity to Waste Sites

The proximity to waste sites indicator measures the average distance to the nearest waste site, which includes: hazardous waste generators and facilities, facilities with documented toxic releases, solid waste sites and facilities, and Cal EPA identified cleanup sites. Location data for this indicator were collected directly from CalEnviroScreen. Data from the most recent CalEnviroScreen update (version 3.0, 2017) represent conditions in 2016, with the exception of facilities with documented toxic releases. This component includes data from 2012-2014. The CalEnviroScreen tool is expected to undergo future updates; however the frequency of those updates is unclear and may not align with CEI updates. Publicly available datasets may be used to update this indicator in line with methods used in the current version of CalEnviroScreen for future CEI updates.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from CalEnviroScreen 3.0. A shapefile was created that integrates the location of waste sites (hazardous waste generators and facilities, facilities with documented toxic releases, solid waste sites and facilities, and Cal EPA identified cleanup sites) used for multiple CalEnviroScreen indicators. Next, the average distance to the nearest waste site was estimated across each census tract. A weighted average distance for each tract was calculated by weighting the average distance of populated neighborhoods by its population.

Data Source(s)

California Environmental Protection Agency (Cal EPA) Office of Environmental Health Hazard Assessment (OEHHA) (2017). *CalEnviroScreen 3.0*. Shapefile

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Pesticide Use

The pesticide use indicator measures the total pounds per square mile (lb/mi^2) of 70 Cal EPA selected pesticides used in production-agriculture. Values for this indicator were collected directly from CalEnviroScreen 3.0. CalEnviroScreen data was last updated in 2017 and data relevant to this indicator use a three-year average from 2012-2014. The CalEnviroScreen tool is expected to undergo future updates; however the frequency of those updates is unclear and may not align with CEI updates. Publicly available datasets may be used to update this indicator in line with methods used in the current version of CalEnviroScreen for future CEI updates.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from CalEnviroScreen 3.0. No additional calculations or adjustments outside of what was done for CalEnviroScreen were done for purposes of the CEI.

Data Source(s)

California Environmental Protection Agency (Cal EPA) Office of Environmental Health Hazard Assessment (OEHHA) (2017). *CalEnviroScreen 3.0*. Shapefile

Drinking Water Contaminants

The drinking water contaminants indicator measures the average concentration of contaminants within drinking water systems in each census tract. Values for this indicator were collected directly from CalEnviroScreen 3.0. CalEnviroScreen data was last updated in 2017 and data relevant to this indicator include the average concentration of drinking water contaminants over one complete compliance cycle (2005-2013). The CalEnviroScreen tool is expected to undergo future updates; however the frequency of those updates is unclear and may not align with CEI updates. Publicly available datasets may be used to update this indicator in line with methods used in the current version of CalEnviroScreen for future CEI updates.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from CalEnviroScreen 3.0. No additional calculations or adjustments outside of what was done for CalEnviroScreen were done for purposes of the CEI.

Data Source(s)

California Environmental Protection Agency (Cal EPA) Office of Environmental Health Hazard Assessment (OEHHA) (2017). *CalEnviroScreen 3.0*. Shapefile

Groundwater Threats

The groundwater threats indicator measures CalEnviroScreen groundwater threat scores for census tracts based on type of pollution site and its location to populated neighborhoods. Potential threats to groundwater include the storage and disposal of hazardous waste in storage tanks either above or underground at commercial, industrial, and/or military sites. Values for this indicator were collected directly from CalEnviroScreen 3.0. CalEnviroScreen data was last updated in 2017 and data used in the analysis relevant to this indicator are form 2016. The CalEnviroScreen tool is expected to undergo future updates; however the frequency of those updates is unclear and may not align with CEI updates. Publicly available datasets may be used to update this indicator in line with methods used in the current version of CalEnviroScreen for future CEI updates.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from CalEnviroScreen 3.0. No additional calculations or adjustments outside of what was done for CalEnviroScreen were done for purposes of the CEI.

Data Source(s)

California Environmental Protection Agency (Cal EPA) Office of Environmental Health Hazard Assessment (OEHHA) (2017). *CalEnviroScreen 3.0*. Shapefile

Impaired Water Bodies

The impaired water bodies indicator measures the number of pollutants across all water bodies designated as impaired within each census tract as calculated by CalEnviroScreen 3.0. CalEnviroScreen data was last updated in 2017 and data used in the analysis relevant to this indicator are form 2012. The CalEnviroScreen tool is expected to undergo future updates; however the frequency of those updates is unclear and may not align with CEI updates. Publicly available datasets may be used to update this indicator in line with methods used in the current version of CalEnviroScreen for future CEI updates.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from CalEnviroScreen 3.0. No additional calculations or adjustments outside of what was done for CalEnviroScreen were done for purposes of the CEI.

Data Source(s)

California Environmental Protection Agency (Cal EPA) Office of Environmental Health Hazard Assessment (OEHHA) (2017). *CalEnviroScreen 3.0*. Shapefile

Socioeconomic Indicators

The following sections detail the data sources and indicator-specific methods used in calculating CEI scores for the following nine (9) socioeconomic indicators:

- Unemployment;
- Educational Attainment;
- Linguistic Isolation;
- Digital Access;
- Median Income;
- Poverty Rate;
- Change in Income;
- Energy Cost Burden; and
- Solar Photovoltaic Systems.

Unemployment

The unemployment rate indicator measures the percent of the population within each census tract that is over the age of 16 and unemployed. Unemployment data are collected from the American Community Survey (ACS), which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. No additional calculations or adjustments were needed to convert data.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Employment Status (S2301). CSV

Educational Attainment

The educational attainment indicator measures the percent of the population within each census tract that is over the age of 25 and has less than a high school education. Educational attainment data are collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder. To calculate the percent of the population over the age of 25 with less than a high school education, the number of individuals with below a high school education were divided by the sum of those with below and those with above a high school education.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Educational Attainment for the Population 25 Years and Over (B15003). CSV

Linguistic Isolation

The linguistic isolation indicator measures the percent of limited-English speaking households within each census tract based on all primary language groups identified in the American Community Survey. The ACS identifies limited-English speaking households for the following language groups: Spanish, Asian and Pacific Island languages, other Indo-European languages, and other languages. Linguistic isolation data are collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. No additional calculations or adjustments were needed to convert data.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Limited English Speaking Households (S1602). CSV

Digital Access

The digital access indicator measures the percent of households without internet access within each census tract. Those considered to have internet access include both households with an active internet subscription and those without, but are still provided internet (e.g., student dorms where the university maintains the internet subscription). Digital access data are collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. Data is provided that identifies those with internet access (either with or without their own subscription) and those without access. To calculate the percent of the population within each census tract without internet access, the number of individuals without internet access was divided by the total number of individuals.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Internet Subscriptions in Household (B28011). CSV

Median Income

The median income indicator measures the median household income within the past 12 months for each census tract. Median income data are collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. No additional calculations or adjustments were needed to convert data.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Median Income in the Past 12 Months (S1903). CSV

Poverty Rate

The poverty rate indicator measures the percent of the population within each census tract with an income below 300% of the federal poverty level ($24,600 for a family of four in 2017). A 300% threshold was chosen as it most closely aligns with guidelines used by the County of San Diego to designate low-income households. Poverty rate data are collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. To calculate the percent of the population below 300% of the federal poverty level, the number of individuals below this threshold was divided by the total number of individuals for each census tract.

Data Source(s)

County of San Diego, Housing Commission (2018). *2017 SDHC Affordable Housing Resource Guide*. PDF

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates.* Poverty Status in the Past 12 Months (S1701). CSV

Change in Income

The change in income indicator measures the five-year annual percent change in median household income for each census tract. Change in income data are collected from the ACS, which is updated annually. The five-year average estimates from 2013-2017 are applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. Data for median household income for the 2013-2017 five-year estimates were collected and the percent change year-over-year was calculated and then averaged for each census tract. This represents the average five-year annual percent change in median household income.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates.* Median Income in the Past 12 Months (S1903). CSV

U.S. Census Bureau (n.d.). *2016 ACS 5-year estimates.* Median Income in the Past 12 Months (S1903). CSV

U.S. Census Bureau (n.d.). *2015 ACS 5-year estimates.* Median Income in the Past 12 Months (S1903). CSV

U.S. Census Bureau (n.d.). *2014 ACS 5-year estimates.* Median Income in the Past 12 Months (S1903). CSV

U.S. Census Bureau (n.d.). *2013 ACS 5-year estimates.* Median Income in the Past 12 Months (S1903). CSV

Energy Cost Burden

The energy cost burden indicator measures the three-year average annual household cost of energy per census tract as a percent of median household income. Energy data was provided to EPIC by request and is available annually by San Diego Gas and Electric (SDG&E). Median income data are collected from the American Community Survey (ACS), which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were collected through American Fact Finder (median household income) and through a Privacy Greenlight request to SDG&E. SDG&E provided energy consumption by census tract and rate schedule for both natural gas and electricity. The average total energy cost per household assumes that each household has one natural gas and one electricity meter. Historic rates for 2015-2017 were multiplied by the kWh or therms reported depending on the corresponding rate schedule. Only those customers on the standard (DR or GR) or low-income (DR-LI or GR-LI) rate schedules were included. These totals were weighted by their respective number of meters and combined to provide a weighted average electricity cost per meter and a weighted average natural gas cost per meter by census tract. The sum of both is the average energy cost for each census tract, which was divided by the median household income to obtain the energy cost burden for that tract.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates.* Median Income in the Past 12 Months (S1903). CSV

SDG&E (n.d.). *2015-2017 Residential Energy Consumption Data*. Provided to EPIC through a Project GreenLight request

SDG&E (2017). *Schedule DR – Residential Rate*. PDF

SDG&E (2017). *Schedule GR – Residential Natural Gas Service*. PDF

SDG&E (2016). *Schedule DR – Residential Rate*. PDF

SDG&E (2016). *Schedule GR – Residential Natural Gas Service*. PDF

SDG&E (2015). *Schedule DR – Residential Rate*. PDF

SDG&E (2015). *Schedule GR – Residential Natural Gas Service*. PDF

Solar Photovoltaic Systems

The solar photovoltaic (PV) systems indicator measures the total number of installed solar photovoltaic (PV) systems per capita. Solar PV data were provide by City staff for years 2015-2018. Data for previous years was unavailable at the time for activity prior to 2015. Google Project Sunroof data was used as a supplement to estimate the number of PV systems installed across the City prior to 2015. Project Sunroof states that imagery used in its calculations was pulled sometime between 2013 and 2015. This means that PV systems may have been left out of the analysis if the imagery was pulled prior to 2015. Since calculating CEI scores, the City has been able to gather installation permit data for activity in earlier years. This will be used in lieu of Project Sunroof data in any updates to the CEI. Additionally, City permit data is continuously updated. Population data used to calculate per capita estimates were collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were directly downloaded from the Project Sunroof website (for years prior to 2015) and provided by the City (2015-2018). Project sunroof data was intersected with the census tract boundary layer and a count was taken of the number of systems within each census tract. Data provided by the City was spatially mapped and the same methods were applied to estimate the number of systems installed between 2015 and 2018. The two counts for each census tract were added together and this sum was divided by the census tract's population to estimate the number of PV systems per capita.

