Appendix A – Community Inventory and Forecast Methodology

City of Sacramento Climate Action Plan Update

prepared for

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March 2020

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1 Introduction

California considers greenhouse gas emissions (GHG) emissions and the impacts of climate change to be a serious threat to the public health, environment, economic well-being, and natural resources of the State, and has taken an aggressive stance to mitigate the impact on climate change at the State-level through the adoption of legislation and policies. Many cities have developed local climate action plans and aligned goals to correspond with State emissions reduction targets. The two major State GHG-related goals are established by Assembly Bill (AB) 32 and Senate Bill (SB) 32. AB 32 required State agencies reduce State GHG emissions to 1990 levels by 2020 whereas SB 32 requires a 40 percent reduction below 1990 levels by 2030. The goals set by AB 32 were achieved by the State in 2016[1] and many jurisdictions are completing GHG inventories to quantify progress toward their own 2020 goals as well as develop targets to align with the requirements of SB 32.

This technical appendix provides a complete analysis of the previous community-wide GHG emissions inventories completed for the City of Sacramento's 2005 and 2011[2] emissions as well as details on the methodology used for the 2016 inventory update which is also used as the baseline for the forecasting process. Emissions are forecast for the years 2020, 2025, 2030, 2040, and 2045 to align with State and City targets.

Estimating GHG emissions enables local governments to establish an emissions baseline, track emissions trends, identify the greatest sources of GHG emissions within their jurisdictions, and set targets for future reductions. This inventory is intended to inform completion of a qualified GHG reduction plan for the City of Sacramento and is compliant with the ICLEI – Local Governments for Sustainability (ICLEI) *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*[3] (Community Protocol) as well as California Environmental Quality Act (CEQA) Guidelines Section 15183.5(b) for the requirements of a 'qualified' GHG emissions reduction plan. Methodology for some sections has been updated slightly to conform with the industry standard for California cities as recommended in the Association for Environmental Professionals (AEP) *California Supplement to the United States Community-Wide GHG Emissions Protocol*[4] (California Supplement). Emissions inventories are an iterative process and each year must be viewed in the context of other inventories and relative trends of each sector to maintain consistency with the emissions inventory methods and factors.

Emissions contained within this inventory include activities under the jurisdictional control or significant influence of the City of Sacramento, as recommended by AEP in preparing Community Protocol and CEQA-compliant inventories.[4] The municipal operations inventory is a subset of the community-wide inventory, meaning the municipal emissions are included within the community-

[1] California Air Resources Board. California Greenhouse Gas Emissions Inventory. Accessed at: https://ww3.arb.ca.gov/cc/inventory/inventory.htm. Accessed on: July 2019

[2] Portions of the 2011 inventory were extrapolated based on growth from 2005 levels and therefore all sectors may not be comparable.

[3] ICLEI. 2013. U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.1

[4] Association of Environmental Professionals. 2013. The California Supplement to the United States Community-Wide Greenhouse Gas (GHG) Protocol.

wide inventory. These municipal emissions calculations and forecast are included in a separate technical appendix.

1.1 Executive Summary

The City of Sacramento has completed a GHG inventory for the 2016 calendar year to measure progress toward its 2020 GHG reduction goals as set in the first City of Sacramento Climate Action Plan[5] and assist in the development of an updated plan by developing a forecast and gap analysis to identify climate action plan policies that will be needed to achieve longer term targets. SB 32[6] established 2030 as the next major milestone of GHG reduction targets. The 2016 City of Sacramento inventory was used to develop a forecast to assist the City in setting targets which are consistent with State-level goals and the City of Sacramento General Plan which is currently being updated. Two projections were developed for the City to quantify expected emissions over time; a *business-as-usual scenario* and an *adjusted scenario*.

In 2016, the City of Sacramento's emissions are estimated to be 3,424,728 metric tons (MT) of carbon dioxide equivalent (CO_2e). A summary of these emissions by sector is provided in Table 1 with a discussion of the inventory methodology and detailed results in Section 3. A summary of the emissions forecast by year through 2045 is provided in Table 4 with further discussion in Section 4.

Table 1 2016 GHG Inventory

Sector	Activity Data	Emission Factors	Units	MT CO_2e
Residential Electricity (kWh)	1,423,419,583	0.000224	MT CO_2e/kWh	318,275
Residential Gas (therms)	59,977,656	0.00531	MT CO_2e/therm	318,304
Industrial and Commercial Electricity (kWh)	2,191,180,705	0.00022	MT CO_2e/kWh	489,945
Commercial Gas (therms)	28,980,911	0.00531	MT CO_2e/therm	153,803 [1]
District Gas (therms)	3,432,409	0.00531	MT CO_2e/therm	18,216 [1]
Transportation (VMT)	4,347,013,534	0.000445	MT CO_2e/mile	1,935,870
Generated Waste (tons)	525,968	0.255412	MT CO_2e/Ton	134,339
Waste-In-Place	N/A[2]	N/A[2]	MT CO_2e/Ton	26,504
Wastewater (kWh)	N/A[3]	N/A[3]	MT CO_2e/kWh	19,867
Water (kWh)	42,963,998	0.00022	MT CO_2e/kWh	9,607
Total Emissions				**3,424,728**

MWh: megawatt hours; kWh: kilowatt hours; CO_2e: carbon dioxide equivalent; MT: metric tons; VMT: vehicle miles traveled

[1] No natural gas usage was reported for large industrial users due to California Public Utilities Commission privacy rules. The remaining industrial usage is from Pacific Gas & Electric "district" users.

[2] Waste-in-place is a direct output of a landfill gas modeling system and does not have activity data

[3] Wastewater is a combination of stationary and process emissions, further detail is Section 3.3.

[5] City of Sacramento. 2012. City of Sacramento Climate Action Plan. *Accessed at* http://www.cityofsacramento.org/~/media/Corporate/Files/CDD /Resources/Online%20Library/CAP%20Climate%20Action%20Plan/3__Chapter_1_Intro%20CAP.pdf Accessed on: June 2019

[6] Senate Bill 32 requires the State of California to reduce its overall greenhouse gas emissions 40 percent from 1990 levels by 2030.

Figure 1 2016 City of Sacramento Community Emissions by Sector

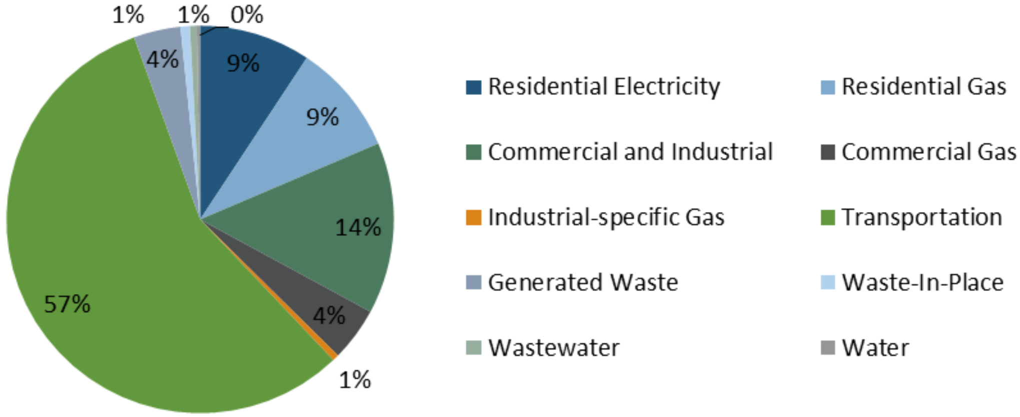


Table 2 Summary of Emissions Changes from 2005 to 2016

	2005 (MT CO_2e)	2016 (MT CO_2e)	Percent Change
Residential Electricity	365,319	318,275	-13%
Commercial/Industrial Electricity	624,811	489,945	-22%
Residential Gas	348,859	318,304	-9%
Commercial/District Gas	186,527	172,019	-8%
Waste	455,222	160,843	-65%
Water	12,810	9,607	-25%
Wastewater	57,380	19,867	-65%
Transportation	2,184,617	1,935,870	-11%
Total Emissions	4,235,545	3,424,728	-19%
Emissions Per Capita	9.57	7.04	-26%

MT CO_2e: metric tons of carbon dioxide equivalent

Since 2005 the City of Sacramento has reduced overall emissions by 18 percent and has seen emissions reductions in every sector as seen in Table 2 Summary of Emissions Changes from 2005 to 2016. Major reductions were seen in the waste sector and wastewater sectors although these sectors make up smaller proportions of the City's overall emissions. Reductions in the natural gas sector were driven primarily by a reduction in gas consumption whereas emissions reductions in the electricity and transportation sectors were driven entirely by reductions in emission factors and saw increases in activity data as shown in Table 3. During this time the City saw an increase in population of 10 percent which resulted in a 26 percent reduction in per capita emissions from 2005 to 2016. This translated to a 19 percent reduction in total GHG emissions from 2005 to 2016. This reduction exceeds the emission reduction target of 15 percent below 2005 levels by 2020 and therefore, if emissions do not increase over the next four years, the 2020 CAP target is expected to be met.

Table 3 Summary of Activity Data Changes from 2005 to 2016

Raw Activity Data	2005 Activity Data	2016 Activity Data	Percent Change
Population	442,662	486,154	10%
Residential Electricity	1,307,301,693	1,423,419,583	9%
Residential Gas Therms	65,698,581	59,977,656	-9%
Commercial Electricity kWh	2,235,898,207	2,191,180,705	-2%
District Industrial Gas Therms	5,339,537	3,432,409	-36%
Commercial Gas Adjusted	29,788,020	28,980,911	-3%
Wastewater kWh	N/A	99,541,452	N/A
Water kWh	N/A	40,101,359.00	N/A
Waste Tons	684,088	525,968	-23%
VMT	4,175,278,800	4,347,013,534	4%
VMT Emission Factor (MT CO_2e/VMT)	0.000523	0.000445	-17%
SMUD Elec Factor (MT CO2e/MWh)	0.279444984	0.223598625	-20%

MT CO_2e: metric tons of carbon dioxide equivalent
kWh: Thousand watt hours
MWh: Million watt hours

A *business-as-usual (BAU)* forecast provides a forecast of how GHG emissions would change over time if consumption trends continue as they did in 2016 and growth were to occur as projected in the City's current General Plan, absent any regulations which would reduce local emissions. The results of the (BAU) scenario are shown in Table 4. Additional discussion on the Business-as-Usual Forecast is included in Section 4.2.

A more informative metric for future emissions is the adjusted forecast. An adjusted forecast incorporates State and federal programs which are currently codified and are expected to continue being implemented through 2045, such as SB 100 and California Air Resources Board (CARB) tailpipe emissions standards. This forecast provides a more accurate picture of future emissions growth and the emissions reduction the City and community will be responsible for after State regulations are implemented. Calculating the difference between the adjusted scenario GHG emissions forecast and the reduction targets set by the City determines the gap to be closed through City Climate Action Plan policies. The results of the adjusted scenario forecast are included in Table 5 and Figure 2.

Table 4 Business-as-Usual Forecast Summary by Sector by Year

	2016 (MT CO_2e)	2020 (MT CO_2e)	2025 (MT CO_2e)	2030 (MT CO_2e)	2040 (MT CO_2e)	2045 (MT CO_2e)
Population	486,154	518,627	559,218	599,809	670,836	699,903
Jobs	217,500	253,837	299,258	344,679	408,640	426,346
Residential Electricity	318,275	339,534	366,108	392,682	439,182	458,212
Commercial/Industrial Electricity	489,945	571,798	674,115	776,431	920,511	960,396
Residential Gas	318,304	339,565	366,141	392,718	439,222	458,253
Commercial/District Gas	172,019	200,757	236,680	272,603	323,190	337,193
Waste	160,843	176,572	196,233	215,893	246,749	257,441
Water	9,607	10,546	11,720	12,895	14,738	15,376
Wastewater	19,867	21,810	24,238	26,667	30,478	31,799
Transportation	1,935,870	1,982,469	2,040,717	2,098,965	2,215,462	2,318,636
Total Emissions	**3,424,728**	**3,643,050**	**3,915,952**	**4,188,855**	**4,629,532**	**4,837,306**
Emissions Per Capita	**7.04**	**7.02**	**7.00**	**6.98**	**6.90**	**6.91**

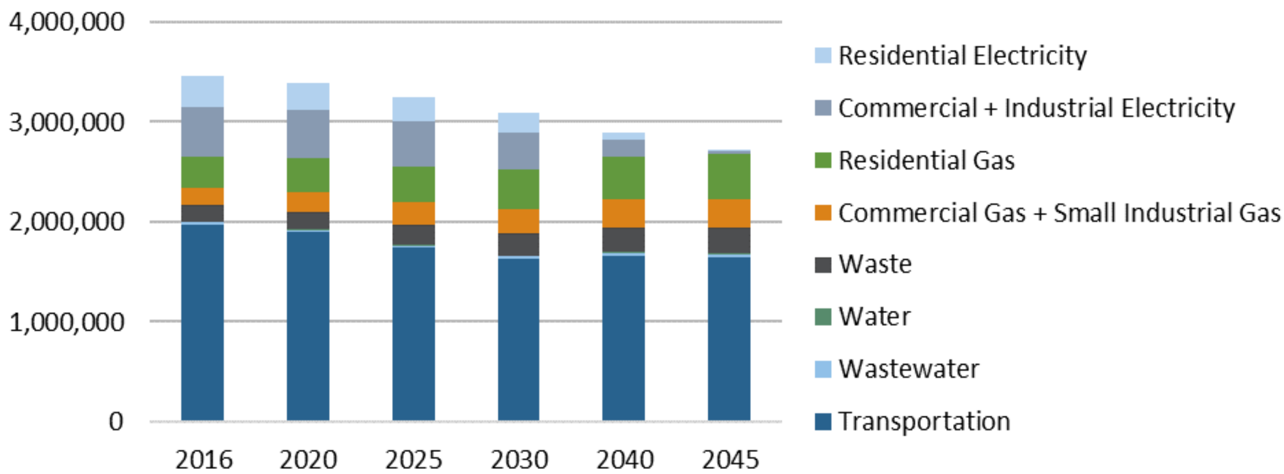
MT CO_2e: metric tons of carbon dioxide equivalent