Data Source(s)

City of San Diego (2019). *2015-2018 Solar PV Installation Data*. Provided to EPIC by City staff

Google Project Sunroof (2019). *Google Project Sunroof Data Explorer*. CSV

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Total Population (B01003). CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Housing Indicators

The following sections detail the data sources and indicator-specific methods used in calculating CEI scores for the following two (2) housing indicators:

- Housing Cost Burden; and
- Overcrowdedness.

Housing Cost Burden

The housing cost burden indicator measures the median housing cost per census tract as a percent of median household income. It is a weighted average metric that factors in both rent and mortgage costs alongside the number of units that rent versus own. Housing cost data are collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. Two datasets were collected to estimate the housing cost burden – median income and select housing characteristics. The select housing characteristics dataset contains information on the number of households that are renter-occupied versus owner occupied as well mortgage and rent cost information. For mortgage costs, the bottom of each range is used for calculations as a conservative estimate and the average mortgage cost is weighted by the number of households within each range. The same is applied to renter costs. The overall average housing cost is weighted by the number of households that rent versus own. The housing cost burden takes the weighted average housing cost and divides it by the median income for the same census tract.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Median Income in the Past 12 Months (S1903). CSV

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Selected Housing Characteristics (DP04). CSV

Overcrowdedness

The overcrowdedness indicator measures the percent of housing units within a census tract with greater than one occupant per room as defined by the American Community Survey and includes both renter and owner occupied units. In estimating the number of occupants per room, the ACS considers a room to be a whole room within a housing unit including: living rooms, dining rooms, kitchens, bedrooms, finished recreation rooms, enclosed porches suitable for year-round use, and lodger's rooms. Overcrowdedness data are collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. No additional calculations or adjustments were needed to convert data.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Tenure by Occupants per Room (B25014). CSV

Mobility Indicators

The following sections detail the data sources and indicator-specific methods used in calculating CEI scores for the following nine (9) mobility indicators:

- Pedestrian Access;
- Commute Burden;
- Transportation Cost Burden;
- Disability;
- Street Conditions;
- Bikeability;
- Access to Public Transit;
- Traffic Density; and
- Electric Vehicle Charging Infrastructure.

Pedestrian Access

The pedestrian access indicator is a combination of four separate measures for each census tract: average walk score, population weighted miles of sidewalk, population weighted number of streetlights, and five-year average number of pedestrian-vehicle collisions. Walk scores were provided by City staff, are current as of 2016, and are frequently updated. Pedestrian-vehicle collision data is also frequently updated and the City provided data through 2018. A five-year average is used for pedestrian-vehicle collisions. The City's sidewalk inventory was most recently updated in 2015 and the streetlight inventory in 2019. It is unclear when the sidewalk and streetlight inventories will be next updated or if these updates will align with CEI updates. This may limit the ability of the CEI to comprehensively track progress on this indicator.

Indicator Specific Methods

All data for this indicator were provided by City staff. Each component (walk score, sidewalk, streetlights, and pedestrian-vehicle collisions) was calculated separately by census tract and then converted to a z-score following the same methods used to calculate CEI scores. Z-scores were then averaged for each census tract to determine an average pedestrian collision z-score to include in the CEI analysis. Walk scores were already provided at the census tract level and no additional calculations were needed before converting to a z-score. Pedestrian-vehicle collision data were averaged across five years of data (2014-2018) for each census tract before converting to z-scores. The sidewalk dataset was intersected with the census tract boundary layer and the total miles of sidewalk within each census tract was weighted by the population. The population weighted miles of sidewalk were then converted to z-scores. A similar approach was used for streetlights by intersecting streetlight data with the census tract boundary layer to determine the number of streetlights per tract. These totals were then weighted by population to get a population weighted number of streetlights per tract before converting to z-scores. The four census tract level z-scores were then averaged into a single value.

Data Source(s)

City of San Diego (2015). *City of San Diego Sidewalk Inventory*. Shapefile. Data provided to EPIC by City staff

City of San Diego (2019). *City of San Diego Pedestrian-Vehicle Collision Data*. Excel. Data provided to EPIC by City staff

City of San Diego (n.d.). *City of San Diego Streetlight Inventory*. Shapefile. Data provided to EPIC by City staff

Walk Score (2019). *City of San Diego Walk Scores*. Shapefile. Data provided to EPIC by City staff

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates.* Total Population (B01003). CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Commute Burden

The commute burden indicator measures the percent of the each census tract population with a commute time over the regional average. This is a weighted average value that considers the regional average commute time for both those that commute by car (~30 minutes) and those by mass transit (~45 minutes) along with the total population that commutes by each. Commute time data are collected from the ACS, which is updated annually. The 2017 five-year average is applied in this analysis.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. Population counts were collected for individuals who commute more than 30 minutes if commuting by car or more than 45 minutes if commuting by mass transit. The sum of these two groups was divided by the total population for each census tract to get the percent of the population with a significant commute burden (a commute time over the regional average).

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates.* Travel Time to Work (B08303). CSV

SANDAG, TrueNorth Research (2018). Park & Ride / Commute Survey. PDF

Transportation Cost Burden

The transportation cost burden indicator measures the median household transportation cost by census tract as a percent of the median household income. This indicator uses data from both ACS and the Center for Neighborhood Technology's (CNT) Housing and Transportation (H+T) Affordability Index. ACS data is updated annually and the 2013-2017 five-year average is applied here for median income. The H+T index was most recently updated in 2017; however, it is unclear how often the index is updated. This may limit the ability of future CEI updates to capture changes in transportation cost burdens.

Indicator Specific Methods

Data for this indicator were directly downloaded at the census tract level through American Fact Finder (ACS) and the CNT website. The average transportation cost included in the CNT dataset was divided by the corresponding median household income in the ACS dataset for each census tract. This provides the transportation cost as a percent of household income.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates.* Median Income in the Past 12 Months (S1903). CSV

Center for Neighborhood Technology (CNT) (2019). *Housing and Transportation (H+T) Affordability Index*. CSV

Disability

The disability indicator measures the percent of the population with a Disability data collected from the ACS, which is updated annually. The 2013-2017 five-year average is applied in this analysis. Types of disabilities counted in the ACS include: ambulatory, hearing, cognitive, vision, independent living, and self-care.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from American Fact Finder, the online ACS data portal. The percent of the population with a disability was calculated by summing total males and females by age class with a disability and dividing that sum by the total population for each census tract.

Data Source(s)

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Sex by Age by Disability Status (B18101). CSV

Street Conditions

The street conditions indicator measures the weighted average Overall Condition Index (OCI) score for each census tract as determined by the City of San Diego. The City maintains the OCI and provides periodic updates for public download. The most recent dataset and that used for this analysis is from 2015. If updates to the publicly available OCI are not aligned with CEI updates, City staff may work internally to identify updates that can be made to the existing dataset explicitly for the CEI.

Indicator Specific Methods

Data for this indicator were provided by City staff and contains a list of all streets within the City and its corresponding OCI score. OCI scores were weighted by the length of the roadway and averaged across all weighted OCI scores within a given census tract to determine census tract level scores.

Data Source(s)

City of San Diego (2019). *City of San Diego Street Overall Condition Index (OCI)*. Excel. Data provided to EPIC by City staff

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Bikeability

The bikeability indicator measures the weighted average bikeability scores of each census tract as determined by the Bicycle Network Analysis. The most recent set of bikeability scores was updated in 2019; however, it is unclear how often scores will be updated to account for significant changes to the bikeability of each census block. This may limit the ability of future CEI updates to track progress for this indicator and updated CEI scores may not accurately capture City efforts to increase bicycle infrastructure within census tracts.

Indicator Specific Methods

Data for this indicator were directly downloaded at the census block level through the Bicycle Network Analysis website. Census block scores were weighted by the block's area and aggregated to the census tract level to achieve a weighted average bikeability score for each census tract.

Data Source(s)

People for Bikes (2019). *Bicycle Network Analysis (BNA)*. Shapefile

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Access to Public Transit

The access to public transit indicator measures the population weighted average distance to the nearest transit stop. Transit stops are included for rail, trolley, and bus lines. Location data relevant to this indicator is publicly available through SanGIS and the most recent file represents transit stops in 2019. While the dataset is expected to undergo future updates; the frequency of those updates is unclear and may not align with CEI updates. This may limit the ability of future CEI updates to track progress for this indicator.

Indicator Specific Methods

Data for this indicator were directly downloaded through SanGIS as a point shapefile indicating transit stops through San Diego County. The average distance to the nearest transit stop was estimated across each census tract and a weighted average distance for each tract was calculated by weighting the average distance of populated neighborhoods by its population.

Data Source(s)

SANDAG, San Diego Metropolitan Transit System (MTS), North County Transit District (NCTD) (2019). Transit Stops – General Transit Feed Specification (GTFS). Shapefile

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Total Population (B01003). CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Traffic Density

The traffic density indicator measures total traffic volume by total road length as estimated by CalEnviroScreen 3.0. CalEnviroScreen data was last updated in 2017 and the most recent year of data available for traffic density is 2013. The CalEnviroScreen tool is expected to undergo future updates; however the frequency of those updates is unclear and may not align with CEI updates. Publicly available datasets may be used to update this indicator in line with methods used in the current version of CalEnviroScreen for future CEI updates.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from CalEnviroScreen 3.0. No additional calculations or adjustments outside of what was done for CalEnviroScreen were done for purposes of the CEI.

Data Source(s)

California Environmental Protection Agency (Cal EPA) Office of Environmental Health Hazard Assessment (OEHHA) (2017). *CalEnviroScreen 3.0*. Shapefile

Electric Vehicle Charging Infrastructure

The electric vehicle (EV) charging infrastructure indicator measures the number of publicly available charging stations within each census tracts. This includes both Level 2 and DC fast chargers. The U.S. Department of Energy’s Alternative Fuels Data Center maintains a database with location data for multiple types charging infrastructure and is continuously updated with new data. Data for this analysis were current as of the download date (August 2019).

Indicator Specific Methods

Data for this indicator were directly downloaded from the Alternative Fuels Data Center website. The dataset was cleaned to include only publicly available EV charging infrastructure (Level 2 and DC fast chargers) within the City of San Diego. This excluded charging stations that are limited to a particular vehicle make or are exclusive to patrons of the facility (e.g., chargers at hotels limited to hotel guest use). Data was then spatially mapped using ArcGIS and overlaid with a census tract boundary layer. The two layers were spatially joined to get a count of the number of chargers within each census tract.