Table 5 Adjusted Forecast Summary by Sector by Year

	2016 (MT CO_2e)	2020 (MT CO_2e)	2025 (MT CO_2e)	2030 (MT CO_2e)	2040 (MT CO_2e)	2045 (MT CO_2e)
Population	486,154	518,627	559,218	599,809	670,836	699,903
Jobs	217,500	253,837	299,258	344,679	408,640	426,346
Residential Electricity	318,275	282,001	244,445	192,905	76,710	0
Commercial/Industrial Electricity	489,945	473,740	446,096	378,081	161,952	0
Residential Gas	318,304	339,193	363,909	388,625	431,874	449,573
Commercial/District Gas	172,019	198,602	223,748	248,894	284,304	294,107
Waste	160,843	176,572	196,233	215,893	246,749	257,441
Water	9,607	8,832	8,204	6,877	2,948	0
Wastewater	19,867	21,810	24,238	26,667	30,478	31,799
Transportation	1,935,870	1,783,491	1,563,815	1,405,213	1,350,195	1,343,471
Total Emissions	**3,424,728**	**3,284,240**	**3,070,688**	**2,863,156**	**2,585,211**	**2,376,391**
Emissions Per Capita	**7.04**	**6.33**	**5.49**	**4.77**	**3.85**	**3.40**

MT CO_2e: metric tons of carbon dioxide equivalent

Figure 2 Adjusted GHG Emissions Forecast Results by Sector and Forecast Year



1.2 Background

The State of California considers GHG emissions and the impacts of global warming to be a serious threat to the public health, environment, economic well-being, and natural resources of California, and has taken an aggressive stance to mitigate the State's impact on climate change through the adoption of legislation and policies, the most relevant of which are summarized below.

- **Executive Order S-3-05,** signed by former Governor Schwarzenegger in 2005, establishes statewide GHG emissions reduction goals to achieve long-term climate stabilization as follows: by 2020, reduce GHG emissions to 1990 levels and by 2050, reduce GHG emissions to 80 percent below 1990 levels. The 2050 goal was accelerated by the 2045 carbon neutral goal established by Executive Order (EO) B-55-18, as discussed below.[7]
- **Assembly Bill 32,** known as the Global Warming Solutions Act of 2006, requires California's GHG emissions be reduced to 1990 levels by the year 2020 (approximately a 15 percent reduction from 2005 to 2008 levels). The AB 32 Climate Change Scoping Plan, first published in 2008, identifies mandatory and voluntary measures to achieve the statewide 2020 emissions limit, and encourages local governments to reduce municipal and community GHG emissions proportionate with State goals.[8]
- **Senate Bill 32,** signed by former Governor Brown in 2016, establishes a statewide mid-term GHG reduction goal of 40 percent below 1990 levels by 2030. CARB formally adopted an updated Climate Change Scoping Plan in December 2017, laying the roadmap to achieve 2030 goals and giving guidance to achieve substantial progress toward 2050 State goals.
- **Executive Order B-55-18,** signed by former Governor Brown in 2018, expanded upon EO S-3-05 by creating a statewide GHG goal of carbon neutrality by 2045. EO S-55-18 identifies CARB as

[7] Executive Orders are binding only unto State agencies. Accordingly, EO S-03-05 will guide State agencies' efforts to control and regulate GHG emissions but will have no direct binding effect on local government or private actions.

[8] Specifically, the AB 32 Climate Change Scoping Plan states CARB, "encourages local governments to adopt a reduction goal for municipal operations emissions and move toward establishing similar goals for community emissions that parallel the State commitment to reduce GHG emissions by approximately 15 percent from current levels by 2020" (p. 27). "Current" as it pertains to the AB 32 Climate Change Scoping Plan is commonly understood as between 2005 and 2008.

the lead agency to develop a framework for implementation and progress tracking toward this goal in the next Climate Change Scoping Plan Update.

The State of California, via CARB, has issued several guidance documents concerning the establishment of GHG emissions reduction targets for local climate action plans to comply with legislated GHG emissions reductions goals and CEQA Guidelines Section 15183.5(b). In the first California *Climate Change Scoping Plan,*[9] CARB encouraged local governments to adopt a reduction target for community emissions paralleling the State commitment to reduce GHG emissions. In 2016, the State adopted SB 32 mandating a reduction of GHG emissions by 40 percent from 1990 levels by 2030 and in 2017 CARB published *California's 2017 Climate Change Scoping Plan* (hereafter referred to as the Scoping Plan Update) outlining the strategies the State will employ to reach these targets.[10] With the release of the Scoping Plan Update, CARB recognized the need to balance population growth with emissions reductions and in doing so, provided a new methodology for proving consistency with State GHG reduction goals through the use of per capita efficiency targets. These targets are generated by dividing a jurisdiction's GHG emissions for each horizon year by the jurisdiction's total population for that target year and are discussed further in Section 5.

1.3 Greenhouse Gases

The 2016 City of Sacramento Community Inventory was developed using the Community Protocol[11] and California Supplement.[12] Emissions were calculated using the principles and methods from these protocols. Emissions from nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2) are included in this assessment. Each GHG has a different capability of trapping heat in the atmosphere, known as its global warming potential (GWP), which is normalized relative to CO_2 and expressed as carbon dioxide equivalent, or CO_2e. The CO_2e values for these gases are derived from the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change GWP values for consistency with the yearly CARB GHG inventory, as shown in Table 6.[13,14]

Table 6 Global Warming Potentials of Greenhouse Gases

Greenhouse Gas	Molecular Formula	Global Warming Potential (CO_2e)
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298

MT CO_2e: metric tons of carbon dioxide equivalent

[9] California Air Resources Board. 2008. Climate Change Scoping Plan. Accessed at: https://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf. Accessed on: June 20, 2019

[10] California Air Resources Board. California's 2017 Climate Change Scoping Plan. Accessed at: https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf. Accessed on: June 20, 2019

[11] ICLEI. 2012. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions.

[12] Association of Environmental Professionals. 2013. The California Supplement to the United States Community-Wide Greenhouse Gas (GHG) Protocol. Accessed at: https://califaep.org/docs/California_Supplement_to_the_National_Protocol.pdf. Accessed on: June 20, 2019

[13] Intergovernmental Panel on Climate Change. 2007. Fourth Assessment Report: Climate Change. Direct Global Warming Potentials.

[14] All calculations use Intergovernmental Panel on Climate Change Fourth Assessment Report GWP values with the exception of the first order of decay modeling performed for waste-in-place at the 28th Street and L&D landfills, which use a static SAR2 GWP value for methane of 21 and cannot be altered.

1.4 Excluded Emissions

The following emissions sectors have been excluded from both the 2005 and 2011 inventories and therefore were also excluded from the 2016 inventory and emissions forecast. Additional updates were also made to the 2005 and 2011 inventories in order to maintain consistency between all inventory years. These changes are summarized in Sections 2.2 and 2.3.

Consumption-based Emissions

GHG emissions from consumption of goods within the city are excluded from the inventory and forecast of City of Sacramento emissions. Currently there exists no widely accepted standard methodology for reporting consumption-based inventories.

Natural and Working Lands

GHG emissions from carbon sinks and sources in natural and working lands are not included in this inventory and forecast due to the lack of granular data and standardized methodology. CARB has included a state-level inventory of natural and working lands in the 2017 Scoping Plan Update[15] greenhouse gas inventory; however, at the time of this City of Sacramento community-wide inventory, sufficient data and tools were not available to conduct a jurisdiction-specific working lands inventory. The Nature Conservancy and California Department of Conservation[16] are exploring options for a tool which may be able to perform these inventories at a more specific geographic level.

Agricultural Emissions

Emissions from agricultural activities are not included in this inventory as the Community Protocol and California Supplement[17] both note agricultural activity is not a required component of Community Protocol inventories and should be included only if relevant to the community conducting the inventory. Regulations exist to encourage urban agriculture within the City boundaries. Many of the emissions from these activities (e.g. energy) are covered under other sectors included in this inventory and no major commercial-scale livestock activity is noted within the city boundaries.

High GWP

High GWP emissions, including chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs) used as substitutes for ozone-depleting substances are not included in this inventory as it is not a required component of the Community Protocol and the California Supplement notes these emissions are not generally included in California inventories, including in Sacramento.

Off-Road Emissions

To maintain consistency with previous inventories (2005 and 2011) off-road emissions were not included in this analysis.

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15 California Air Resources Board. 2017. California's Climate Change Scoping Plan.

16 California Department of Conservation. TerraCount Scenario Planning Tool. Accessed at: https://maps.conservation.ca.gov/terracount/. Accessed on: May 15, 2019

17 Association of Environmental Professionals. 2013. *The California Supplement to the United States Community-Wide Greenhouse Gas (GHG) Emissions Protocol.* https://califaep.org/docs/California_Supplement_to_the_National_Protocol.pdf

1.5 Forecast and Target Years Summary

Prior to 2016, the City of Sacramento completed two community-wide GHG emissions inventories, one for the year 2005 and an updated inventory for 2011. Portions of the 2011 inventory, including water, waste-in-place, and transportation, allocated emissions based solely on the overall growth of the city and therefore an accurate historical comparison between all inventories may not be feasible without further modifications to previous inventories as discussed in Section 2.

The emissions forecast is based upon the latest available data from City GHG inventories, in this case the 2016 inventory completed by Rincon. This forecast uses benchmark years of 2020, 2025, 2030, 2040 and 2045, consistent with currently codified GHG reduction targets or executive orders which are expected to be codified in future, and a target of carbon neutrality on or before 2045.

The forecast years align with the following targets:

- 2020 (AB 32)
- 2025 (progress evaluation)
- 2030 (SB 32)
- 2040 (General Plan horizon year)
- 2045 (EO B-55-18)

The 2030 and 2040 targets are required for consistency with SB 32 and the Sacramento 2040 General Plan Update respectively, while the remainder of the targets identify a clear path and milestones of progress toward the long-term State reduction goals.

2020 Progress

The first City of Sacramento Climate Action Plan was adopted in 2012. It identified how the City and broader community can reduce the City of Sacramento's GHGs and included a GHG emissions reduction target of 15 percent reduction below 2005 emissions levels by 2020 or 3,600,213 MT of CO_2e. The City of Sacramento Climate Action Plan was incorporated into the City's 2035 General Plan[18] and adopted in 2015. Based on the 2016 inventory the City of Sacramento exceeded the 2020 reduction goal by 4.8 percent and four years ahead of schedule by emitting an estimated 3,424,728 MT of CO_2e.

This 2016 inventory and forecast also considered per capita emissions reductions due to the rate at which Sacramento has grown since 2005. In 1990, GHG emissions were an estimated 9.75 MT CO_2e per person. This was calculated by back-casting the 2005 GHG inventory to 1990 (which assumes a 15 percent emission increase from 1990 to 2005) and then dividing by the 1990 population. In 2016, per capita emissions dropped to 7.04 MT CO_2e per person. This equates to an emissions reduction of 26 percent below 2005 levels and 28 percent below 1990 levels. Details and discussion of previous inventories and changes made for consistency as part of this update can be found in Section 2.

[18] City of Sacramento. 2035 General Plan. Accessed at: http://www.cityofsacramento.org/Community-Development/Resources/Online-Library/2035--General-Plan Accessed on: May 15, 2019

2 Previous Inventories

A summary of previous GHG emissions inventories can be found in Table 7. A description of the variability between methodologies used in each of the inventory years is summarized in the following sections.

Table 7 Sacramento GHG Inventories Summary

Sector	1990[1] (MT CO_2e)	2005[3] (MT CO_2e)	2011[3] (MT CO_2e)	2016 (MT CO_2e)
Residential Energy	607,052	714,178	656,472	636,578
Commercial & Industrial Energy	689,637	811,337	650,627	661,964
Transportation	1,856,925	2,184,617	2,091,154	1,935,870
Generated Waste	344,506	405,301	113,192	134,339
Waste-in-place	42,432	49,921	25,773	26,504
Wastewater	48,773	57,380	18,719	19,867
Water	10,889	12,810	9,804	9,607
Total Emissions	**3,600,213**	**4,235,545**	**3,565,741**	**3,424,728**
Emissions per capita	9.75	9.57	7.58	7.04

MTCO_2e: metric tons of carbon dioxide equivalent

[1] All 1990 inventory data calculated as a 15 percent reduction from 2005 inventory levels per California Air Resources Board guidelines.