Data Source(s)

U.S. Department of Energy, Alternative Fuels Data Center (2019). *Alternative Fueling Station Locator*. CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Health Indicators

The following sections detail the data sources and indicator-specific methods used in calculating CEI scores for the following five health indicators:

- Asthma Rates;
- Cancer Fatalities;
- Healthy Food Access;
- Low Infant Birth Weight; and
- Heart Attack Fatalities.

Asthma Rates

The asthma rates indicator measures the rate of emergency department visits due to asthma. This includes all age groups and is expressed as an age-adjusted rate per 10,000 individuals. Asthma rate data are collected from Tracking California. Data are updated annually and the most recent year available is 2017.

Indicator Specific Methods

Data for this indicator were gathered at the zip code level from Tracking California. Rates were collected for zip codes that overlap with census tracts within the City of San Diego. A weighted average rate was then calculated for each census tract by weighting the respective rate for each zip code by its area that overlaps with a particular census tract. This was done by intersecting a zip code shapefile with the census tract boundary layer in ArcGIS. This is consistent with methods used in CalEnvironScreen to apportion zip code values to census tracts.

Data Source(s)

Tracking California, CA Office of Statewide Health Planning and Development (OSHPD) (2019). *Asthma*. CSV

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Total Population (B01003). CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Cancer Fatalities

The cancer fatalities indicator measures the five-year average percent of deaths within each census tract that are cancer related. Cancer fatality data were collected from the California Department of Public Health by zip code for years 1992-2016. Data is updated annually, however, there is a three year delay for each year. For instance, the most recent data available in 2019 is for 2016. A five year average is used in this analysis, which includes years 2012-2016.

Indicator Specific Methods

The data for this indicator were directly downloaded from the CA Department of Public Health's website by zip code. First, the percent of deaths associated with cancer was calculated for each zip code by dividing the total number of cancer related deaths by the total number of deaths. A weighted average percent was then calculated for each census tract by weighting the respective percent for each zip code by the area that zip code overlaps with a particular census tract. This was done by intersecting a zip code shapefile with the census tract boundary layer in ArcGIS. This is consistent with methods used in CalEnvironScreen to apportion zip code values to census tracts.

Data Source(s)

CA Department of Public Health (CDPH) (2018). *Leading Causes of Death by Zip Code 1989-Current*. CSV

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Total Population (B01003). CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

Healthy Food Access

The healthy food access indicator measures the percent of the population within each census tract that has a lower level of access to healthy foods as measured by the USDA Food Access Research Atlas. Low access is considered greater than ½ mile for urban census tracts and greater than 10 miles for rural census tracts. The Food Access Research Atlas was last updated in 2015 and data contained within the atlas are reflective of that year. The Atlas is expected to undergo future updates; however the frequency of those updates is unclear and may not align with CEI updates. This may limit the ability of future CEI updates to track progress for this indicator.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from The USDA Food Access Research Atlas. Population counts are provided for the number of individuals considered to have low access to healthy food. Low access is defined as living greater than ½ mile from healthy food options for urban census tracts and greater than 10 miles for rural census tracts. The percent of the population considered to have low access was found by dividing the population with low access by the total population for each census tract.

Data Source(s)

U.S. Department of Agriculture (USDA) (2015). *Food Access Research Atlas*. Excel

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates*. Total Population (B01003). CSV

Low Infant Birth Weight

The low infant birth weight indicator measures the percent of full term births (37 weeks of gestation) within each census tract with a birthweight less than 2,500 grams. Low infant birthweight data is collected from Tracking California. Data is updated annually; however, each update is for data that is for three to four years previous. As such the most recent data available is for 2015.

Indicator Specific Methods

Data for this indicator were gathered at the census tract level from Tracking California. No additional calculations or adjustments outside of what was done for Tracking California were done for purposes of the CEI.

Data Source(s)

Tracking California, CA Department of Public Health, Office of Vital Statistics (2019). *Maternal and Infant Health*. CSV

Heart Attack Fatalities

The heart attack fatalities indicator measures the five-year average percent of deaths within each census tract that are heart attack related. Heart attack fatality data were collected from the California Department of Public Health by zip code for years 1992-2016. Data is updated annually, however, there is a three year delay for each year. For instance, the most recent data available in 2019 is for 2016. A five year average is used in this analysis, which includes years 2012-2016.

Indicator Specific Methods

The data for this indicator were directly downloaded from the CA Department of Public Health's website by zip code. First, the percent of deaths associated with heart attacks was calculated for each zip code by dividing the total number of heart attack related deaths by the total number of deaths. A weighted average percent was then calculated for each census tract by weighting the respective percent for each zip code by the area that zip code overlaps with a particular census tract. This was done by intersecting a zip code shapefile with the census tract boundary layer in ArcGIS. This is consistent with methods used in CalEnvironScreen to apportion zip code values to census tracts.

Data Source(s)

CA Department of Public Health (CDPH) (2018). *Leading Causes of Death by Zip Code 1989-Current*. CSV

U.S. Census Bureau (n.d.). *2017 ACS 5-year estimates.* Total Population (B01003). CSV

SANDAG, U.S. Census Bureau (2014). Census Tracts 2010. Shapefile

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Supplemental Documentation

CITY OF SAN DIEGO 2016-2018 GREENHOUSE GAS EMISSIONS INVENTORY

City of San Diego Greenhouse Gas Emissions Inventory Methodology and Updates

November 2019

Prepared for

The City of SAN DIEGO

Prepared by the Energy Policy Initiatives Center

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

About EPIC

The Energy Policy Initiatives Center (EPIC) is a non-profit research center of the USD 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 educating law students.

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

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1 OVERVIEW

This document presents a summary of the greenhouse gas (GHG) emissions estimate for the City of San Diego (referred to as San Diego or the City) in calendar years 2016, 2017 and 2018, and the methods used. This is a supplement to the City's Climate Action Plan (CAP) 2019 Annual Report and its appendix.

In preparation for the 2019 Annual Report and 2018 GHG emissions inventory, revisions and refinements were made to the 2016 and 2017 GHG emissions presented in the previous 2018 CAP Annual Report[1] to reflect updated data supplied by agencies not managed by the City, and to ensure consistency with the 2018 GHG emissions estimates. This approach follows the approach used by the California Air Resources Board (CARB) when updating its California statewide inventory, and based on the Intergovernmental Panel on Climate Change (IPCC) recommendations to maintain a consistent time-series when developing GHG inventories.[2] Similarly, the 2018 GHG emissions reported in this document are subject to change when updated data and information become available in the following years.

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 2016, 2017 and 2018 GHG emissions inventory results summary;
- Section 4 provides the methods used to prepare each category of the inventory; and,
- Section 5 discusses the updates to the GHG emissions inventory since the 2018 CAP Annual Report.
- Section 6 discusses the methods and parameters used to estimate uncertainties related to the 2018 emissions inventory estimates

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). The 100-year GWPs reported by the IPCC from the IPCC Fourth Assessment Report (AR4) are used to estimate GHG emissions and provided in Table 1.[3] 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 Climate Action Plan 2018 Annual Report and Appendix (2018), accessed October 21, 2019.
[2] California Air Resources Board (CARB): California Greenhouse Gas Emissions for 2000 to 2017. Trends of Emissions and Other Indicators, p. 16 Additional Information (2019), accessed October 21, 2019.
[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 a 20-year GWPs because the SLCP has greater climate impact in the near-term compared to the long-lived GHGs.

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

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

2.2 Categories of Emissions

The U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (U.S. Community Protocol), developed by ICLEI USA, requires a minimum of five basic emissions-generating activities to be included in a Protocol-compliant community-scale GHG inventory.[5] These categories are: built environment (electricity and 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). For these categories, methods used in this inventory were based on the U.S. Community Protocol standard methods and modified with regional- or City-specific data when available.

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

2.3 Demographics

The San Diego Association of Governments (SANDAG) estimates and forecasts population and employment for all jurisdictions in the San Diego region. The San Diego citywide population and housing estimates for 2016 to 2018 used in this document are provided in Table 2.[6]

Table 2 Population and Housing Estimates (San Diego 2016, 2017 and 2018)

Year	Population Estimates	Housing Estimates (Units)	
		Total	Occupied
2016	1,387,362	527,273	502,780
2017	1,399,924	531,422	505,531
2018	1,419,845	535,510	509,216
Housing unit types include single detached units, single attached units, two to four units, five plus or apartment units, and mobile homes. SANDAG 2019.			

[5] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012).
[6] SANDAG: Demographic & Socio-Economic Estimates for San Diego (May 25, 2019 Version). SANDAG Data Surfer, accessed September 5, 2019. California Department of Finance (DOF) also publishes annual population and housing estimates for cities, counties and the State. Population and occupied housing unit estimates from SANDAG's 2019 version match DOF's estimate of May 2018. The number of total housing units from the two sources vary by approximately 1%.

2.4 Rounding of Values in Tables and Figures

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

3 SUMMARY OF 2018 GHG EMISSIONS INVENTORY

The total GHG emissions from San Diego in 2018 were approximately 9.8 million metric tons CO_2e (MMT CO_2e), distributed into categories as shown in Figure 1.

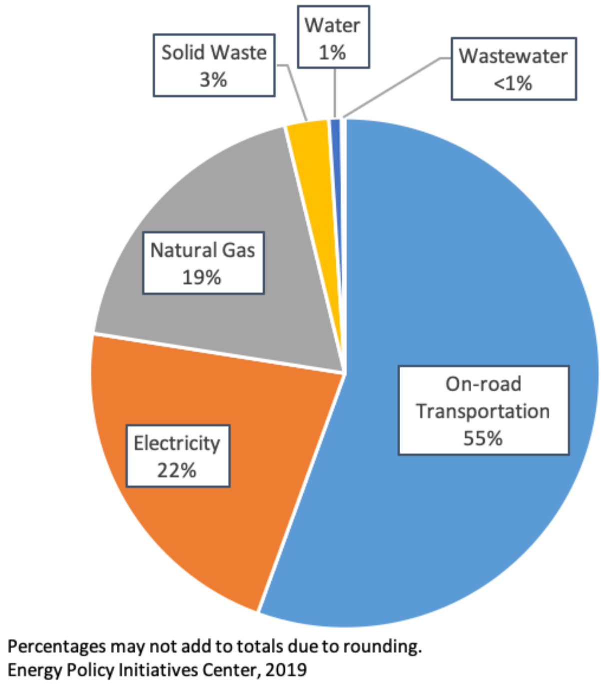
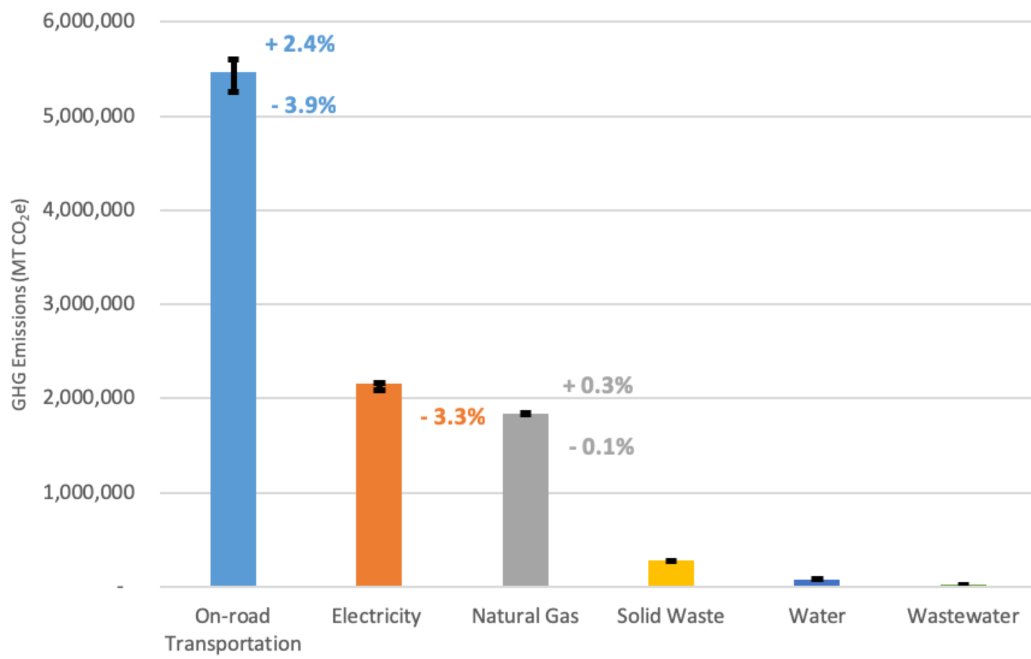


Figure 1 Breakdown of GHG Emissions in San Diego (2018)

The 2018 GHG emissions are calculated based on the best available input activity data and emission factors as of October 2019, therefore 9.8 MMT CO_2e citywide GHG emissions is the best available estimates. However, it is useful to be aware of the reliability of numbers especially when used in policy development.[7] The reliability of a number is dependent upon the level of uncertainty placed on the input. A full quantitative uncertainty analysis for GHG emissions results is not possible or desirable here because not all uncertainties in the input activity data and emission factors are available. For example, some input data based on measured and reported values (such as electricity and natural gas consumption billing data) may include measurement errors, reporting errors, or changes in customer classification over time. Emission factors may have similar uncertainties and ranges. Another source of uncertainty occurs when measured data is not available (such as on-road transportation fuel use by city) and proxies are used (the proxy for vehicle fuel use by city is vehicle miles traveled (VMT)). Proxies themselves (such as VMT) may be modeled (by regional activity-based models) or available in part by monitoring (highway performance monitoring with sensors). Proxies themselves may need to be extrapolated.

[7] IPCC: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 1, General Guidance and Reporting, Chapter 3, Uncertainties, accessed November 4, 2019.

These uncertainties and variety of input sources can result in a range of emissions results. The range may not be the same for each emission category, and the best available data used in calculating the 2018 GHG inventory (9.8 MMT CO_2e) may not be in the middle of the range, due to the different ranges in data in each category. Figure 2 below shows the range for three of the emissions categories (on-road transportation, electricity and natural gas) based on known uncertainties and input ranges for the year 2018 only. More details on the methods to calculate the resulting ranges are provided in Section 6.



Energy Policy Initiatives Center 2019

Figure 2 Ranges in Emissions by Category in San Diego (2018)

In 2018, the largest categories of emissions are on-road transportation, electricity, and natural gas, which represent most emissions (96%). The totals and a breakdown of emissions by category for 2016 to 2018 are presented in Table 3.

Table 3 Total and Breakdown of GHG Emissions Estimates in San Diego (2016 to 2018)

Emissions Category	2016 GHG Emissions (MT CO_2e)	2017 GHG Emissions (MT CO_2e)	2018 GHG Emissions with Range (MT CO_2e)
On-Road Transportation*	5,542,000	5,525,000	5,472,000 (5,257,000 – 5,601,000)
Electricity	2,219,000	2,184,000	2,161,000 (2,090,000 - 2,161,000)
Natural Gas	2,058,000	2,093,000	1,842,000 (1,840,000 – 1,847,000)
Solid Waste	255,000	264,000	275,000
Water	73,000	67,000	79,000
Wastewater	21,000	21,000	20,000
Total	**10,169,000**	**10,153,000**	**9,849,000 (9,561,000 – 9,984,000)**

Sums may not add up to totals due to rounding. Numbers in parentheses indicate the ranges in emissions, ranges are not available for solid waste, water, and wastewater category.
GHG emissions for each category are rounded to the nearest thousand. Values are not rounded in the intermediary steps in the calculation.
* 2016 emissions are based on SANDAG's Series 14 modeled vehicle miles traveled (VMT) estimates, and 2017 and 2018 emissions are based on 2016 VMT and adjusted to account for regional VMT growth as reflected in the California Highway Performance Monitoring System.
Energy Policy Initiatives Center 2019.

The total emissions in 2018, 9.8 MMT CO_2e, are approximately 3% lower than the total emissions in 2017, which is mainly due to a decrease in natural gas use. The emissions from the natural gas category in 2018 are 12% lower than in 2017, which is significantly different from the uncertainty range in natural gas emissions. However, emissions in 2018 from the water category are 19% higher than in 2017.

4 METHODS TO CALCULATE EMISSIONS INVENTORY

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 in a given year.

4.1.1 Vehicle Miles Traveled (VMT)

Annual VMT was estimated based on the average weekday VMT for the City provided by SANDAG using its activity-based model (ABM).[8] SANDAG provided VMT estimates for 2016. The 2016 VMT provides the starting point for the 2017 and 2018 VMT values, which were estimated using annual VMT growth rates from California's public road data for the San Diego region derived from the Highway Performance Monitoring System (HPMS)[9] as explained below.

SANDAG uses the 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, and employment

[8] SANDAG (2015): San Diego Forward: The Regional Plan. Appendix T Travel Demand Model Documentation.
[9] California Department of Transportation: Highway Performance Monitoring System (HPMS).

growth for the San Diego region. SANDAG updates the ABM with inputs from the Regional Growth Forecast and performs various model calibrations. Each Regional Growth Forecast is named a new Series. As of October 2019, the most recent forecast is the Series 14 Growth Forecast with a base year of 2016 and the most recent model is ABM release 14.0.1. The 2016 VMT data provided by SANDAG for the City are the base year data from Series 14 (ABM release 14.0.1). 2017 and 2018 VMT data from Series 14 are not available as of October 2019, therefore, 2017 and 2018 VMT are estimated using 2016 Series 14 VMT with VMT monitoring data from other sources. 2016 VMT is used as starting point for estimation because 2016 is a base year of SANDAG Series 14 forecast and base year the forecast is considered the best available data year.

SANDAG allocates the VMT derived from the ABM to the City of San Diego using the Origin-Destination (O-D) method.[10] 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 3).[11]

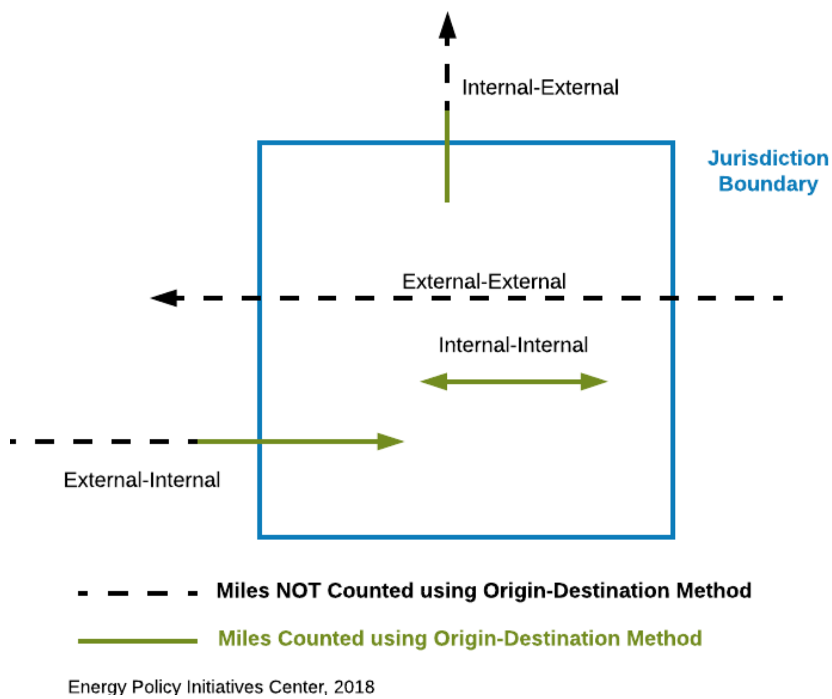


Figure 3 Components of O-D Method for VMT Calculation

O-D VMT allocated to San Diego include 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.

[10] SANDAG (2013): Vehicle Miles Traveled Calculation Using the SANDAG Regional Travel Demand Model. Technical White Paper.
[11] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012), Appendix D: Transportation and Other Mobile Emission Activities and Sources.

The total average weekday VMT were multiplied by 347 to adjust from average weekday VMT to average annual VMT, which includes weekends.[12]

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.[13]

Table 4 Best Available Year 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/Weekday)	Total City VMT (Miles/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	22,073,116	29,342,990	3,322,216	36,744,611	12,750,380,176

*Miles from External-External trips (pass-through trips) are the portion within the City boundary, not from the entire trip.
Based on SANDAG Series 14 VMT estimates. 2016 is the Series 14 Base Year and the only year with Series 14 data available
The conversion factor from miles/weekday to miles/year is 347.
SANDAG 2019, Energy Policy Initiatives Center 2019.

Data from other than 2016 base year are not available under Series 14 ABM Version 2.0. Therefore, to estimate 2017 and 2018 VMT, the 2016 O-D VMT was adjusted by the annual rates of increase from 2016 to 2018, as indicated by the State public road VMT monitoring system (CalTrans HPMS). Annual Caltrans HPMS VMT was used to estimate VMT growth rates for the San Diego region. The rates were applied to the City of San Diego 2016 Series 14 O-D VMT data as a reasonable 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 from 2016-2018 based on CalTrans HPMS data are given in Table 6.[14]

Table 5 San Diego Region Daily VMT Derived from the CalTrans Highway Performance Monitoring System

Year	San Diego Region Daily VMT (thousand miles/day)	Annual Rate of Increase (%)
2016	79,622	-
2017	81,253	2.0%
2018*	82,424	1.4%

*2018 CalTrans HPMS data were yet available as of October 2019. Therefore the 2018 daily VMT were estimated using the average annual rate of increase from 2012 to 2017.
CalTrans 2019, Energy Policy Initiatives Center 2019.

[12] 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).
[13] Series 14 2016 (Base Year) average weekday VMT estimates were provided by SANDAG (September 30, 2019). Original data tables provided by SANDAG are in 0.
[14] California Department of Transportation: HPMS Data, accessed October 21, 2019.