[2] Methodology inconsistent, cannot be compared directly to other years

[3] Table 6 reflects the most recent numbers updated for consistency as part of the 2016 inventory and forecast

2.1 1990 Baseline

The State of California uses 1990 as a reference year to remain consistent with AB 32 and SB 32, which codified the State's 2020 and 2030 GHG emissions targets by directing CARB to reduce statewide emissions to 1990 levels by 2020 and 40 percent below 1990 levels by 2030. The City of Sacramento's initial inventory was conducted for the year 2005. The State indicated in the first Climate Change Scoping Plan in 2008 that local governments wishing to remain consistent with State targets could use a 15 percent reduction from 2005-2009 levels as a proxy for a 1990 baseline.[19] The updated 1990 proxy baseline used for target setting by the City of Sacramento is 3,600,213 MT CO_2e.

2.2 2005 Inventory Updates

In 2009, the Sacramento County Department of Environmental Review and Assessment, with guidance from ICF, Jones & Stokes prepared a GHG inventory of 2005 emissions in Sacramento

[19] Due to lack of 1990 inventory data for local governments, page 27 of the 2008 Climate Change Scoping Plan identifies 15 percent below "current" (2005-2009) levels by 2020 as consistent with the State goals of 1990 levels by 2020, allowing local governments to back-cast to develop 1990 baselines for future GHG reduction targets.

County. This inventory included unincorporated areas as well as the cities of Citrus Heights, Elk Grove, Folsom, Galt, Isleton, Rancho Cordova, and Sacramento.

Several updates to the 2005 inventory were performed as part of the current inventory and forecast efforts to align the 2005, 2011, and 2016 methodologies. These included removing large industrial natural gas users, updating the transportation emissions calculation methodologies and updating waste emissions methodology to California-specific emissions factors and AR4 GWP. Complete data for water and wastewater was not available, so the original numbers were left as found.

Natural Gas

Because of the California Public Utility Commission (CPUC) 15/15 Rule[20], although PG&E reported industrial gas use for 2005, PG&E did not report comparable data in 2016. To allow for a comparison between across all years, the 2005 inventory was updated to remove industrial gas. Large industrial emitters removed from the inventories are under the purview of the CARB Cap-and-Trade Program for emissions reductions and are, therefore, also already accounted for in the 2017 Scoping Plan Update. Attempts were made to estimate industrial natural gas emissions through CAP and Trade program data and permits, however, no complete data set could be identified. Therefore, using best available data (utility data provided by PG&E) industrial gas needed to be removed from historical inventories to allow for a consistent comparison of GHG emissions from this sector over time. Because industrial and commercial data was aggregated in the 2005 inventory, an estimate of commercial gas was made by calculating the average of the 2017 and 2016 ratios of commercial gas usage to residential gas usage (0.48207). This ratio was then used to identify the commercial portion of the commercial/industrial aggregated natural gas data. The commercial gas portion was then used to recalculate emissions for 2005 (and 2011) and the estimated industrial portion was dropped.

The ratio of residential to commercial gas use was used to correct for population growth and temperature changes which might have increased or decreased gas use in the city of Sacramento. Natural gas consumption labeled as “district” users, such as fire and school districts, were included in all years. In future years if the California Energy Commission were to change their data aggregation rules, industrial data could be reincorporated.

Waste

In 2005 and 2011, two different waste emission factors were utilized. This caused an increase in emissions from 2005 to 2011 even though the City achieved a 37 percent reduction in overall tonnage. However, neither the 2005 nor 2011 inventory documentation provided clear guidance on the methodologies used to calculate these emission factors. These values also did not make sense as an increase in methane capture occurred during these times. Therefore, to address this problem updated emission factors were derived from a waste characterization study performed by CalRecycle, previously known as the California Integrated Waste Management Board (CIWMB). Factors from the 2004 waste characterization study for the State of California were applied to the 2005 waste tonnage.

Waste-in-place was also assessed for the 2005 inventory. When the waste-in-place inventory was originally completed, it used 2002 as the baseline year for tonnage of waste in the landfills and did

[20] The 15/15 rule states no data can be provided if there are less than 15 users in any sector or if one user makes up more than 15 percent of the total usage. This applies to natural gas and electricity consumption.

not include tonnage added to the landfill from 2002 through 2005. This information was added to the CARB first order decay model and rerun to achieve a more accurate value.

Transportation

The 2005 inventory data provided in the 2012 City of Sacramento Climate Action Plan includes total transportation emissions as well as the daily vehicle miles traveled (VMT).[21] However, detailed emissions factors were not cited. Therefore, the EMFAC2017 model was used to re-calculate an emission factor, weighted average emissions per VMT, for 2005. Recalculating the emission factor and updating the 2005 inventory ensures consistency with future inventories and provides transparency for future work if needed. While not able to verify the methodology used to derive the VMT number, the VMT values appear to be consistent between inventory years and a note in the previous inventory files indicated that the data was established using the Regional Targets Advisory Committee (RTAC) origin-destination model.

Summary of Inventory Data

Table 8 and Table 9 include all of the activity data, emission factors, and total emissions available for both the original 2005 inventory (Table 8) and the updated inventory (Table 9). The only sectors for which an emission factor and activity data could not be established either through the historical inventory or through the update process were water and wastewater.

Table 8 Original 2005 GHG Inventory Data

	Original Activity Data	Original Emission Factor	Original (MT CO_2e)
Residential Electricity (kWh)	1,307,301,693	0.00028	748,792[1]
Residential Gas (therms)	65,698,581	0.00531	
Commercial and Industrial Electricity (kWh)	2,235,898,207	0.00028	979,777[1]
Commercial Gas (therms)	61,791,582	0.00531	
Industrial Gas (therms)	*included in Commercial	0.00531	
District Gas (therms)	5,339,537	0.00531	28,656
On-road Transportation (VMT)	4,175,278,800	0.000482	2,013,962
Waste (tons)	684,088	0.299459	204,856
Waste-in-Place	N/A	N/A	37,006
Wastewater	Unknown	Unknown	57,380
Water (MGY)	Unknown	Unknown	12,810
Total			**4,083,239**

kWh: kilowatt hours; mgy: million gallons per year; N/A: not applicable; MT CO_2e: metric tons of carbon dioxide equivalent; VMT: vehicle miles traveled

1: Data presented as it was provided in the original 2005 inventory.

21 Ascent Environmental, January 13, 2012. http://ascentenvironmental.com/files/9714/0537/0505/Sacramento_CAP_Final_Draft.pdf

Table 9 Updated 2005 GHG Inventory Data

	Updated Activity Data	Updated Emission Factor	Updated ($MT\ CO_2e$)
Residential Electricity (kWh)	1,307,301,693	0.00028	365,319
Residential Gas (therms)	65,698,581	0.00531	348,859
Commercial and Industrial Electricity (kWh)	2,235,898,207	0.00028	624,811
Commercial Gas (therms)	29,787,868	0.00531	158,174
Industrial Gas (therms)	*Removed from Inventory	0.00531	–
District Gas (therms)	5,339,537	0.00531	28,353
On-road Transportation (VMT)	4,175,278,800	0.000523	2,184,617
Waste (tons)	684,088	0.59247	405,301
Waste-in-Place	N/A	N/A	49,921
Wastewater	Unknown	Unknown	57,380
Water (mgy)	Unknown	Unknown	12,810
Total			**4,235,545**

kWh: kilowatt hours; mgy: million gallons per year; N/A: not applicable; MT CO_2e: metric tons of carbon dioxide equivalent; VMT: vehicle miles traveled

2.3 2011 Inventory Updates

In 2015, the City of Sacramento, with the assistance of Ascent Environmental, conducted a GHG inventory estimate of community-wide emissions for the year 2011. After reviewing the inventory during the 2019 CAP 2.0 process, several inconsistencies were identified between the 2005 inventory, 2011 inventory, and current best practices.

Several updates to the 2011 inventory estimate were performed as part of the current effort to align the 2005, 2011, and 2016 methodologies. These included removing large industrial natural gas users (due to data availability in 2016), updating waste emissions methodology to California-specific emissions factors and AR4 GWP, and updating the transportation emissions calculation methods.

The following section outlines the changes made to the 2011 inventory for consistency with the other inventory years. Although 2011 is less important than 2005 (which derives the baseline 1990 emissions) and 2016 (which informs current progress), it still provides a useful data point for the City of Sacramento's overall emission reduction progress.

Natural Gas

Because of the CPUC 15/15 Rule[22], industrial gas was no longer reported in 2016. To allow for a comparison between across all years, the 2011 inventory was updated to remove industrial gas. Large industrial emitters removed from the inventories are under the purview of the CARB Cap-and-Trade Program for emissions reductions and are, therefore, also already accounted for in the 2017 Scoping Plan Update. Because industrial and commercial data was aggregated in the 2011 inventory, an estimate of industrial gas was made and subtracted to isolate the commercial emissions. To accomplish this, the average of the 2017 and 2016 ratios of commercial gas usage to residential gas

[22] The 15/15 rule states no data can be provided if there are less than 15 users in any sector or if one user makes up more than 15 percent of the total usage. This applies to natural gas and electricity consumption.

usage (0.48207) was applied to the 2011 inventory. This ratio was then used to identify the industrial emissions portion of the commercial/industrial aggregated natural gas data.

The ratio of residential to commercial gas use was used to correct for population growth and temperature changes which might have increased or decreased gas use in the city of Sacramento. Natural gas consumption labeled as "district" users, such as fire and school districts, was included in all years.

Waste

As noted above, in 2005 and 2011 two different waste emission factors were utilized. This caused an increase in emissions from 2005 to 2011 even though the City achieved a 37 percent reduction in overall tonnage. This was because the original 2005 calculation methodology was not able to be identified during the 2011 inventory. To address this problem, emission factors derived from the CalRecycle (formerly CIWMB) waste characterization study for the State of California for 2008 were applied to the tons of waste generated in 2011.

Waste-in-place was also updated for the 2011 inventory. When the inventory was originally completed, it simply re-used the 2005 data for 2011. However, waste-in-place is a cumulative emissions calculation. Because the landfills in Sacramento are either closed or accepting less waste, this led to an overestimate of emissions. A first order decay model using landfill waste data from 2005 to 2011 was used to update the waste-in-place number.

Transportation

The 2011 inventory data includes total transportation emissions as well as the daily VMT.[23] However, the emissions factor was calculated using older methods no longer considered standard. Therefore, the EMFAC2017 model was used to re-calculate the average emissions per VMT in 2011. While not able to verify the methodology used to derive VMT, the VMT values appear to be consistent between inventory years and a note in the previous inventory workbook suggested the data was provided using the RTAC origin-destination model.

Summary of Inventory Data

Table 10 and Table 11 include all of the activity data, emission factors, and total emissions available for both the original inventory(Table 10) and the updated inventory (Table 11). The only sectors for which an emission factor and activity data could not be established either through the historical inventory or through the update process were water and wastewater.

[23] The documents provided by Ascent in the summary of the 2005/2011 inventories stated that VMT values were derived from the RTAC Origin-Destination model and were provided by Fehr and Peers as well as SACMET.

Table 10 Original 2011 GHG Inventory Data

	Original Activity Data	Original Emission Factor	Original (MT CO_2e)
Residential Electricity (kWh)	1,343,895,669	0.00020	656,472[1]
Residential Gas (therms)	74,151,520	0.00531	
Commercial and Industrial Electricity (kWh)	2,346,768,051	0.00020	814,087[1]
Commercial Gas (therms)	66,911,808	0.00531	
Industrial Gas (therms)	*included in Commercial	0.00531	
District Gas (therms)	3,872,204	0.00531	20,561
On-road Transportation (VMT)	4,234,269,734.09	0.000475	2,009,724
Waste (tons)	427,980	0.78300	335,108
Waste-in-Place	N/A	N/A	37,006
Wastewater	Unknown	Unknown	18,719
Water (mgy)	37,149	0.263921	9,804
Total			**3,901,481**

kWh: kilowatt hours; mgy: million gallons per year; N/A: not applicable; MT CO_2e: metric tons of carbon dioxide equivalent; VMT: vehicle miles traveled

1: Numbers presented as they were in the original 2011 GHG inventory.

Table 11 Updated 2011 GHG Inventory Data

	Original Activity Data	Original Emission Factor	Original (MT CO_2e)
Residential Electricity (kWh)	1,343,895,669	0.00020	262,727
Residential Gas (therms)	74,151,520	0.00531	393,745
Commercial and Industrial Electricity (kWh)	2,346,768,051	0.00020	458,786
Commercial Gas (therms)	32,256,175	0.00531	171,280
Industrial Gas (therms)	*included in Commercial	0.00531	
District Gas (therms)	3,872,204	0.00531	20,561
On-road Transportation (VMT)	4,234,269,734	0.000494	2,091,154
Waste (tons)	427,980	0.264478517	113,192
Waste-in-Place	N/A	N/A	25,773
Wastewater	Unknown	Unknown	18,719
Water (MGY)	37,149.00	0.263921	9,804
Total			**3,565,741**

kWh: kilowatt hours; mgy: million gallons per year; N/A: not applicable; MT CO_2e: metric tons of carbon dioxide equivalent; VMT: vehicle miles traveled

3 2016 Community Inventory

The methodologies, data sources, calculations, and results associated with the 2016 GHG inventory update are included in this section. Information regarding updates to the 2005 and 2011 inventories and information relating to the emissions forecast are located in Section 2.2 and Section 2.3 of the technical appendix, respectively.

The 2016 GHG inventory is structured based on emissions sectors. The ICLEI Community Protocol recommends local governments examine their emissions in the context of the sector responsible for those emissions. Many local governments will find a sector-based analysis more directly relevant to policy making and project management, as it assists in formulating sector-specific reduction measures for climate action planning. The reporting sectors are made up of multiple subsectors to allow for easier identification of sources and targeting of reduction policies.