Using these annual rates of increase, the estimated 2017 and 2018 VMT for the City of San Diego are provided in Table 6. It is assumed that the City of San Diego VMT growth follows the pattern of the San Diego regional VMT growth shown in the CalTrans HPMS data. The adjustment method may change if better information becomes available on City of San Diego VMT and travel patterns.

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 EMFAC2017 developed by CARB.[15]

EMFAC2017 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] The average emission rates (g CO_2e/mile) were calculated by dividing the total vehicle GHG emissions by total VMT. This document assumes that the City of San Diego has the same distribution of vehicle types as the San Diego region. The 2016 to 2018 emission rates are provided in Table 6.

4.1.3 Total Emissions from On-Road Transportation

Total estimated VMT, average vehicle emission rates, and corresponding GHG emissions from the on-road transportation category for 2016 to 2018 are given in Table 6.

Table 6 VMT, Emission Rate, and GHG Emissions from the On-Road Transportation Category (San Diego, 2016 and 2017)

Year	Total VMT (Miles/year)	Average Vehicle Emission Rate (g CO_2e/mile)	GHG Emissions (MT CO_2e)
2016	12,750,380,176	435	5,542,000
2017	13,011,627,174	425	5,525,000
2018	13,199,157,354	415	5,472,000

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 2019.

VMT increased from 2016 to 2018. However, as average fleet CO_2e emission rates decreased at a faster rate than VMT increased, the emissions from on-road transportataion in 2018 was lower than that in 2016. The decrease in the emission rate is likely due to the vehicle turnover rate in the San Diego region and the improved vehicle emission standards for new vehicles.

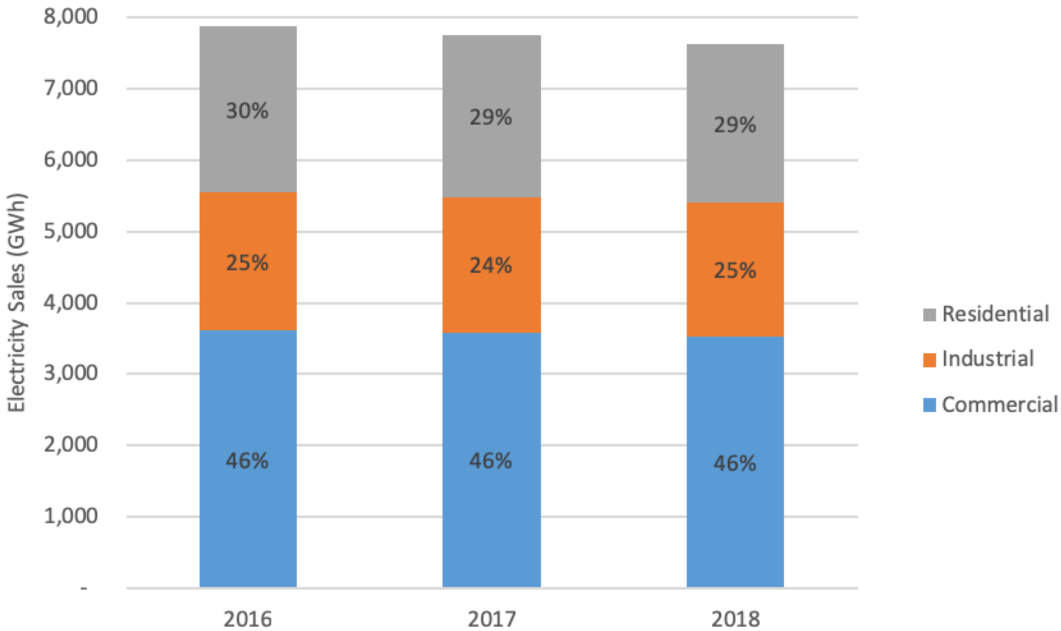
4.2 Electricity

Emissions from electricity in 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.[17]

[15] CARB: EMission FACtors model, EMFAC 2017.
[16] The EMFAC2017 v.1.0.2 was run by EPIC on March 20, 2018 using the default activity mode. The outputs of the model run include 2000-2050 San Diego region (SANDAG area) total VMT (miles/day), CO_2e emissions (short tons/day), vehicle population and number of trips.
[17] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012), Appendix C: Built Environment Emission Activities and Sources.

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).[18] 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 2016 to 2018 by customer class are shown in Figure 4.



SDG&E's electricity sales in City of San Diego. Sales exclude transmission and distribution losses, and exclude sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and the military.
SDG&E 2019

Figure 4 SDG&E Electricity Sales to City of San Diego by Customer Class (2016, 2017 and 2018)

The percentage of electricity use from each customer class (residential, commercial and industrial) is similar in each of the three years. The electricity sales were then adjusted by 1) a loss factor[19] of 1.07[20] 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 (see Section 4.5).

The adjusted net energy for load (electricity sales + losses) is provided in Table 7.

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 power mix of bundled power[21] and Direct Access

[18] 2016–2018 metered electricity sales were provided to EPIC by SDG&E (October 17, 2019).
[19] 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).
[20] 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.
[21] SDG&E bundled power includes the electricity from SDG&E-owned power plants and the electricity from its net procurements.

(DA) power[22] in the City and their respective emission factors. The 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 Program[24] data on SDG&E-owned and purchased power, and U.S. EPA Emissions and Generating Resource Integrated Database (eGRID) 2016 Edition[25] on specific power plant emissions. The DA emission factor is based on California Public Utilities Commission (CPUC) Decision D.14-12-037.[26]

The differences in the City-specific electricity emission factors reflect the changes in the percentages of electricity sales to SDG&E bundled versus DA customers, the change in the electricity power mix in the City and in SDG&E's service territory. For example, the citywide emission factor will change if SDG&E's renewable power content stays the same but its purchased power amount changes. As another example, if the DA customer load increases relative to SD&E's total load, the emission factor for the city will be impacted and be higher, as the emission factor for DA is a default value higher than that of SDG&E.

City-specific electricity emission factors are provided in Table 7.

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 the years 2016 to 2018 are shown in Table 7.

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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 FERC: Form 1 – Electric Utility Annual Report: Report Year 2018, updated July 9, 2019, and accessed September 18, 2019.

24 CEC: Power Source Disclosure Program under Senate Bill 1305. The SDG&E annual power source disclosure reports from 2016 to 2018 were provided by CEC staff to EPIC. The 2018 SGD&E bundled emission factor is 528 lbs CO_2e/MWh.

25 U.S. EPA. eGRID 2016 Edition, released February 15, 2018, accessed June 29, 2018.

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). However, the recommended emission factor has not changed since 2014 while the all electric service suppliers must meet the Renewables Portfolio Standards in the target years.

Table 7 Net Energy for Load, Emission Factor and GHG Emissions from Electricity Category (San Diego 2016, 2017 and 2018)

Year	Net Energy for Load (electricity sales + losses) (MWh)	City-Specific Emission Factor (lbs CO_2e/MWh)	GHG Emissions (MT CO_2e)
2016	8,399,395	582	2,219,000
2017	8,265,203	582	2,184,000
2018	8,130,596	586	2,161,000

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 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. The changes in the City-specific electricity emission factors reflect the changes in the percentages of electricity sales to SDG&E bundled and DA customers, and the change in the electricity power mix (renewable and non-renewable sources) in the City and in SDG&E's service territory.
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 2019.

The net energy for load does not include self-serve renewable supply such as customer-owned behind-the-meter photovoltaic (PV) systems, or self-serve non-renewable supply because electricity generation from behind-the-meter PV systems is considered renewable and assumed to have no associated GHG emissions. The newly installed and total behind-the-meter PV systems in the City from 2016 to 2018 and estimated solar generation are shown in Table 8.[27]

[27] NEM Interconnection Data Set, current as of July 31, 2019, accessed on October 23, 2019. Service cities include San Diego, La Jolla and San Ysidro, all within the City of San Diego. Based on the date of NEM interconnection applications approved and the Permission to Operate letters issued to the customers. Solar capacities are reported in direct current (DC). However, the 2010–2013 capacity was converted to DC from alternating current (AC), because the number of systems reported in AC and DC are inconsistent before 2014. Estimated electricity generation is converted from capacity using an average solar PV system capacity factor of 20% and an annual system degradation rate of 1%.

Table 8 Behind-the-meter PV Systems and Electricity Generation (San Diego 2016, 2017 and 2018)

Year	New PV Systems Installed in Given Year		Cumulative PV Systems since 1999		Estimated Behind-the-meter Solar Generation (MWh)
	Number of Systems	Capacity (MW_{dc})	Number of Systems	Capacity (MW_{dc})	
2016	9,367	62	32,111	230	392,833
2017	5,904	48	38,015	277	472,556
2018	7,345	62	45,360	340	577,225

The PV systems included here are those currently interconnected to the grid. Estimated electricity generation is converted from capacity using an average solar PV system capacity factor of 20% and an annual system degradation rate of 1%.
California Distributed Generation Statistics 2019, Energy Policy Initiatives Center 2019.

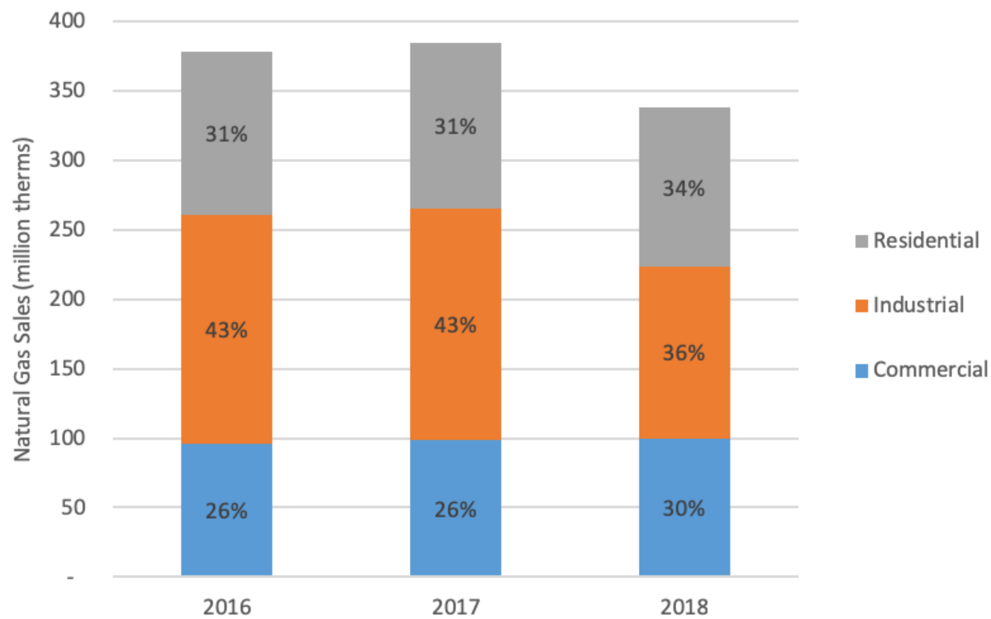
4.3 Natural Gas

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 in a given year.[28]

4.3.1 Natural Gas Use

Annual natural gas sales were provided by SDG&E, broken down by residential, commercial and industrial customer class.[29] The natural gas sales data do not include the sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and military. The natural gas sales from 2016 to 2018 by customer class are shown in Figure 5.