The 2016 inventory reports all Basic Emissions Generating Activities[24] required by the Community Protocol[25] by the following main sectors:

- Energy (electricity and natural gas)
- Transportation
- Water and Wastewater
- Solid Waste

The data used to complete this inventory and forecast came from multiple sources, as summarized in Table 12. Data for the 2016 inventory calculations were provided by the City via personal communication with Helen Selph.

[24] Required emissions generating activities include: use of electricity by the community, use of fuel in residential and commercial stationary combustion equipment, on-road passenger and freight motor vehicle travel, use of energy in potable water and wastewater treatment and distribution, and generation of solid waste by the community.

[25] ICLEI. 2012. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. Section 2.2.

Table 12 Inventory and Forecast Data Sources

Sector	Activity Data	Unit	Source
Inventory			
Energy	Electricity Consumption	kWh	Sacramento Municipal Utilities District
	Natural Gas Consumption	Therms	Pacific Gas and Electric
Transportation	Annual Mileage	VMT	EMFAC2017 Model; Sacramento Area Council of Governments
Water	Water Pumping Electricity Usage	AF kWh	Sacramento DOU
Wastewater	Electricity Consumption, Water Treated	kWh MGD	Sacramento DOU; Sacramento Regional County Sanitation District; City of Sacramento 2011 Climate Action Plan
Solid Waste	N/A	N/A	CalRecycle; Sacramento Public Works Department United States Environmental Protection Agency Landfill Methane Outreach Program Reporting
Forecast Growth Indicators			
Population	Residents	Persons	City of Sacramento General Plan; California Department of Finance Demographic Projections
Commerce	Jobs	Number of Jobs	City of Sacramento General Plan
Transportation	Annual Mileage, Emissions	N/A	EMFAC2017 Model; Sacramento Area Council of Governments
Building Efficiency	Title 24 Efficiency Increases	Percent	California Energy Commission
Electricity Emissions	Renewable Portfolio Standard	Percent	Renewable Portfolio Standard; Senate Bill 100

kWh; kilowatt hours; VMT: vehicle miles traveled; AF: acre-foot; MGD: million gallons per day; N/A: not applicable; Sacramento DOU: Sacramento Department of Utilities

3.1 Energy

The energy sector includes GHG emissions resulting from the consumption of electricity and natural gas. Both energy sources are used in residential, commercial, and industrial buildings and for other power needs throughout the City of Sacramento. The following subsections describe the data sources, emission factors and calculation methodologies associated with electricity and natural gas.

Overall, residential and non-residential (commercial and industrial) energy emissions were approximately equal in 2016 at 49 percent and 50 percent respectively (Figure 3). It should be noted that, similar to previous years, this does not include large industrial users' gas use in the analysis. Non-residential electricity was reported in aggregate by Sacramento Municipal Utility District (SMUD) and included both industrial and commercial data. Due to data availability issues, large industrial gas data were not provided by PG&E and not been included in this inventory. Additional information on why this change was made as well as the methodologies used to estimate 2016 commercial gas data are provided in the natural gas section.

Electricity

Emissions resulting from electricity consumption were estimated by multiplying annual electricity consumption by an electricity emission factor representing the average emissions associated with generation of one megawatt hour (MWh) of electricity. Electricity is supplied to the City by SMUD. In its 2016 report to the verification body, The Climate Registry, SMUD reported an electricity carbon intensity factor of 492.95 pounds CO_2e per MWh.[26] SMUD also reported to the California Energy Commission, an average of 20 percent renewable energy in its portfolio in 2016.[27] From 2005, residential electricity use increased by 116.1 MWh while commercial electricity decreased by 44.7 MWh for a net increase of 71.4 MWh. Therefore, the 181,910 MT CO_2e reduction in GHG emissions from electricity between 2005 and 2016 was due to an approximately 20 percent reduction in the SMUD electricity emission factor.

To calculate emissions from electricity, the total electricity use reported by SMUD was multiplied by the carbon intensity factor to determine MT CO_2e. This value represents all residential, commercial, and industrial electricity use within the city. Prior to performing this calculation, the electricity use associated with in-boundary water sector activities (42,964 MWh) was removed to avoid double counting water emissions. This is discussed further in the water and wastewater section.

In 2016, a total 808,220 $MTCO_2e$ was generated within the community due to residential and commercial electricity use. Table 13 and Table 14 show the breakdown of emissions from electricity by both category (residential, commercial/industrial) and by source.

Natural Gas

In order to calculate emissions from natural gas consumption, the total therms consumed is multiplied by the PG&E reported emissions factor of 11.7 pounds CO_2/therm. Due to CPUC privacy regulations, the majority of 2016 industrial therms were not provided.[28] This resulted in a substantial decrease in emissions from industrial natural gas use from the 2005 baseline.

Any remaining reported industrial use is from PG&E "district" users, such as fire and school districts. Industrial emissions removed from the inventories are under the purview of the CARB Cap-and-Trade Program for emissions reductions and are, therefore, already accounted for in the 2017 Scoping Plan Update. The California Supplement does not recommend including these sources unless they are under the direct jurisdictional control of the reporting agency.[29] Overall natural gas usage in the commercial sector decreased from 29.8 million therms in 2005 to 29.0 million therms in 2016 while the emission factor remained constant. This means that 100 percent of the 45,063 MT CO_2e reduction was attributed to a decrease in gas use.

In 2016, the commercial, district industrial, and residential categories consumed a total of 92,390,976 therms of natural gas, which, based on the emission factor of 0.00531 MT CO_2/therm, generated 490,323 $MTCO_2e$. A complete breakdown of natural gas use by category and sector is provided in Table 14.

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[26] The Climate Registry. 2016 Default Emissions Factors. Accessed at: https://www.theclimateregistry.org/wp-content/uploads/2014/11/2016-Climate-Registry-Default-Emission-Factors.pdf. Accessed on: June 17, 2019

[27] California Energy Commission. Sacramento Municipal Utility District 2016 Power Content Label. Accessed at: https://ww2.energy.ca.gov/pcl/labels/2016_labels/Sacramento_Municipal_Utility_District.pdf Accessed July 15, 2019

[28] Minor industrial emissions reported through PG&E from the 'District' customer class are included in this inventory.

[29] Association of Environmental Professionals. 2013. The California Supplement to the United States Community-Wide Greenhouse Gas (GHG) Protocol. Page 9.

Figure 3 Energy Emissions by Category for Year 2016

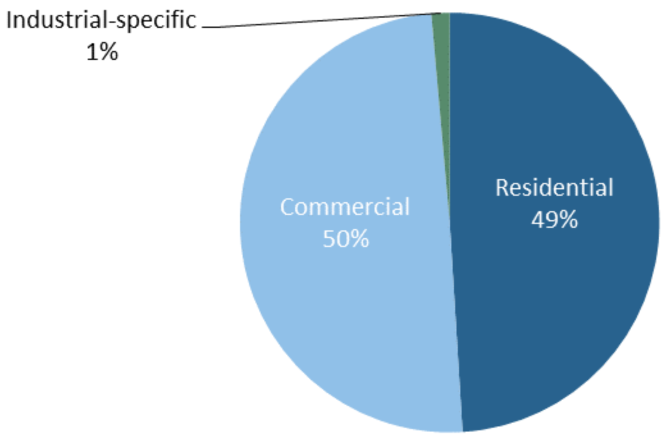


Table 13 Energy Emissions by Category for Year 2016

Source	Activity Data	Emission Factor	Total Emissions ($MTCO_2e$)
Residential			**636,578**
Natural Gas	59,977,656 therms	0.00531 MT CO_2e/therm	318,304
Electricity	1,423,420 MWh	0.2236 MT CO_2e/MWh	318,275
Commercial			**643,747**
Natural Gas	28,980,911 therms	0.00531 MT CO_2e/therm	153,803
Commercial and Industrial Electricity	2,191,181 MWh	0.2236 MT CO_2e/MWh	489,945
District Industrial			**18,216**
Natural Gas[1]	3,432,409 therms	0.00531 MT CO2e/therm	18,216
Total			**1,298,542**

MWh: megawatt hours; MT CO_2e: metric tons of carbon dioxide equivalent

[1] Large industrial natural gas has been removed due to CPUC privacy rules. See Energy Section for discussion

Table 14 Energy Emissions by Energy Source for Year 2016

Source	Activity Data	Emission Factor	Total Emissions ($MTCO_2e$)
Natural Gas	**92,390,976 therms**	**0.00531 MT CO_2e/therm**	**490,332**
Commercial	28,980,911 therms	0.00531 MT CO_2e/therm	153,803
Residential	59,977,656 therms	0.00531 MT CO_2e/therm	318,304
District Industrial[1]	3,432,409 therms	0.00531 MT CO_2e/therm	18,216
Electricity	**3,581,960 MWh**	**0.2236 MT CO_2e/MWh**	**808,220**
Commercial/Industrial	2,191,181 MWh	0.2236 MT CO_2e/MWh	489,945
Residential	1,423,420 MWh	0.2236 MT CO_2e/MWh	318,275
Total			**1,298,542**

MWh: megawatt hours; MT CO_2e: metric tons of carbon dioxide equivalent

[1] Large industrial natural gas has been removed due to CPUC privacy rules. See Energy Section for discussion

3.2 Transportation

Transportation modeling for VMT attributed to the City of Sacramento was completed by Fehr & Peers Transportation Consultants using Sacramento Area Council of Government (SACOG) activity-based model, SACSIM.[30] The emissions associated with on-road transportation were then calculated by multiplying the estimated daily VMT and the average vehicle emissions rate established by CARB EMFAC2017 modeling for vehicles within the region. In 2016 on-road transportation attributed to the City of Sacramento resulted in 1,935,870 MT CO_2e a 248,747 MT CO_2e reduction compared to 2005. During this time VMT increased by 4 percent or 172 million miles traveled. Therefore, the emissions reductions in this sector were driven by an increase in average vehicle efficiency and adoption of electric vehicles which resulted in a 10 percent decrease in average vehicles emissions per mile.

The VMT modeling results allocate VMT derived from the activity-based model to the City of Sacramento using the Origin-Destination (O-D) method. The O-D VMT method is the preferred method recommended by the U.S Community Protocol in on-road methodology TR.1 and TR.2 to estimate miles traveled based on trip start and end locations. Under these recommendations, all trips that start and end within the City are attributed to the City. Additionally, one half of the trips that start internally and end externally and vice versa are attributed to the City. A summary of the VMT results can be found in Table 15.

Table 15 Estimated Transportation Emissions for 2016

Source	Activity Data (VMT)[2]	Emission Factor	Total Emissions ($MTCO_2e$)
Internal-Internal Daily VMT	3,588,476	0.000445 MT CO_2e per VMT	1,598
½ Internal-External Daily VMT	4,463,016	0.000445 MT CO_2e per VMT	1,988
½ External-Internal Daily VMT	4,475,924	0.000445 MT CO_2e per VMT	1,993
Total Daily VMT	12,527,417	0.000445 MT CO_2e per VMT	5,579
Yearly VMT[1]	**4,347,013,534**	**0.000445 MT CO_2e per VMT**	**1,935,870**

MT CO_2e: metric tons of carbon dioxide equivalent; VMT: vehicle miles traveled

[1] Weekday to annual conversion of 347 is used per CARB guidance on VMT modeling

2 The origin-destination methodology for VMT calculation attributes 100 percent of internal to internal daily trips, 50 percent of internal-external and external-internal daily trips, and excludes all pass through trips. This sum is then multiplied by 347 to get an annual VMT number.

Transportation emissions are generated by the community of Sacramento through on-road transportation, including passenger, commercial, and heavy machinery. Emissions factors are established using the latest CARB and EPA-approved emissions modeling software, 2017 State EMissions FACtors (EMFAC) Model. Carbon dioxide, nitrous oxide, and methane emissions from engine combustion are multiplied by their GWP to determine CO_2e per VMT. Emissions for both passenger and commercial vehicles were established using the EMFAC2017 GHG module and weighted by VMT to establish an average emissions factor per VMT for the City. Emissions from electricity used by charging of electric vehicles are captured under the electricity sector. In 2016, the

30 Sacramento Area Council of Governments. SACOG Travel Demand Model. Accessed at: https://www.sacog.org/modeling Accessed on: October 4, 2019

average emissions factor for cars on the road in the County of Sacramento was 0.000445 $MTCO_2e$ per VMT as calculated using the EMFAC2017 model.[31] Technical details on the EMFAC2017 modeling tool can be found on the EMFAC Mobile Source Emissions Inventory Technical Support Documentation Portal.[32]

3.3 Water and Wastewater

Water

Water is supplied to Sacramento by the Sacramento Department of Utilities, primarily sourced from the Sacramento and American rivers. The primary water treatment plant facilities for the community are E.A. Fairbairn Water Treatment Plant and Sacramento River Water Treatment Plant, both located within the city boundaries. Water supplied to the community contributes emissions through the use of energy to extract, convey, treat, and deliver water. The amount of energy required for community water usage was calculated following Community Protocol Method WW.14, where the total emissions are equal to the energy used in each of the four phases above. The energy required for each segment of the water cycle was provided by the Sacramento Department of Utilities or based on phase-specific averages where it was unavailable. SMUD provided the annual electricity use for the water extraction, conveyance, and delivery phases (40,101 MWh),[33] while a kWh phase average of 100 kwh/million gallons was used for the treatment phase. As all energy use is in-boundary, total MWh for water transactions has been subtracted from the community energy use total calculated in Section 3.1 to avoid double counting.