[28] ICLEI– Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012), Appendix C: Built Environment Emission Activities and Sources.
[29] 2016-2018 metered natural gas sales were provided by SDG&E to EPIC (October 17, 2019).



SDG&E's electricity sales in City of San Diego, excluding sales to San Diego County Regional Airport Authority, San Diego Unified Port District, and the military.
SDG&E 2019

Figure 5 SDG&E Natural Gas Sales to City of San Diego by Customer Class (2016, 2017 and 2018)

The natural gas sales in 2018 were approximately 12% below sales in 2017, and 11% below sales in 2016. This is mainly due to the decrease in sales in the industrial customer class, which in 2018 was 26% lower than in 2017.

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.[30] The natural gas emission factors are given in Table 9.

4.3.3 Total Emissions from Natural Gas

To estimate emissions from the combustion of natural gas, fuel use was multiplied by the emission factor. The total natural gas use and corresponding GHG emissions from the natural gas category for the years 2016 to 2018 are given in Table 9.

30 CARB: GHG Current California Emission Inventory Data.

Table 9 Natural Gas Use and GHG Emissions from Natural Gas Category (San Diego 2016, 2017 and 2018)

Year	Natural Gas Use (Million Therms)	Natural Gas Emission Factor (Million MT CO_2e/Million Therms)	GHG Emissions (MT CO_2e)
2016	378	0.0545	2,058,000
2017	384	0.0545	2,093,000
2018	338	0.0545	1,842,000
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 2019, Energy Policy Initiatives Center 2019.			

4.4 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 a given year and an emission factor for mixed solid waste. [31] This represents the immediate and all future emissions from decay of this waste.

4.4.1 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 and per-capita solid waste disposal are given in Table 11.[33]

4.4.2 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, was used as a proxy for San Diego's solid waste composition.[34] 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 mixed solid waste emission factor is given in Table 10.

[31] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012), Appendix E: Solid Waste Emission Activities and Sources.
[32] CalRecycle: Disposal Reporting System (DRS): Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility, accessed September 11, 2019.
[33] 2016 to 2018 waste disposal were provided by City of San Diego Environmental Services Department (August 2017, July 2018 and August 2019).
[34] City of San Diego: Waste Characterization Study 2012–2013 Final Report (2014), accessed November 04, 2019.

Table 10 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 v14 Containers /Packaging
Newspaper	*0.8%*	0.95	Exhibit 3-27, WARM v14 Containers /Packaging
Magazine	*0.6%*	1.08	Exhibit 3-27, WARM v14 Containers /Packaging
Mixed Paper (general)	*10.4%*	2.14	Exhibit 3-27, WARM v14 Containers /Packaging
Plastic	8.9%	0	-
Glass	1.7%	0	-
Metal	3.5%	0	-
Organics	38.9%		
Food	*15%*	1.57	Exhibit 1-49, WARM V14 Organic Materials
Tree	*5.3%*	0.77	Exhibit 2-11 WARM V14 Organic Materials
Leaves and Grass	*6.8%*	0.59	Exhibit 2-11 WARM V14 Organic Materials
Trimmings	*3.5%*	0.59	Exhibit 2-11 WARM V14 Organic Materials
Mixed Organics	*8.3%*	0.53	Exhibit 2-11 WARM V14 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		**0.744**	

Source: 1) City of San Diego 2014. 2) EPA Waste Reduction Model (WARM) Version 14 (2016)

4.4.3 Total Emissions from Solid Waste

The mixed waste emission factor given in Table 10 is the emission factor without landfill gas collection at the landfills. The default capture rate of CH_4 emissions from landfills, 75%, is applied in the emissions calculation, based on the default rate in the U.S. Community Protocol. The total and per-capita solid waste disposal and the corresponding GHG emissions for the years 2016 to 2018 are given in Table 11.

Table 11 Solid Waste Disposal and GHG Emissions from Solid Waste Category (San Diego 2016, 2017 and 2018)

Year	Solid Waste Disposed			GHG Emission Factor (MT CO_2e/Short Ton)	Oxidation Rate**	Total GHG Emissions (MT CO_2e)	Default CH_4 Capture Rate	Remaining Emissions (MT CO_2e)
	City-wide (Short Tons/Year)	City-wide (MT/Year)	Per Capita Solid Waste Disposal (kg/person/day)*					
2016	1,521,363	1,380,158	2.7	0.744	10%	1,018,965	75%	255,000
2017	1,576,105	1,429,819	2.8	0.744	10%	1,055,629	75%	264,000
2018	1,639,817	1,487,617	2.9	0.744	10%	1,098,302	75%	275,000

GHG emissions for each category are rounded to the nearest hundred. Values are not rounded in the intermediary steps in the calculation.
* Informational, based on total waste disposal and population estimates (Table 2). Used in projections.
**The oxidation rate is the default amount of methane that is oxidized and not emitted, therefore only 90% of total methane emissions are produced.
City of San Diego 2014-2019, Energy Policy Initiatives Center 2019.

4.4.4 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 which can be reported optionally. The Protocol provides a separate method to estimate emissions from past disposal together with emissions from disposal in the current inventory year. This is the method used by landfills themselves to report emissions. 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 can be used an emission estimate for the City of San Diego. 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.[35]

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 from the method provided in Section 4.4.3 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 12.

[35] CARB: Landfill Gas Tool v1.3, released on November 14, 2011, download date: May 19, 2016. The tool reports CO_2e of CH_4 using 21 as CH_4 GWP, recalculated using 25 as CH_4 GWP.

Table 12 Emissions from In-Boundary Landfills (Not Reported in GHG Inventory)

Landfill	Status	2016 Landfill Emissions (MT CO_2e)	2017 Landfill Emissions (MT CO_2e)	2018 Landfill Emissions (MT CO_2e)	Source
West Miramar Sanitary Landfill	Active	201,795	143,021	161,310	EPA MRR
Sycamore Landfill	Active	82,018	115,226	99,907	EPA MRR
North Miramar Sanitary Landfill	Closed in 1983	2,333	2,813	3,271	EPA MRR
South Chollas Sanitary Landfill	Closed in 1981	n/a	n/a	n/a	Discontinued reporting to EPA MRR in 2015
Arizona Street Landfill	Closed in 1974	11,062	10,843	10,628	CARB Landfill Emission Tool (CARB LET) result using waste received before closing
Mission Bay Landfill #1	Closed in 1959	6,308	6,253	6,130	CARB LET result using operational period 1952-1959 and waste-in-place at the end of 1990
Total	-----	303,516	278,156	281,246	-

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, EPA 2019, Energy Policy Initiatives Center 2019.

4.5 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 shown in Figure 6. The energy required to move water is primarily electricity but may include natural gas or other fuels.

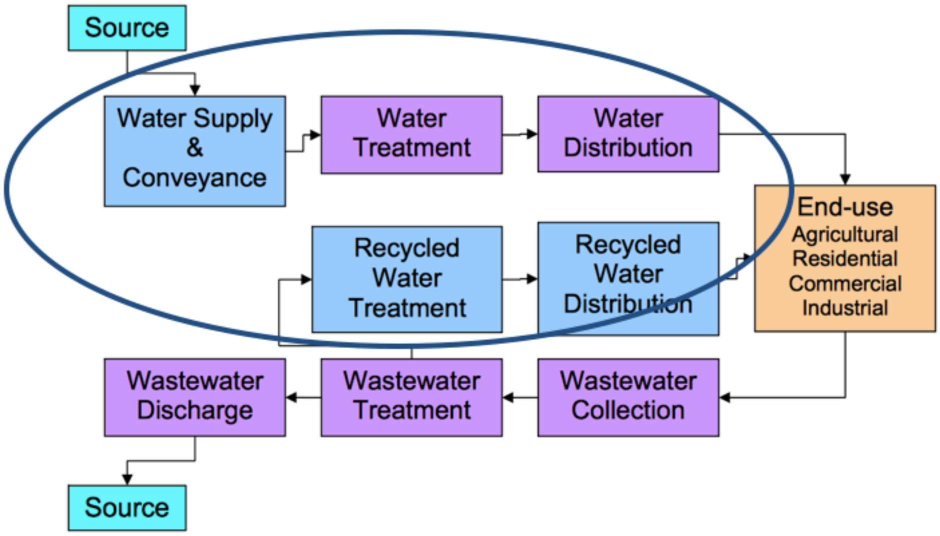


Figure 6 Segments of the Water Cycle

Emissions from water were estimated using the method Wastewater and Water (WW.14) from the U.S. Community Protocol.[36] Emissions associated with water end-use, such as water heating and cooling, are included in the electricity and natural gas category (Section 4.2 and Section 4.3), not in this water category, as data are not available to separate out those values.

4.5.1 Water Use

The City of San Diego is one of the member agencies 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 and the California American Water Company (CalAm).[37]

The potable water supply sources for 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.[38] 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 13.[39]

[36] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012), Appendix F: Wastewater and Water Emission Activities and Sources.
[37] 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).
[38] City of San Diego, 2015 Urban Water Management Plan, Section 6 System Water Supplies (2016).
[39] 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 sales to City of Del Mar is from the imported raw water treated in City of San Diego's WTPs. The water sales to CalAm (excluding CalAm's service area in City of San Diego's South Bay area) is from local water treated in WTPs. Recycled water was produced at the City's North City Water Reclamation Plant and provided to City customers only.

Table 13 Water Supplied and Supply Source (San Diego, 2016 and 2017)

Year	Potable Water Supplied					Recycled Water Supplied (Acre-Feet)
	Imported SDCWA Treated *	Imported SDCWA Untreated	Local Surface Reservoir	Local Groundwater Basin	Potable Water Supplied (Acre-Feet)	
2016	8%	84%	8%	0.3%	170,632	5,024
2017	12%	71%	16%	0.3%	164,226	5,189
2018	12%	83%	5%	0.3%	175,932	10,019

Potable water supplied (acre-feet) is the City of San Diego's water production excluding sales to other water agencies in a given year.
* Desalinated water, about 9% of total SDCWA water since 2016, is considered imported treated water.
City of San Diego 2017-2019, Energy Policy Initiatives Center 2019.

In 2018, City imported a larger portion of water from SDCWA and smaller portion of local surface water, compared with 2017. This is mainly due to less local water availability as a result of lower rain and runoff in the City reservoirs in 2018 compared with 2017. The recycled water sales in 2018 were almost double that in 2017, reportedly due to an increase in new customers and existing customer usage.