SMUD is the electricity provider for the City; therefore, SMUD's energy emissions factor of 492.95 pounds CO_2e/MWh was applied to the calculated electricity used for water consumption in the city. Energy consumption related to water use in the city of Sacramento resulted in the generation of approximately 9,607 $MTCO_2e$ in 2016, or 33 percent of total water and wastewater emissions. In 2016, Sacramento water treatment plants produced 87,811 acre-feet of water. The 2005 water consumption for the City was not recorded in the previous inventory and therefore, a comparison of the methodology was not possible. However, it is likely that emission reductions have been driven in part by a reduced electricity emission factor.

Wastewater

The wastewater generated by community residents and businesses creates GHG emissions during the treatment processes, including process, stationary, and fugitive emissions. The sources and magnitude of emissions depend on the type of wastewater treatment plant and the treatment processes utilized.

Wastewater generated in the city of Sacramento is collected in local sewer lines which ultimately discharge into the Sacramento Regional Wastewater Treatment Plant managed by Regional San in Elk Grove, California. As the wastewater treatment plant treats sewage from multiple jurisdictions, methane and nitrous oxide emissions were allocated to Sacramento on a population basis per Community Protocol Methodology WW.13 shown in Figure 4. Total carbon dioxide emissions from

[31] EMFAC2017. Base year 2016, County of Sacramento model run. Accessed at: https://www.arb.ca.gov/emfac/ Accessed on: July 16, 2019

[32] California Air Resources Board. EMFAC Software and Technical Support Documentation. Accessed at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-modeling-tools-emfac Accessed on: October 4, 2019.

[33] D. Vang, personal communication, August 2018.

the Sacramento Regional Wastewater Treatment Plant were unavailable from the USEPA Greenhouse Gas Reporting Program, the ICLEI-recommended data source. Therefore, separate emissions sources (nitrous oxide, methane, electricity use) were calculated based on the population increase from 2011. In 2016, a total of 40 MT N_2O and 32 MT CH_4 were emitted from the effluent discharge and stationary sources at the treatment plant. As shown in Table 16 the total process emissions and electricity usage for Sacramento wastewater treatment and disposal resulted in emissions of 19,867 MT CO_2e per year, or 67 percent of the water and wastewater emissions.

Table 16 Water and Wastewater Emissions for Year 2016

Source	Activity Data	Emission Factor	Total Emissions (MT CO_2e)
Water Use	**42,963,998 MWh**	**0.22359 MT CO_2e/MWh**	**9,607**
Supply, Conveyance, Distribution	40,101 MWh	0.22359 MT CO_2e/MWh	8,967
Treatment	2,863 MWh	0.22359 MT CO_2e/MWh	640
Wastewater Generation	**–**	**–**	**19,867**
Process Nitrous Oxide Emissions	40 MT N_2O	1 N_2O to 298 CO_2e	11,780
Stationary Methane Emissions	32 MT CH_4	1 CH_4 to 25 CO_2e	804
Electricity Emissions	32,640 MWh	0.22359 MT CO_2e/MWh	7,298
Total			**29,474**

MWh: megawatt hours; MT: metric tons; CO_2e: carbon dioxide equivalent; CH_4: methane; N_2O: nitrous oxide

Figure 4 Wastewater Methodology

Equation WW.13$_{CH4}$ Attributed CH_4 Emissions

*Attributed CH_4 Emissions = P/P_{tot} * E*

Where:

Description		Value
Attributed CH_4 Emissions	= Annual CH_4 credited to the community ($mtCO_2e$)	Result
P	= Population of community served by the given WWTP	User input
P_{tot}	= Total population the WWTP serves	User input
E	= Total CH_4 produced by WWTP ($mtCO_2e$)	User input

Source: Developed by ICLEI Staff and Wastewater Technical Advisory Committee

3.4 Solid Waste

GHG emissions result from management and decay of organic material solid waste. The Community Protocol provides multiple accounting methods to address both emissions arising from solid waste generated by a community (regardless of where it is disposed of) as well as emissions arising from solid waste disposed of inside a community's boundaries (regardless of where it was generated). GHG emissions from the decomposition of organic material in this sector are broken down into two parts:

- Community Waste - Lifetime methane emissions from solid waste generated by the community in the year of the inventory, using Community Protocol method SW.4[34]. This methodology attributes 100 percent of lifetime GHG emissions from the tonnage reported in the inventory year.
- Waste-in-Place - Methane emissions from existing solid waste-in-place at landfills located within the community limits using Community Protocol method SW.1[35] This methodology attributes just the GHG emissions emitted in the inventory year based on the total lifetime tonnage in the landfill.

Due to the slow rate of emissions generation associated with decomposition of solid waste, this two-pronged approach also allows policy makers to target solid waste activity in a particular year, similar to other sectors (e.g., fuel combustion resulting in immediate emissions). Accounting for both of these sources may lead to some double counting in the waste sector as any waste counted in the total tonnage for the year, but also put in the City's in-boundary landfill would be counted twice. However, the City's in-boundary landfills are now closed and both methodologies convey different aspects of the solid waste emissions profile and are included for consistency with previous inventories. All emissions from vehicular transport of solid waste are included in the transportation emissions sector.

Two landfills are located within the city, therefore, solid waste emissions were estimated using both SW.1 to calculate the in-boundary landfill emissions and SW.4 to calculate the full methane commitment of solid waste generated by Sacramento in 2016. A summary of waste emissions is provided in Table 17.

Table 17 Summary of Solid Waste Emissions for Year 2016

Source	Activity Data (tons)	Emission Factor	Total Emissions (MT CO_2e)
Waste-in-Place	**–**	**–**	**26,504**
28th Street Landfill	–	–	12,027
L & D Landfill	–	–	14,478
Waste Disposal	**525,968**	**0.2554 MT CO_2e/ton**	**134,339**
Total Waste Emissions			**160,843**

MT CO_2e: metric tons of carbon dioxide equivalent

Waste-in-Place

As a primary data source for waste-in-place emissions, the Community Protocol recommends utilizing data reported from the United States Environmental Protection Agency (USEPA) in accordance with the GHG Mandatory Reporting Rule (MRR; 40 Code of Federal Regulations [CFR] §98). If the facilities are not subject to the USEPA MRR, then the alternate approach SW.1.1 should be used. Method SW.1.1 estimates emissions based on the first order decay (FOD) model and the waste-in-place in the landfill and is summarized in Figure 5. The FOD model is an exponential equation which estimates the amount of landfill gas generated in a municipal solid waste landfill based upon the amount of municipal solid waste in the landfill (or "waste-in-place") at the point of

34 https://icleiusa.org/publications/us-community-protocol/
35 https://icleiusa.org/publications/us-community-protocol/

time for which landfill gas generation is to be estimated, the capacity of that waste to generate methane and a methane generation rate constant which describes the rate at which municipal solid waste in the landfill is expected to decay and produce landfill gas.

Figure 5 Waste-in-Place Methodology

Equation SW.1.1 Alternate Method – Methane Emissions from Landfills

Annual fugitive CH_4 emissions =

*Comprehensive LFG Collection: ((TMMG*LFGE)*(Ox))*
Partial or No LFG Collection: ((TMMG(1-%LF)*Ox)+((TMMG*%LF*LFGE)*(Ox)))*
Where:

Term	Description	Value
Annual CH_4 emissions	= Total annual fugitive landfill CH_4 emitted ($mtCO_2e$)	Result
TMMG	= Total modeled CH_4 generated	User Input
OX*	= Account for 10% oxidation rate	(1-.10)
% LF	= Percent of landfill covered by gas collection	User Input
LFGE	= Account for 75% LFG collection efficiency	(1-.75)

Source: 40 CFR 98, Subpart HH, and 40 CFR 60, Subpart WWW

* If using the California ARB Landfill Emissions Tool oxidation has already been incorporated into landfill outputs therefor you do not have to multiply by 0.9.

The Community Protocol recommends reviewing the Landfill Methane Outreach Program (LMOP) maintained by the USEPA as the first source of emissions verification for landfills.[36] As of 2016, no emissions from the 28th Street Landfill or L&D Landfill were reported to LMOP,[37] therefore, a FOD modeling tool developed by CARB and recommended by ICLEI was utilized.[38] The FOD model outputs emissions in methane and carbon dioxide. However, only methane emissions were accounted for as the carbon dioxide is considered biogenic in origin and not recommended for inclusion per the Community Protocol. Results of the model runs for both 28th Street Landfill and L&D Landfill can be found in the attached documentation and Table 18. A collection efficiency of 75 percent was applied per the Community Protocol for landfills with methane capture. Fugitive methane emissions from existing waste at the L&D and 28th Street landfills were calculated to be 26,504 MT CO_2e in 2016. Annual waste-in-place emissions decreased by 23,416 MT CO_2e from 2005 to 2016 due to the amount of waste remaining in the now closed landfills as modeled by the FOD modeling tool.

[36] United States Environmental Protection Agency. 2016. Landfill Methane Outreach Program. Accessed at: https://www.epa.gov/lmop/project-and-landfill-data-state. Accessed on: May 15, 2019

[37] United States Environmental Protection Agency. 2016. Greenhouse Gas Reporting Program. Accessed at: https://www.epa.gov/ghgreporting. Accessed on: May 15, 2019

[38] California Air Resources Board. Local Government Operations Protocol for Greenhouse Gas Assessments. Accessed at: https://ww3.arb.ca.gov/cc/protocols/localgov/localgov.htm. Accessed on: May 20, 2019

Table 18 Waste-in-Place Summary for Year 2016

Emissions Forecast	28th Street Landfill ($MT\ CO_2e$)	L&D Landfill ($MT\ CO_2e$)
Methane generated	48,107	57,910
Methane captured (removed) at landfill	- 36,080	- 43,432
Subtotal Waste-in-Place Emissions	12,027	14,478
Total Waste-in-Place		**26,504**

MT CO_2e: metric tons of carbon dioxide equivalent

Community Generated Waste

While communities may want to understand the GHG emissions from landfills located within their boundaries (SW.1.1)[39], they are required to estimate the emissions resulting from waste disposed by the community (SW.4.1)[39], regardless of whether the receiving landfill(s) are located inside or outside of the community boundary.

Community Protocol Method SW.4.1[39] is summarized in Figure 6, utilizing mass of waste being disposed, organic content of waste, methane capture ability of the landfill, oxidation rate, and methane GWP. The 2016 emissions factor for generated waste in Sacramento was derived from the 2014 CalRecycle State Waste Characterization Study shown in Table 19.

Figure 6 Waste Generation Methodology

Equation SW.4.1 Methane Emissions

$$CH_4\ Emissions = GWP_{CH4} * (1 - CE) * (1 - OX) * M * \sum_i P_i * EF_i$$

Where:

Term	Description	Value
CH_4 emissions	= Community generated waste emissions from waste M ($mtCO_2e$)	Result
GWP_{CH4}	= CH_4 global warming potential	
M	= Total mass of waste entering landfill (wet short ton)	User Input
P_i	= Mass fraction of waste component i	User Input
EF_i	= Emission factor for material i ($mtCH_4$/wet short ton)	Table SW.5
CE	= Default LFG Collection Efficiency	No Collection, 0 Collection, 0.75
OX	= Oxidation rate	0.10

Source: As developed by ICLEI staff and Solid Waste Technical Advisory Committee. Emissions factors from U.S. EPA Municipal Solid Waste Publication (2008) available at http://www.epa.gov/epawaste/nonhaz/municipal/pubs/msw2008data.pdf

39 https://icleiusa.org/publications/us-community-protocol/

In 2016, Sacramento produced 525,968 tons of waste.[40] A CO_2e emissions factor for mixed-waste of 0.2554 MT CO_2e/ton was established and multiplied by the total waste disposed of from the community to calculate emissions from waste generated in 2016 of 134,339 MT CO_2e. This emission factor includes the expected lifetime emissions associated with the specified tonnage of waste sent to landfill. The emissions factor was developed using SW 4.1[39] as well as the relative waste stream percentages of different organic materials as shown in Table 19 to establish a methane emissions factor. The efficiency capture used was 75 percent, which was an update from previous inventories which relied on a regional average (42 percent) from the 2005 inventory. CalRecycle and USEPA LMOP data allow for more precise tracking of waste destination and methane capture ability and the majority of Sacramento's waste in 2016 was transported to L & D Landfill in Sacramento, Kiefer Landfill in Sloughhouse, and Forward Landfill in Manteca, all of which operate landfill gas capture programs.[41] From 2005 to 2016 GHG emissions from community waste decreased by 270,963 MT of CO_2e. This was due to a combination of factors including a reduced emission factor due to installation of methane capture programs at landfills as well as an overall reduction in waste generation of 158,120 tons.