4.5.2 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 (MWD)'s and SDCWA's service area. The upstream supply and conveyance energy use for SDCWA treated water consists of that associated with SDCWA untreated water and the water treatment energy use 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).[40]

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 2015 UWMP voluntary energy intensity reporting 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 14.

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

Table 14 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 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 water treatment plant (WTP). 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 with 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 15.

Table 15 Local Water Conveyance and Treatment Energy Intensity (San Diego 2016, 2017 and 2018)

Combined Miramar, Otay and Alvarado WTPs	CY2016	CY2017	CY2018	Description
Water Treated (Acre-Feet)	163,823	151,181	161,463	Total water treated at three WTPs
Total Treatment + Conveyance Energy Use (kWh)	11,168,268	14,260,711	12,412,808	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)	68	94	77	Total energy Intensity (total electricity divided by water treated)
Solar Production (kWh)	2,502,592	2,102,587	1,857,874	Annual electricity generated Alvarado and Otay on-site PV systems
Net Treatment + Conveyance Energy Use (kWh)	9,151,144	12,167,796	10,563,594	Net electricity purchase from the grid (SDG&E). Total electricity consumption minus solar production.
Net Treatment + Conveyance Energy Intensity (kWh/Acre-Foot)	**56**	**80**	**65**	**Net Energy Intensity (net energy divided by water treated)**

WTP – Water Treatment Plant.
The energy intensities are the average of all three City of San Diego WTPs, do not represent the energy intensity of each individual WTP.
City of San Diego 2017-2019, Energy Policy Initiatives Center 2019.

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 intensities are given in Table 16.

Table 16 Local Water Distribution Energy Intensity (San Diego 2016, 2017 and 2018)

Citywide Water Distribution	CY2016	CY2017	CY2018	Description
Total Water Moved (Acre-Feet)	177,684	171,287	183,245	Total City of San Diego water production from all water sources (including sales to other water agencies)
Distribution Pump Stations Energy Use (kWh)	20,819,977	25,498,820	24,873,826	Electricity use at water pump stations excluding lake pump stations
Water Distribution Energy Intensity (kWh/Acre-Foot)	**117**	**149**	**136**	**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 2017-2019, Energy Policy Initiatives Center 2019.

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

4.5.3 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.[42] 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 because SDG&E is the electricity supplier. The electricity emission factors are given in Table 17.

Table 17 Electricity Emission Factors for Water-Energy Intensities

Year	Electricity Emission Factors for Water-Energy Intensities (lbs CO_2e/MWh)	
	Upstream (WECC-California from eGRID)	Local (SDG&E)*
2016	530	527
2017		528
2018		528

*SDG&E emission factors are different from City-specific electricity emission factors shown in Table 7, which are based on percentages of electricity sales to SDG&E bundled and DA customers, SDG&E and DA emission factors.
EPA 2018, Energy Policy Initiatives Center 2019.

For upstream supply and conveyance emissions, the volume of water from SDCWA (treated and untreated) was multiplied by the upstream energy intensities (Table 14) and the upstream electricity emission factor (Table 17). 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 15) and local SDG&E's electricity emission factor (Table 17). 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.

[41] City of San Diego, 2015 Urban Water Management Plan, Table 10-4 Energy Intensity for Wastewater and Recycled Water.
[42] The Western Electricity Coordinating Council (WECC) CAMX (eGRID Subregion) emission rate (530 lbs CO_2e/MWh) from eGRID was used as representative of the average California electricity emission rate for upstream electricity. U.S. EPA. eGRID 2016 Edition. Released February 15, 2018, accessed June 29, 2018.

For local water distribution emissions, total water within the City (excluding sales to other agencies) was multiplied by the water distribution energy intensity (Table 16) and local SDG&E's electricity emission factor (Table 17). 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-FootTable 16) and local SDG&E's electricity emission factor (Table 17). 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.

In 2018, 89% of the GHG emissions in the water category were from upstream supply and conveyance. The breakdown of emissions for the water category is given in Figure 7.

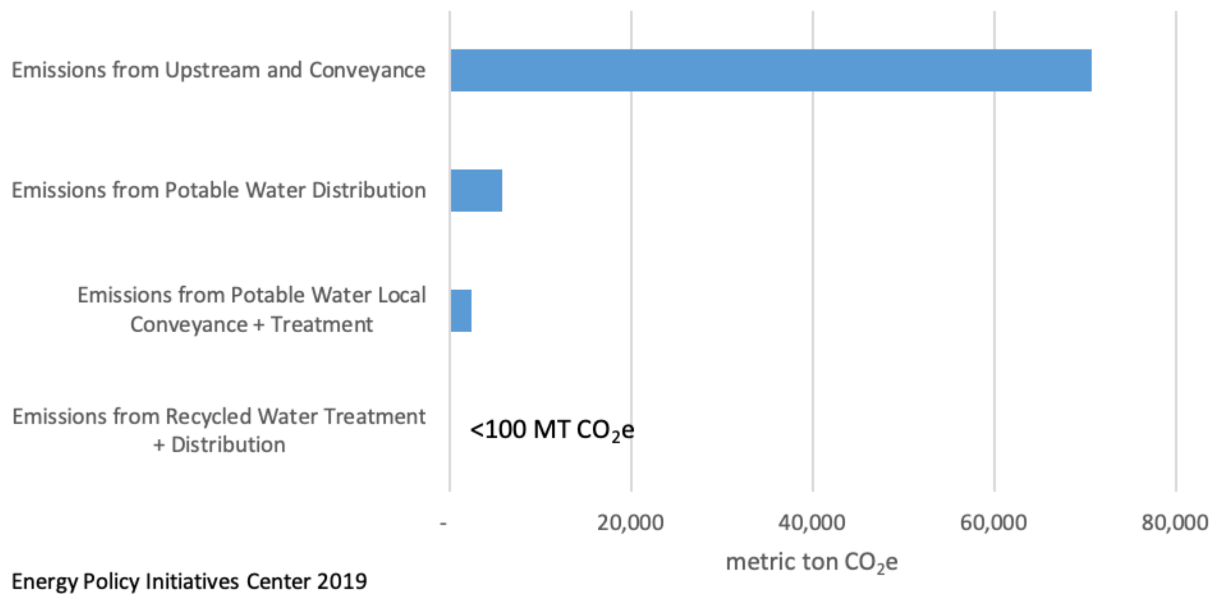


Figure 7 Emissions from the Water Category by Water System Segment (San Diego, 2018)

The total potable and recycled water supplied and the corresponding GHG emissions from the water category for 2016 to 2018 are given Table 18.

Table 18 Water Supplied and GHG Emissions from the Water Category (San Diego 2016, 2017 and 2018)

Year	Potable Water Supplied (Acre-Feet)	Potable Water GHG Intensity (MT CO_2e/Acre-Feet)	Recycled Water Supplied (Acre-Feet)	Recycled Water GHG Intensity (MT CO_2e/Acre-Feet)	GHG Emissions (MT CO_2e)
2016	170,631	0.43	5,024	0.01	73,000
2017	164,226	0.41	5,189	0.01	67,000
2018	175,932	0.45	10,019	0.01	79,000

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 2019.

4.6 Wastewater

The emissions from wastewater generated by San Diego were estimated by multiplying the total amount of wastewater generated in a given year 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.'[43]

4.6.1 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.[44]

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 19.

Table 19 City of San Diego Wastewater Generation (San Diego 2016, 2017 and 2018)

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
2016	85%	5%	10%	101	36,719
2017	86%	5%	10%	103	37,632
2018	86%	4%	10%	100	36,391

Sum may not add up to totals due to rounding.
WWTP – wastewater treatment plant; WRP – water reclamation plant.
City of San Diego 2017-2019, Energy Policy Initiatives Center 2019.

[43] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.0 (2012), Appendix F: Wastewater and Water Emission Activities and Sources.
[44] 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.

4.6.2 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.[45] 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 from 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 gallon) at Point Loma WWTP and North City WRF are calculated by dividing the reported GHG emissions by the plants' wastewater flows, as shown in Table 20.[46]

Table 20 Emission Factors at Wastewater Treatment Plant (San Diego, 2016 and 2017)

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)
2016	48,834	22,584	0.46	5,756	7,283	1.27
2017	51,027	22,102	0.43	5,749	7,434	1.29

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, 2017 and 2018. Energy Policy Initiatives Center, 2018.

4.6.3 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 21.

[45] CARB: Mandatory GHG Reporting – Reported Emissions. 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.
[46] Point Loma WWTP and North City WRP GHG Reports and the wastewater flow into each facility were provided by City of San Diego in August 2017 and July 2018.

Table 21 Wastewater Generated and GHG Emissions from Wastewater Category (San Diego 2016, 2017 and 2018)

Year	Total Wastewater Generated (Million Gallons/year)	Wastewater Emission Factor (MT CO_2e/ Million Gallon)	GHG Emissions (MT CO_2e)
2016	36,719	0.58	21,000
2017	37,632	0.56	21,000
2018	36,391	0.55	20,000

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 2019.

5 INVENTORY UPDATES

In preparing the 2019 CAP Annual Report and 2018 GHG emissions inventory, revisions and refinements were made to the 2016 and 2017 GHG emissions presented in the previous 2018 CAP Annual Report to reflect updated data supplied by agencies not managed by the City, and to ensure consistency with the 2018 GHG emissions estimates. This section provides descriptions of the inventory updates since the 2018 CAP Annual Report.

This approach to update inventories follows the procedures used by CARB for the California statewide inventory, and is based on IPCC recommendations to maintain a consistent time-series when developing GHG inventories.[47] CARB publishes annually a supplement summarizing GHG inventory revisions along with the statewide GHG inventory.[48]

5.1 On-Road Transportation: Vehicle Miles Traveled Adjustment

In this inventory update, 2016 Series 14 average weekday VMT estimates provided by SANDAG were used directly for 2016 emissions inventory calculation. VMT estimates for 2017 and 2018 VMT were derived by applying the San Diego region's annual rates of VMT increase from CalTrans HPMS public road data to the SANDAG Series 14 2016 VMT estimates.

Previously, SANDAG Series 12 average weekday VMT were used and adjusted with CalTrans HPMS data to estimate 2013–2017 VMT.

With the most recent and newly available SANDAG 2016 VMT data, the 2016 and 2017 annual average VMT reported in this document are less than 1% lower than the 2016 and 2017 annual average VMT reported in the 2018 CAP Annual Report appendix, as show in Figure 8 below.

[47] CARB: California Greenhouse Gas Emissions for 2000 to 2017. Trends of Emissions and Other Indicators, p. 16 Additional Information (2019), accessed October 21, 2019.
[48] CARB: Inventory Updates since the 2018 Edition of the Inventory, supplement to the Technical Support Document (August 2019), accessed October 21, 2019.