Table 19 CalRecycle 2014 Waste Characterization Factor

Waste Type	WIPFRAC	TDOC	DANF	ANDOC	Weighted CH_4/ton	Weighted MT CO_2e/ton
Newspaper	1.44%	47.09%	15.05%	0.117%	0.000143208	0.003580198
Office Paper	0.73%	38.54%	87.03%	0.617%	0.000344557	0.00861393
Corrugated Boxes	3.13%	44.84%	44.25%	0.952%	0.000872251	0.021806282
Coated Paper	12.10%	33.03%	24.31%	0.721%	0.001366096	0.034152408
Food	18.12%	14.83%	86.52%	1.990%	0.00326912	0.081728001
Grass	1.84%	13.30%	47.36%	0.120%	0.000163279	0.004081975
Leaves	3.52%	29.13%	7.30%	0.069%	0.00010509	0.002627254
Branches	3.27%	44.24%	23.14%	0.200%	0.000470807	0.011770174
Lumber	11.91%	43.00%	23.26%	1.451%	0.00167506	0.041876495
Textiles	5.85%	24.00%	50.00%	0.656%	0.000986758	0.024668962
Diapers	4.29%	24.00%	50.00%	0.520%	0.000723544	0.018088588
Construction/Demolition	2.31%	4.00%	50.00%	0.110%	6.48827E-05	0.001622068
Medical Waste	0.11%	15.00%	50.00%	0.000%	1.19281E-05	0.000298201
Sludge/Manure	0.57%	5.00%	50.00%	0.001%	1.991E-05	0.000497751
MSW Total				7.52 %	0.010216492	0.255412288

WIPFRAC: fraction of waste in waste-in-place; TDOC: total degradable organic carbon; DANF: decomposable anaerobic fraction; ANDOC: anaerobically degradable organic carbon; CH_4: methane; MT CO_2e: metric ton of carbon dioxide equivalent

40 Waste tonnage and destinations from https://www2.calrecycle.ca.gov/LGCentral. Accessed on: May 20, 2019

41 Landfill gas capture program data verified from https://www.epa.gov/lmop/project-and-landfill-data-state . Accessed on: May 20, 2019

4 Forecast

A baseline inventory (i.e., the City of Sacramento's 2016 inventory) sets a reference point for a single year. However, annual emissions change over time due to external factors such as population and job growth. An emission's forecast accounts for projected growth and presents an estimate of GHG emissions in a future year. Calculating the difference between the GHG emissions forecast and the reduction targets set by the City determines the gap to be closed through City Climate Action Plan policies. This section quantifies the reduction impact State regulations will have on the City of Sacramento's forecast and presents the results in an *adjusted scenario* forecast. The *adjusted scenario* incorporates the impact of State regulations which would reduce the City of Sacramento's GHG emissions to provide a more accurate picture of future emissions growth and the responsibility of the City and community for GHG reductions once State regulations to reduce GHG emissions have been implemented.

Several indicator growth rates were developed and applied to the various emissions sectors to forecast emissions as shown in Table 22**Error! Reference source not found.**. The growth rates were applied to the most recent inventory year (2016) data to obtain projected activity data (e.g., energy use, waste production). Growth rates were developed from the 2035 Sacramento General Plan population and job forecasts, EMFAC Modeling, and Department of Finance population forecasts for Sacramento County. Applicable State and federal regulatory requirements, including Corporate Average Fuel Economy standards, Advanced Clean Car Standards, Renewable Portfolio Standard, and Title 24 efficiencies were then incorporated to accurately reflect expected reductions from State programs.

As the City of Sacramento General Plan Update is completed, population forecasts will shift. Therefore, the forecast presented in Section 4.1 may be updated over the course of the project to be consistent with the General Plan Update. To deal with these changes, a "model" has been developed which allows for these variables to be easily adjusted as changes occur.

4.1 Forecast Results Summary

Overall emissions in Sacramento are forecast to decrease 30 percent by 2045 under existing programs and regulations (Adjusted Forecast) as shown in Table 20. The adjusted forecast emissions reductions are due to SB 100 requiring 100 percent GHG-free electricity in 2045, electricity-related emissions are expected to reduce to zero. Transportation, natural gas, and waste emissions are expected to constitute the majority of emissions by 2045.

Table 20 Summary of BAU Forecast and Legislative Reductions by Year

Emissions Forecast	2020 (MT CO_2e)	2025 (MT CO_2e)	2030 (MT CO_2e)	2040 (MT CO_2e)	2045 (MT CO_2e)
Business-as-usual forecast	**3,643,050**	**3,915,952**	**4,188,855**	**4,629,532**	**4,837,306**
Reduction from State measures	358,811	845,264	1,325,699	2,044,321	2,460,915
Adjusted Forecast	**3,284,240**	**3,070,688**	**2,863,156**	**2,585,211**	**2,376,391**

MT CO_2e: metric tons of carbon dioxide equivalent

Waste emissions will likely be lower than the current forecast due to SB 1383 and the requirements for a statewide 75 percent reduction in organic materials being sent to landfill by 2025. Due to the uncertainty of how these requirements will be enacted within the city of Sacramento, the modeling of the change in emissions from SB 1383 was not included and waste-reduction measures identified in the Climate Action Plan will be credited to the City.

As shown in Table 21, State regulations will reduce community GHG emissions substantially by 2045. However, a substantial gap remains between the adjusted scenario and the targets discussed in Section 5. The required reductions to close the gap will come from existing and newly identified GHG reduction measures included in this and future iterations of the Sacramento Climate Action Plan.

Table 21 Adjusted Absolute and Per Capita Emissions Forecast

Year	Population	Absolute Emissions ($MT\ CO_2e$)	Per Capita ($MT\ CO_2e$)
2016	486,154	3,424,795	7.04
2020	518,627	3,284,240	6.33
2025	599,218	3,070,688	5.49
2030	599,809	2,863,156	4.77
2040	670,836	2,585,211	3.85
2045	699,903	2,376,391	3.40

$MT\ CO_2e$: metric tons of carbon dioxide equivalent

4.2 Business-as-Usual Forecast

The City of Sacramento business-as-usual scenario forecast provides an estimate of how GHG emissions would change in the forecast years if consumption trends continue as in 2016, absent any new regulations which would reduce local emissions. Several indicator growth rates were developed from 2016 activity levels and applied to the various emissions sectors to project future year emissions. Table 22 contains a list of growth factors used to develop the business-as-usual scenario forecast, with a summary of the results in Table 23. The BAU growth factors were then multiplied by the population or service person growth rates to develop the BAU emissions forecast.

Table 22 Business-as-Usual Growth Factors

Sector	Activity Data
Emissions per capita (MT CO2e/capita)	7.04
Residential electricity per capita (kWh/capita)	2,928
Commercial electricity use per job (kWh/employment)	10,074
Residential gas per capita (therm/capita)	123
Commercial gas use per job (therm/job)	133.2
Industrial gas per job (therm/job)	15.8
Per job industrial gas use (therm)	15.8
Waste per service person (tons/SP)	0.75
Per service pop WW GHG (MT CO2e)	0.0282
CO2e per ton waste (MT CO2e/ton)	0.306
Water electricity per service person (kWh/SP)	61.1
Water emissions per capita (MT CO2/capita)	0
Total VMT per service person (VMT/SP)	6,178

kWh: kilowatt hour; SP: service person (sum of population and employment) MT CO_2e: metric tons of carbon dioxide equivalent; VMT: vehicle miles traveled

Under the business-as-usual forecast scenario, the City of Sacramento's GHG emissions are projected to continue increasing through 2045 as shown in Table 23. This increase is led primarily by a strong commercial and residential development trend. After the current General Plan horizon year of 2035, major increases in in emissions are largely attributed to the increased population and vehicular traffic from the greater Sacramento County Area traveling into the city. By 2045, the City is expected to produce 4,837,306 MT CO_2e under business-as-usual projections, an increase of 42 percent over 2016 emissions.

Table 23 Business-as-usual Forecast by Sector

Sector	2020 (MT CO_2e)	2025 (MT CO_2e)	2030 (MT CO_2e)	2040 (MT CO_2e)	2045 (MT CO_2e)
Residential Electricity	339,534	366,108	392,682	439,182	458,212
Commercial & Industrial Electricity	571,798	674,115	776,431	920,511	960,396
Residential Gas	339,565	366,141	392,718	439,222	458,253
Commercial & Small Industrial Gas	200,757	236,680	272,603	323,190	337,193
Waste	176,572	196,233	215,893	246,749	257,441
Water	10,546	11,720	12,895	14,738	15,376
Wastewater	21,810	24,238	26,667	30,478	31,799
Transportation	1,982,469	2,040,717	2,098,965	2,215,462	2,318,636
Total Emissions	**3,643,050**	**3,915,952**	**4,188,855**	**4,629,532**	**4,837,306**
Emissions Per Capita	**7.02**	**7.00**	**6.98**	**6.90**	**6.91**

MT CO_2e: metric tons of carbon dioxide equivalent

4.3 State Legislation

The adjusted scenario estimates future City of Sacramento emissions under codified GHG reduction strategies currently being implemented at the State and federal level. The 2017 Scoping Plan Update identified several existing State programs and targets, or known commitments required by statute which can be assumed to achieve GHG reductions without City action, such as increased fuel efficiency standards of mobile vehicles. The following known commitments are factored into the adjusted scenario projection and a summary of the programs can be found in Table 24.

The largest GHG reductions realized by State programs in Sacramento will occur from the increasing decarbonization of the electricity supply due to SB 100 and the Renewable Portfolio Standard (RPS), avoiding over 1,200,000 MT CO_2e by 2045. The transportation sector will also experience over 975,000 MT CO_2e by 2045 through State and federal fuel efficiency and tailpipe emissions standards.

Table 24 Summary of Legislative Reductions

Legislation	2020 (MT CO_2e)	2025 (MT CO_2e)	2030 (MT CO_2e)	2040 (MT CO_2e)	2045 (MT CO_2e)
Senate Bill 100	148,350	299,462	505,630	966,438	1,245,550
Title 24	11,483	68,900	126,316	212,616	240,201
Transportation (Pavley, etc.)	198,977	476,902	693,752	865,267	975,164
Total	358,811	845,264	1,325,699	2,044,321	2,460,915

MT CO_2e: metric tons of carbon dioxide equivalent

Transportation Legislation

The CARB EMFAC2017 transportation modeling program incorporates legislative requirements and regulations including Advanced Clean Cars program (Low Emissions Vehicles III, Zero Emissions Vehicles program, etc.), and Phase 2 federal GHG Standards. Signed into law in 2002, AB 1493 (Pavley Standards) required vehicle manufactures to reduce GHG emissions from new passenger vehicles and light trucks from 2009 through 2016, with a target of 30 percent reductions by 2016, while simultaneously improving fuel efficiency and reducing motorists' costs.[42]

Prior to 2012, mobile emissions regulations were implemented on a case-by-case basis for GHG and criteria pollutant emissions separately. In January 2012, CARB approved a new emissions-control program (the Advanced Clean Cars program) combining the control of smog, soot causing pollutants, and GHG emissions into a single coordinated package of requirements for passenger cars and light trucks model years 2017 through 2025. The Advanced Clean Cars program coordinates the goals of the Low Emissions Vehicles, Zero Emissions Vehicles, and Clean Fuels Outlet programs. The new standards will reduce Californian GHG emissions by 34 percent in 2025.[43]

[42] California Air Resources Board. Clean Car Standards – Pavley, Assembly Bill 1493. May 2013.

[43] California Air Resources Board. Facts About the Advanced Clean Cars Program. December 2011. Accessed at: http://www.arb.ca.gov/msprog/zevprog/factsheets/advanced_clean_cars_eng.pdf. Accessed on: May 20, 2019

Reductions in GHG emissions from the above referenced standards were calculated using the CARB EMFAC2017 model for Sacramento County. The EMFAC2017 model integrates the estimated reductions into the mobile source emissions portion of the model.[44]

Title 24

Although it was not originally intended to reduce GHG emissions, California Code of Regulations Title 24, Part 6: California's Energy Efficiency Standards for Residential and Nonresidential Buildings, was adopted in 1978 in response to a legislative mandate to reduce California's energy consumption, which in turn reduces fossil fuel consumption and associated GHG emissions. The standards are updated triennially to allow consideration and possible incorporation of new energy-efficient technologies and methods. Starting in 2020, new residential developments will include on-site solar generation and near-zero net energy use. For projects implemented after January 1, 2020, the California Energy Commission estimates the 2019 standards will reduce consumption by seven percent for residential buildings and 30 percent for commercial buildings, relative to the 2016 standards. These percentage savings relate to heating, cooling, lighting, and water heating only and do not include other appliances, outdoor lighting not attached to buildings, plug loads, or other energy uses. The calculations and GHG emissions forecast assume all growth in the residential and commercial/industrial sectors is from new construction.

The 2017 Scoping Plan Update calls for the continuation of ongoing triennial updates to Title 24 which will yield regular increases in the mandatory energy and water savings for new construction. Future updates to Title 24 standards for residential and non-residential alterations past 2023 are not taken into consideration due to lack of data and certainty about the magnitude of energy savings realized with each subsequent update.

Renewables Portfolio Standard & Senate Bill 100

Established in 2002 under SB 1078, enhanced in 2015 by SB 350, and accelerated in 2018 under SB 100, California's RPS is one of the most ambitious renewable energy standards in the country. The RPS program requires investor-owned utilities, publicly-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to 50 percent of total procurement by 2026 and 60 percent of total procurement by 2030. The RPS program further requires these entities to increase procurement from GHG-free sources to 100 percent of total procurement by 2045.

SMUD provides electricity in Sacramento and is subject to the RPS requirements. SMUD forecast emissions factors include reductions based on compliance with RPS requirements through 2045. In 2016, SMUD reported an emissions factor of 492.95 pounds CO_2e per MWh.

Assembly Bill 939 & Assembly Bill 341

In 2011, AB 341 set the target of 75 percent recycling, composting, or source reduction of solid waste by 2020 calling for the California Department of Resources Recycling and Recovery (also

[44] Additional details are provided in the EMFAC2017 Technical Documentation, July 2018. Accessed at: https://www.arb.ca.gov/msei/downloads/emfac2017-volume-iii-technical-documentation.pdf. Accessed on: May 20, 2019. The Low Carbon Fuel Standard (LCFS) regulation is excluded from EMFAC2017 because most of the emissions benefits due to the LCFS come from the production cycle (upstream emissions) of the fuel rather than the combustion cycle (tailpipe). As a result, LCFS is assumed to not have a significant impact on CO_2 emissions from EMFAC's tailpipe emissions estimates.

known as CalRecycle) to take a statewide approach to decreasing California's reliance on landfills. This target was an update to the former target of 50 percent waste diversion set by AB 939.

As actions under AB 341 are not assigned to specific local jurisdictions, actions beyond the projected waste diversion target of 5.9 pounds per person per day set under AB 939 for the City of Sacramento will be quantified and credited to the City during the Climate Action Plan measure development process. As of 2016, Sacramento is meeting both the 5.9 pounds per person per day and 9.5 pounds per job per day diversion targets set by CalRecycle under AB 341.

Senate Bill 1383

SB 1383 established a methane emissions reduction target for short-lived climate pollutants in various sectors of the economy, including waste. Specifically, SB 1383 establishes targets to achieve a 50 percent reduction in the level of the statewide disposal of organic waste from the 2014 level by 2020 and a 75 percent reduction by 2025.[45] Additionally, SB 1383 requires a 20 percent reduction in "current" edible food disposal by 2025. Although SB 1383 has been signed into law, compliance at the jurisdiction-level has proven difficult. For example, Santa Clara County suggests the 75 percent reduction in organics is not likely achievable under the current structure; standardized bin colors are impractical; and the general requirement is too prescriptive.[46] As such, SB 1383 is not included as part of the adjusted forecast. Instead measures addressing compliance with SB 1383 will be addressed through newly identified GHG reduction measures included in the Climate Action Plan.

4.4 Adjusted Scenario Forecast

The adjusted scenario is based on the same information as the business-as-usual scenario but also includes the legislative actions and associated emissions reductions occurring at the State and federal levels. These actions include regulatory requirements to increase vehicle fuel efficiency or standards to reduce the carbon intensity of electricity. The difference between the emissions projected in the adjusted scenario and the GHG reduction targets established for each horizon year is the amount of GHG reductions which are the responsibility of the City. This "gap analysis" provides the City with the total GHG emissions reduction required as well as information on the emissions sectors and sources which have the most GHG reduction opportunities.

The electricity and water/wastewater sectors all experience a strong downward trend, approaching near-zero in 2045 due to extremely stringent RPS from SB 100. Natural gas emissions are expected to continue an upward trajectory until the 2035 due to strong population growth projections in the city. This trend is partially offset due to the increasingly stringent efficiency requirements for new homes in the upcoming Title 24 code cycles. Commercial growth will also lead commercial natural gas emissions on a similar trajectory. Transportation emissions are expected to decrease sharply in the next 10 to 15 years due to existing fuel efficiency requirements and fleet turnover rates. As most current regulations expire in 2025 or 2030, emissions standards will experience diminishing returns while VMT continues to increase, leading to lower rates of emissions reduction in the transportation sector.

[45] CalRecycle. April 16, 2019. Short-Lived Climate Pollutants (SLCP): Organic Waste Methane Emissions Reductions (General Information). Accessed at: https://www.calrecycle.ca.gov/climate/slcp. Accessed on: Maty 20, 2019

[46] Santa Clara County. June 20, 2018. SB 1383 Rulemaking Overview. Accessed at: https://www.sccgov.org/sites/rwr/rwrc/Documents/SB%201383%20PowerPoint.pdf. Accessed on: May 20, 2019

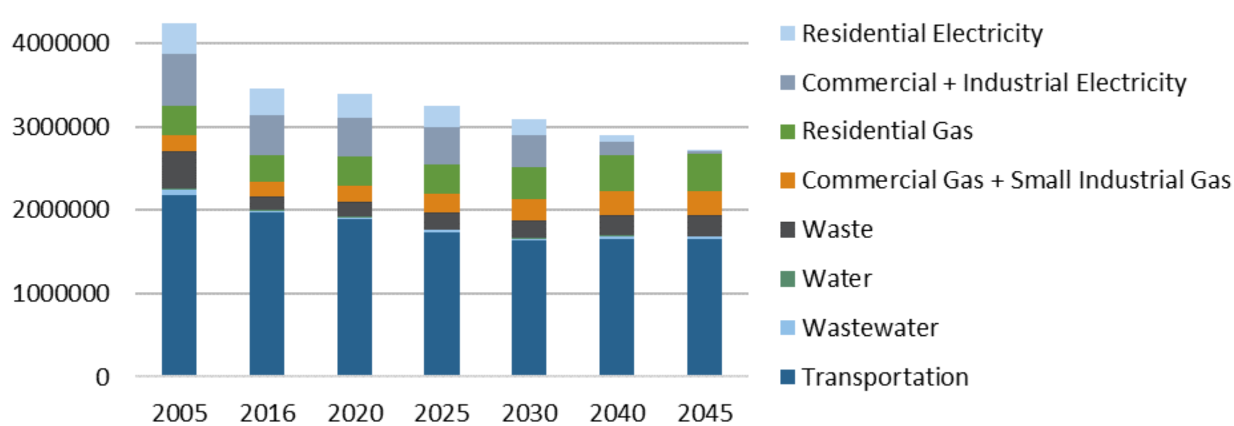
A summary of Sacramento's projected emissions by sector and year through 2045 can be found in Figure 7 and Table 25. Further details on the growth rates and emissions for each sector can be found in the corresponding discussion sections.

Table 25 Adjusted Scenario Forecast Summary by Sector by Target Year

	2016 ($MT\ CO_2e$)	2020 ($MT\ CO_2e$)	2025 ($MT\ CO_2e$)	2030 ($MT\ CO_2e$)	2040 ($MT\ CO_2e$)	2045 ($MT\ CO_2e$)
Population	486,154	518,627	559,218	599,809	670,836	699,903
Jobs	217,500	253,837	299,258	344,679	408,640	426,346
Residential Electricity	318,275	282,001	244,445	192,905	76,710	0
Commercial/ Industrial Electricity	489,945	473,740	446,096	378,081	161,952	0
Residential Gas	318,304	339,193	363,909	388,625	431,874	449,573
Commercial + District Industrial Gas	172,019	198,602	223,748	248,894	284,304	294,107
Waste	160,843	176,572	196,233	215,893	246,749	257,441
Water	9,607	8,832	8,204	6,877	2,948	0
Wastewater	19,867	21,810	24,238	26,667	30,478	31,799
Transportation	1,935,870	1,783,491	1,563,815	1,405,213	1,350,195	1,343,471
Total Emissions	**3,424,729**	**3,284,240**	**3,070,688**	**2,863,156**	**2,585,211**	**2,376,391**
Emissions Per Capita	**7.04**	**6.33**	**5.49**	**4.77**	**3.85**	**3.40**

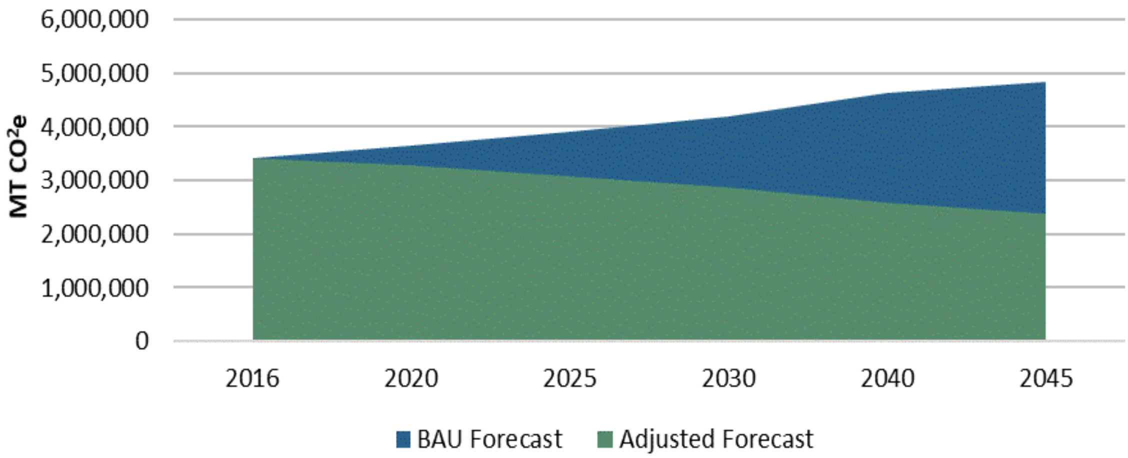
$MT\ CO_2e$: metric tons of carbon dioxide equivalent

Figure 7 Summary of Adjusted Scenario Forecast by Sector by Year



As shown in Figure 8, without legislative reductions, the City's emissions would increase proportionally with population and economic growth. In reality, several existing legislative reductions would limit the City's emissions growth, causing projected emissions to decrease. This scenario is depicted by the Adjusted Forecast. The legislative reductions for each sector and scaling methods used to project emissions are discussed in detail below.

Figure 8 BAU Scenario and Adjusted Scenario Forecast



4.5 Electricity

Between 2016 and 2045, electricity emissions for commercial, residential, and industrial buildings in the city of Sacramento, together representing the building energy electricity sector, are assumed to decrease from 808,220 MT CO_2e to 0 MT CO_2e, despite steady growth in Sacramento's population and employment levels due to the adoption of SB 100 and the renewable portfolio standard. SMUD's current plan to reach carbon neutral electricity includes the use of offsets. These offsets have not been identified fully and future work will need to ensure no double counting occurs between SMUD and Sacramento's efforts to reach carbon neutral emissions.

Emissions from future electricity use were forecasted by projecting anticipated growth in residential and commercial sectors and multiplying by expected electricity emission factors. Anticipated growth in the residential sector was projected as a function of population growth within the city while commercial sector electricity use was projected as a function of employment projections. Legislative adjustments included in the electricity sector forecast include RPS of 60 percent by 2030 and 100 percent GHG-free by 2045. Additionally, Title 24 building code efficiency increases for the 2019 code cycle were applied to all new growth within the city. The methodologies for the electricity sector which were forecasted in the adjusted scenario are summarized in Table 26 and Table 27.

Table 26 Electricity Sector Adjusted Scenario Forecast Methodology

Source Category	Forecasted Activity Data (Scaling Factor)	Emission Factor	Applied Legislative Reductions
Residential Electricity	Population growth in Sacramento	Assumes an electricity mix of 44 percent, 60 percent, and 100 percent GHG-free by 2025, 2030, and 2045, respectively, for SMUD emission factors per RPS requirements.	Title 24 standards for new construction in 2019 (53 percent residential, 30 percent commercial), RPS requirements
Commercial & Industrial Electricity	Employment growth in Sacramento		

RPS: Renewable Portfolio Standard; GHG: greenhouse gas; SMUD: Sacramento Municipal Utility District

Table 27 Electricity Adjusted Scenario Forecast Results by Target Year

Activity Data	2020	2025	2030	2040	2045
Residential Electricity					
Population	518,627	559,218	599,809	670,836	699,903
BAU per capita kWh	2,927.92	2,927.92	2,927.92	2,927.92	2,927.92
BAU total kWh	1,518,497,438	1,637,344,756	1,756,192,074	1,964,153,671	2,049,259,247
Adjusted kWh (Title 24)	1,505,899,622	1,561,757,862	1,617,616,101	1,715,358,052	1,755,357,672
Emissions factor (MT CO_2e/MWH)	0.18726	0.15652	0.11925	0.04472	0.0
MT CO_2e	**282,001**	**244,445**	**192,905**	**76,710**	**0**
Commercial Electricity					
Employment	253,837	299,258	344,679	408,640	426,346
BAU per job kWh	10,074.39	10,074.39	10,074.39	10,074.39	10,074.39
BAU total kWh	2,557,252,371	3,014,841,953	3,472,431,535	4,116,801,724	4,295,180,223
Adjusted kWh (Title 24)	2,529,796,996	2,850,109,703	3,170,422,411	3,621,481,543	3,746,346,492
Factor (MT CO_2e/MWh)	0.18726	0.15652	0.11925	0.04472	0.00000
MT CO_2e	**473,740**	**446,096**	**378,081**	**161,952**	**0**

MT CO_2e: metric ton of carbon dioxide equivalent; kWh: kilowatt hour; MWh: megawatt hour; BAU: business-as-usual

4.6 Natural Gas

Emissions from projected natural gas use were forecast using a similar methodology to the electricity sector. Anticipated natural gas use was projected for the residential and commercial sectors separately using population change and employment increase as growth indicators respectively. These results were multiplied by a natural gas emission factor of 0.00531 MT CO_2e per therm of natural gas.[47] Unlike electricity, the natural gas emission factor is based on the quality of the gas and remains relatively constant over time. This analysis did not consider any shift to renewable gas which may become more common over time and the use of which may affect future natural gas emission factors. The methodologies and data used to calculate natural gas emissions over time are summarized in Table 28 and Table 29.

Legislative adjustments applied for the natural gas sector include efficiency increases from Title 24 building code updates for new construction after the 2019 code cycle begins. Specific efficiency increases for new buildings over the previous triennial cycle are discussed in Section 4.3.