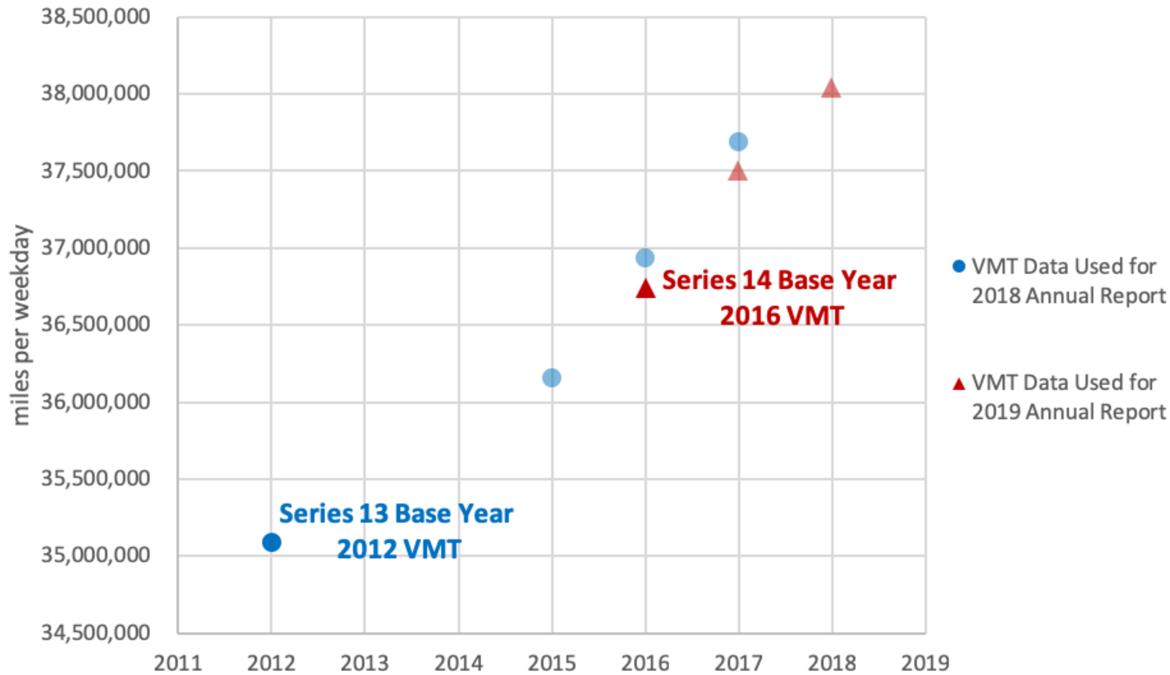


Figure 8 Comparison of VMT Data Used in 2018 and 2019 Annual Report

SANDAG is in the process of developing the 2021 Region Plan (the Vision Plan), if the VMT model is updated in support of the Vision Plan, the VMT estimates will be updated accordingly in the next Annual Report.

5.2 Electricity: Updated 2017 Electricity Emission Factor

To calculate the emissions from electric generation at SDG&E's owned power plants (Miramar Energy Facility, Palomar Energy Center, Desert Star Energy Center, and Cuyamaca Energy Center), the fuel consumption and the net electric generation from the FERC Form 1 Electric Utility Annual Report is used. The reports are available annually and latest data available as of October 2019, are the 2018 reporting year data.[49]

In the previous 2018 Annual Report and 2017 GHG inventory, the 2017 FERC Form 1 Electric Utility Annual Report for report year 2017 was not available in August 2018. The plant net generation and annual heat input in 2016 from EPA eGRID 2016 edition was used for year 2017. The change in the estimated 2017 SDG&E electricity emission factor as a result of the difference, 528 lbs CO2e/MWh compared with 531 lbs CO2e/MWh reported in 2018 Annual Report, is less than 1%.

6 RANGES IN EMISSIONS INVENTORY ESTIMATES

Uncertainty arises whenever GHG emissions are quantified and is a key component of GHG emissions data quality management. The GHG Protocol' Initiative's *Guidance on Uncertainty Assessment in GHG Inventories and Calculating Statistical Parameter Uncertainty (the Guidance)*, developed based on IPCC's guideline for national GHG inventories, provides an overview of the types of uncertainties in GHG

[49] FERC: Form 1 – Electric Utility Annual Report: Report Year 2018, updated July 9, 2019, and accessed September 18, 2019.

inventory and the methods to estimate the uncertainty.[50] The Guidance discusses two types of estimation uncertainty. One is model uncertainty, referring to uncertainty associated with the mathematical models used to characterize the relationships between parameters and emission process. An example of the mathematical model is the CARB Landfill Emissions Tool discussed in Section 4.4.4, that models the GHG emissions from the organic waste decay process. Uncertainty may rise if incorrect model or incorrect inputs to the model is used.

The other type of uncertainty is parameter uncertainty, referring to the uncertainty associated with quantifying the parameters used as input data. Examples of the parameters used to estimate GHG emissions are activity data (MWh of electricity sales, miles of VMT) and emission factors (lbs CO_2e/MWh of electricity, g CO_2e/mile of average vehicle).

The parameter uncertainty is the focus in this section because the emissions estimation model used in this document, using U.S. Community Protocol, is based on activity data times an emission factor that does not include model uncertainty (i.e., the correlation between emissions and activity data is linear). Parameter uncertainty can be calculated using statistical analysis (e.g., probability distribution), precision in measurement equipment, or other judgements.

Due to data limitations, only the uncertainty of parameters associated with on-road transportation, electricity, and natural gas emissions category are calculated here. However, these three emissions categories represent 96% of the total emissions, as shown in Figure 1, the uncertainty in these categories largely determines the aggregated uncertainty of the total emissions. The following Table 22 shows the ranges of input data in each emission category as percentages, based on variations in parameters from difference sources or different versions of the same parameter source.

Table 22 Ranges of Input Data in Each Emissions Category for 2018 GHG Inventory

Emissions Category	Parameter (Input Data)	Lower Bound (%) and Methods	Upper Bound (%) and Methods
Transportation	VMT (annual miles)	-3.8% Difference between the 2018 VMT used and 2018 VMT interpolated between SANDAG Series 13 2012 Estimates and 2020 Projection	0.5% Difference between the 2018 VMT used and the 2018 VMT projected with SANDAG Series 13 2012 Estimates and 2012-2018 HPMS annual rate of Increase
	Average Vehicle Emission Rate (g CO_2e/mile)	N/A	-1.9% Difference between EMFAC2017 vehicle emission rates used and EMFAC2014 vehicle emission rates
Electricity	Direct Access Emission Factor* (lbs CO_2e/MWh)	-12.2% Difference between the default emission factor used and the emission factor adjusted with the estimated 2018 renewable content in electricity from electric service providers	N/A
Natural Gas	Natural Gas Sales (therms)	-0.1%	0.3%

[50] GHG Protocol Initiative: Guidance on Uncertainty Assessment in GHG Inventories and Calculating Statistical Parameter Uncertainty, accessed November 1, 2019.

Emissions Category	Parameter (Input Data)	Lower Bound (%) and Methods	Upper Bound (%) and Methods
		Lower bound of differences among energy data from multiple requests with the same criteria for the same data year	Upper bound of differences among energy data from multiple requests with the same criteria for the same data year
The ranges possible in all other parameters such as the natural gas emission factor and SDG&E bundled electricity emission factor are not determined. The uncertainty in electricity sales data is less than 0.1% and not included here. *Direct access emission factor is not the city-specific emission factor and only applied to the electricity sales of DA customers. The default direct access emission factor is 836 lbs CO_2e/MWh, however, one of the assumptions used to calculate the emission factor is 20% renewables in 2012. All electric service providers have to meet the 33% Renewables Portfolio Standard by 2020, therefore, the emission factor is adjusted to 734 lbs CO_2e/MWh in 2018 assuming they have 30% renewables in electricity in 2018. Energy Policy Initiatives Center 2019.			

As a result of the parameter uncertainty, the resulting ranges in each emissions category is given in Table 23 below and presented in Figure 2 *Ranges in Emissions by Category in San Diego (2018)* in Section 3.

Table 23 Range in Each Emissions Category for 2018 GHG Inventory

Emissions Category	Range Lower Bound (%)	Range Upper Bound (%)
Transportation	-3.9%	2.4%
Electricity	-3.3%	N/A
Natural Gas	-0.1%	0.3%
Energy Policy Initiatives Center 2019.		

Appendix A. SAN DIEGO VMT BY TRIP TYPE

Average weekday VMT data tables were provided by SANDAG (from SANDAG ABM Series 14, Release 14.0.1). Emphasis (red squares and text) was added by EPIC. Red outlines indicate how the values are used in the calculation of on-road transportation emissions.

2016 VMT ID232						
JURISDICTION	TOTAL VMT	TOTAL City of San Diego VMT	Two Trip End City of San Diego VMT	One Trip End City of San Diego VMT	NON-City of San Diego VMT	City of San Diego Intra-Zonal VMT
		I-I, I-E and E-I	I-I	I-E and E-I	E-E	INTRA
CARLSBAD TOTAL	3,325,095	868,373	-	868,373	2,456,722	
CHULA VISTA TOTAL	3,965,775	1,895,401	-	1,895,401	2,070,373	
CORONADO TOTAL	278,171	163,058	-	163,058	115,114	
DEL MAR TOTAL	69,282	47,369	-	47,369	21,912	
EL CAJON TOTAL	2,038,191	728,332	-	728,332	1,309,859	
ENCINITAS TOTAL	1,848,672	980,699	-	980,699	867,973	
ESCONDIDO TOTAL	2,794,689	1,019,902	-	1,019,902	1,774,787	
External TOTAL	221,430	111,956	-	111,956	109,475	
IMPERIAL BEACH TOTAL	100,878	48,849	-	48,849	52,028	
LA MESA TOTAL	1,666,499	1,020,350	-	1,020,350	646,149	
LEMON GROVE TOTAL	856,247	521,835	-	521,835	334,412	
NATIONAL CITY TOTAL	1,714,854	1,225,149	-	1,225,149	489,705	
OCEANSIDE TOTAL	2,898,843	337,940	-	337,940	2,560,903	
POWAY TOTAL	912,421	505,190	-	505,190	407,230	
SAN DIEGO TOTAL	38,879,701	35,557,485	22,073,116	13,484,368	3,322,216	34,460
SAN MARCOS TOTAL	2,106,532	274,345	-	274,345	1,832,187	
SANTEE TOTAL	1,021,814	459,198	-	459,198	562,615	
SOLANA BEACH TOTAL	641,694	469,353	-	469,353	172,341	
Unincorporated TOTAL	16,311,317	5,074,436	-	5,074,436	11,236,881	
VISTA TOTAL	1,767,334	106,885	-	106,885	1,660,449	
REGIONWIDE TOTAL	83,419,438	51,416,106	22,073,116	29,342,990	32,003,331	34,460

0% of E-E VMT

100% of I-I VMT

50% of I-E/E-I VMT

Figure A-1 Estimated San Diego 2016 VMT by Trip Type (Series 14)