[47] The Climate Registry. 2016 Default Emissions Factors. Accessed at: https://www.theclimateregistry.org/wp-content/uploads/2014/11/2016-Climate-Registry-Default-Emission-Factors.pdf. Accessed on May 20, 2019

Table 28 Natural Gas Adjusted Scenario Forecast Methodology

Source Category	Forecasted Activity Data (Scaling Factor)	Emission Factor	Applied Legislative Reductions
Residential Natural Gas	Population growth in Sacramento	0.00531 MT CO_2e/therm	Title 24 standards for efficiency in new construction in 2019 (7 percent residential, 30 percent commercial over 2016 Title 24)
Commercial & District Natural Gas	Employment growth in Sacramento		

MT CO_2e: metric ton of carbon dioxide equivalent

Table 29 Natural Gas Adjusted Scenario Forecast Results by Target Year

Activity Data	2020	2025	2030	2040	2045
Residential Gas					
BAU therms	63,983,886	68,991,674	73,999,463	82,762,198	86,348,233
Title 24 adjusted therms	63,913,777	68,571,020	73,228,263	81,377,607	84,712,620
Factor (MT CO_2e/therm)	0.00531	0.00531	0.00531	0.00531	0.00531
MT CO_2e	**339,193**	**363,909**	**388,625**	**431,874**	**449,573**
Commercial Gas					
BAU therms	37,828,482	44,597,434	51,366,386	60,898,314	63,537,001
Title 24 adjusted therms	37,422,345	42,160,611	46,898,878	53,571,228	55,418,308
Factor (MT CO_2e/therm)	0.00531	0.00531	0.00531	0.00531	0.00531
MT CO_2e	**198,602**	**223,748**	**248,894**	**284,304**	**294,107**

MT CO_2e: metric ton of carbon dioxide equivalent; BAU: business-as-usual

4.7 Waste

The forecast used a baseline emissions rate of 0.7458 tons of waste per service population along with projected growth in Sacramento service population to establish the estimated tonnage of waste being disposed yearly through 2045. As the inventoried waste emissions include both waste-in-place and waste generation, an emissions factor of MT CO_2e per ton of waste was used to forecast emissions. An overall 2016 solid waste emissions factor, incorporating both generated waste and waste-in-place emissions, of 0.3058 MT CO_2e per ton of municipal solid waste was used to project emissions consistent with service population growth. Emissions from the waste sector will likely be less than the projected totals due to decreasing rates of organic material in the waste stream and recent legislation such as SB 1383 discussed in previous sections. At this time no mandate exists for individual cities and the waste reductions from these bills are incorporated into the Climate Action Plan through City reduction measures to avoid double counting. A summary of the methodologies and data used to model waste emission over time are provided in Table 30 and Table 31.

Table 30 Solid Waste Adjusted Scenario Forecast Methodology

Forecasted Activity Data (Scaling Factor)	Emission Factor	Applied Legislative Reductions
Service population growth	0.7458 tons per service person, 0.3058 MT CO_2e/ton of solid waste	N/A

MT CO_2e: metric ton of carbon dioxide equivalent; N/A: not applicable

Table 31 Waste Emissions Adjusted Scenario Forecast Results by Target Year

Activity Data	2020	2025	2030	2040	2045
Service Population	772,464	858,476	944,488	1,079,476	1,126,249
Ton waste per Service Population	0.7475	0.7475	0.7475	0.7475	0.7475
Total tons waste	577,402	641,694	705,987	806,888	841,850
Waste Factor (MT CO_2e/ton)	0.3058	0.3058	0.3058	0.3058	0.3058
MT CO_2e	**176,572**	**196,233**	**215,893**	**246,749**	**257,441**

MT CO_2e: metric ton of carbon dioxide equivalent

4.8 Transportation

Transportation emissions forecasts were developed consistent with the inventory methodology, through the determination of on-road annual VMT multiplied by a year-specific weighted emissions factor for emissions per mile travelled. VMT forecasts for the City of Sacramento were provided by Fehr and Peers Transportation Consultants through the use of SACOG SACSIM software. SACSIM was utilized to model VMT through 2040 with projected annual growth in County VMT as a proxy to extrapolate VMT for the years 2040 to 2045. Emissions factors were established for each year through the use of the EMFAC2017 GHG module, which established VMT and total emissions for each vehicle type in the County. These respective emissions factors were applied in each year to establish transportation emissions forecasts as shown in Table 32 and Table 33.

Table 32 Transportation Adjusted Scenario Forecast Methodology

Source Category	Forecasted Scaling Factor	Emissions Factor	Applied Legislative Reductions
On-road Transportation	SACSIM VMT Modeling[1]	EMFAC2017 model analyzing light duty (LDA, LDT1, LDT2, MDV, MCY) and heavy duty (LHD, T6, T7, PTO, MH, SBUS, UBUS, OBUS, Motor Coach, All Other Buses) vehicles.	EMFAC emission factors account for legislative reductions from Advanced Clean Cars, Pavley Clean Car Standards, Tractor-Trailer Greenhouse Gas Regulation, and adopted fuel efficiency standards for medium- and heavy-duty vehicles.

MT CO_2e: metric ton of carbon dioxide equivalent; VMT: vehicle miles traveled

[1]SACSIM incorporates data from many sources, including US Census, travel survey, and highway monitoring information. More information can be found on the SACOG SACSIM website at https://www.sacog.org/modeling

Table 33 Transportation Adjusted Scenario Forecast Results by Target Year

Activity Data	2020	2025	2030	2040	2045
Population Increase	518,627	559,218	599,809	670,836	699,903
VMT	4,451,651,325	4,582,448,563	4,713,245,802	4,974,840,279	5,206,516,958
EMFAC (MT CO_2e/VMT)	0.000401	0.000341	0.000298	0.000271	0.000258
MT CO_2e	1,783,491	1,563,815	1,405,213	1,350,195	1,343,471

MT CO_2e: metric ton of carbon dioxide equivalent; VMT: vehicle miles traveled

4.9 Water and Wastewater

Due to the increased use of the water system attributed to increases in job and population growth in Sacramento, service population was used as a scaling metric to determine water and wastewater service emissions through 2045. The Sacramento Wastewater Treatment Plant is currently undergoing renovations and upgrades through 2023 to modernize its facilities. As part of the "EchoWater Project", future wastewater emissions are expected to be lower than quantified here due to ammonia effluent reductions.

Projections for water used a baseline activity factor of 60.92 kWh per service population per year. This emissions factor was multiplied by service population growth through 2045 to find total kWh usage. The RPS for electricity generation was then applied to water emissions, as described in the Legislative Adjustment Section, to determine final MT CO_2e emissions as shown in Table 35 and Table 36.

As wastewater emissions are calculated from both methane as well as stationary and process nitrous oxide emissions, wastewater projections used an emissions factor of 0.028 MT CO_2e per service population per year and a growth indicator of service population to determine future wastewater emissions.

Table 34 Water and Wastewater Adjusted Scenario Forecast Methodology

Forecasted Activity Data (Scaling Factor)	Emissions Factor	Applied Legislative Reductions
Service population (population and employment growth)	SMUD electricity emissions factors, 60.92 kWh per service population per year	Assumes an electricity mix of 44 percent, 60 percent, and 100 percent GHG-free by 2025, 2030, and 2045 respectively for SMUD emission factors per RPS requirements.
Service population (population and employment growth)	0.0282 MT CO_2e per service person per year for wastewater	N/A

MT CO_2e: metric ton of carbon dioxide equivalent; kWh: kilowatt hour; SMUD: Sacramento Municipal Utility District; N/A: not applicable

Table 35 Water Adjusted Scenario Forecast Results by Target Year

Activity Data	2020	2025	2030	2040	2045
Service Population	772,464	858,476	944,488	1,079,476	1,126,249
kwh/Service Person	61.06	61.06	61.06	61.06	61.06
Total kWh	47,165,408	52,417,171	57,668,933	65,911,104	68,766,992
RPS Electricity Factor (MT CO_2e/kWh)	0.1872638	0.1565190	0.1192526	0.0447197	0
MT CO_2e	8,832	8,204	6,877	2,948	0

MT CO2e: metric ton of carbon dioxide equivalent; kWh: kilowatt hour; RPS: renewable portfolio standard

Table 36 Wastewater Adjusted Scenario Forecast Results by Target Year

Activity Data	2020	2025	2030	2040	2045
Service Population	772,464	858,476	944,488	1,079,476	1,126,249
MT CO_2e/Service Population	0.028	0.028	0.028	0.028	0.028
MT CO_2e	**21,810**	**24,238**	**26,667**	**30,478**	**31,799**

MT CO_2e: metric ton of carbon dioxide equivalent; kWh: kilowatt hour;

5 Provisional Target Setting

Climate action plan GHG-reduction targets can be set as either an efficiency target (MT CO_2e per capita or per service population per year) or as a community wide mass emissions target (total MT CO_2e). With CARB's publication in 2017 of the Scoping Plan Update, the State recommended using efficiency metrics for local targets to incentivize growth in a coordinated manner and not penalize cities which are growing at significant rates.[48] Throughout this section, targets are discussed in terms of per capita metrics, however, they must occasionally be translated into absolute emissions reductions to quantify reduction measures and identify the magnitude of reductions required.

Target setting is an iterative process which must be informed by the reductions that can realistically be achieved through the development of feasible GHG reduction measures. Furthermore, as mentioned previously, changes to the General Plan Update may impact the forecast results. As such, the targets identified herein should remain provisional until the General Plan Update values are finalized and the quantification and analysis of potential GHG reduction measures completed.

The City of Sacramento has achieved both efficiency and absolute emissions reductions between 2005 and 2016 despite high population growth rates. The purpose of target setting is to develop the trajectory toward achieving the State's 2030 goal and prepare for the deep decarbonization needed by 2045 in a cost-effective manner by setting an incremental path toward achieving the EO B-55-18 goals. There are several target pathways available to be consistent with State reduction goals, discussed further below.

- **SB 32 Target Pathway** is the pathway toward achieving the minimum reductions required by State law. This will require minimal reductions until 2030 and then steep reductions from 2030 to 2045.
- **Linear Carbon Neutrality Pathway** is an incremental linear pathway from current per capita emissions levels straight to carbon neutrality in 2045. This pathway is also compliant with the 2030 State goal.
- **Mass Emissions Reduction Pathway** is the pathway determined by reducing mass emissions without consideration to population growth. This pathway will require steep reductions to 2030 and then a slightly more gradual reduction to the 2045 carbon neutrality goal. This pathway is also compliant with the 2030 goal.

At this time, the State has codified a goal of reducing emissions to 40 percent below 1990 emissions levels by 2030 (SB 32) and has developed a Scoping Plan to demonstrate how the State will achieve the 2030 goal and make substantial progress toward the State's long-term GHG reduction goals. Sufficient data does not exist to perform a full 1990 inventory, however, as discussed in the Background section, the State has indicated a 15 percent reduction from 2005 GHG emissions levels can be considered equivalent to a 1990 baseline. Consistent with this methodology, a 1990 emissions level of 3,600,213 MT CO_2e, or 9.75 MT CO_2e per capita was established for Sacramento.

The State recommends utilizing a per capita efficiency metric for SB 32 targets, therefore, a target of 5.85 MT CO_2e per capita (40 percent reduction from 9.75 MT CO_2e per capita in 1990) was established as an emissions level compliant with SB 32 target levels. This is the equivalent of 3,510,283 MT CO_2e based on the 2030 forecasted population for the City.

[48] California Air Resources Board. 2017. California's Climate Change Scoping Plan, p. 99-102.

While no State plan exists to achieve carbon neutrality by 2045, EO B-55-18 directs CARB to ensure future Scoping Plan updates identify and recommend measures to achieve the carbon neutrality goal. Executive Orders are binding only unto State agencies and are not binding on local governments or the private sector. However, showing progress toward this goal is expected to be a mandatory component of CEQA analyses upon publication of the next Scoping Plan.

Based on this information, establishing provisional targets for the years 2025 (interim target), 2030 (SB 32 target year), 2040 (General Plan horizon year), and 2045 (EO B-55-18 target year) is recommended. The 2045 target is intended to be a long-term commitment demonstrating the City's commitment to achieving the long-term goal presented in EO B-55-18. The City has several potential pathways to show consistency with State targets as shown in Table 37.

To account for the expected growth in Sacramento's population and economy over the next 10 to 25 years, a per capita efficiency metric is used to normalize emissions targets. Table 37 shows the per capita emissions forecast and the different target pathway options available to achieve consistency with the SB 32 and EO B-55-18 goals.

Table 37 Per Capita Pathway Targets by Target Year

Year	Forecast	SB 32 then Carbon Neutral Pathway	Linear Carbon Neutral Pathway	Mass Reduction Pathway
	MT CO_2e per person per year			
2020	6.3	6.3	6.1	5.9
2025	5.5	6.1	4.8	4.7
2030	4.8	5.8	3.6	3.6
2040	3.9	1.9	1.2	1.1
2045	3.4	0.0	0.0	0.0

MT CO_2e: metric ton of carbon dioxide equivalent

The absolute GHG emissions gap in 2030, 2040, and 2045 between each target pathway and the forecast emissions can be found in Table 38. This gap will be bridged by local actions developed in the City of Sacramento Climate Action Plan.

Table 38 Remaining GHG Emissions Gap in 2030 and 2040 by Pathway

Pathway Emissions Gap (MT CO_2e)	SB 32 Target Pathway (minimum)	Linear Carbon Neutral Pathway	Mass Reduction Pathway
2030 Gap	-647,127	683,271	703,028
2040 Gap	1,277,478	1,773,109	1,865,168
2045 Gap	2,376,391	2,376,391	2,376,391

MT CO2e: metric ton of carbon dioxide equivalent

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