CITY OF CUPERTINO

2018 COMMUNITY-WIDE AND MUNICIPAL OPERATIONS GREENHOUSE GAS EMISSIONS INVENTORY REPORT

Inventory Completed: October 2019

Report Date: July 2020

Acknowledgements

This 2018 Community-wide and Municipal Operations Greenhouse Gas Emissions Inventory Report was developed for the City of Cupertino Office of the City Manager. The community-wide inventory was developed using the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) and the municipal operations inventory was developed using the Local Government Operations Protocol (LGO). These inventories are intended to assist the City of Cupertino in tracking progress towards the City's emissions reduction goals established in the City of Cupertino Climate Action Plan (2015).

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1. INTRODUCTION

The City of Cupertino is pleased to present the 2018 community-wide and municipal operations greenhouse gas (GHG) emissions inventories. Emissions inventories are developed to help community and government leaders understand how GHG emissions are generated from various activities in the community. Emissions accounting standards and protocols are used to assist cities in compiling emissions data at both the community-wide scale and at the municipal operations scale.

Cupertino established a baseline community-wide inventory and municipal operations inventory for calendar year 2010 as part of the 2015 Climate Action Plan (CAP) process. In 2017, the city updated both baseline inventories for calendar year 2015. This 2018 inventory was developed to help the City track progress towards achieving emissions reduction goals established in the CAP. The results of this inventory will be used to help forecast and assess potential trends in emissions from 2018 to 2020, 2035 and 2050, and to determine if the City is on track to meet its GHG reduction targets.

The community-wide inventory follows the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) developed by the World Resources Institute, C40 Cities, and ICLEI Local Governments for Sustainability. The GPC is the required protocol for The Global Covenant of Mayors for Climate and Energy (Global Covenant)[1], of which Cupertino is a member. The municipal operations inventory follows the Local Government Operations Protocol (LGO) developed by the California Air Resources Board, California Climate Action Registry, ICLEI and the Climate Registry. Calendar year 2018 was chosen as the year for this inventory because it was the most recent calendar year with complete data available.

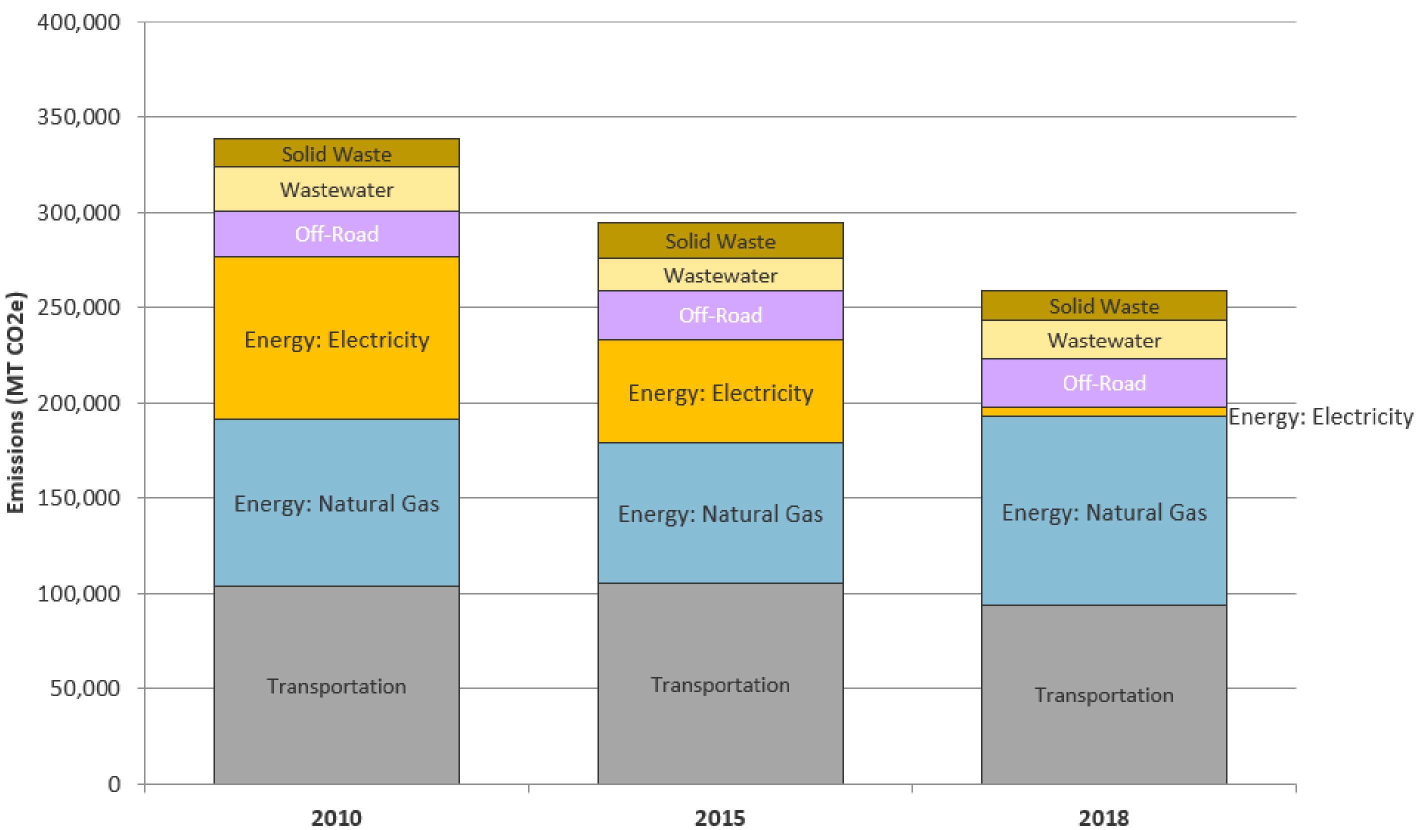
[1] The Global Covenant of Mayor's for Climate and Energy is the new designation for the Compact of Mayors. The Compact of Mayors was launched by UN Secretary, C40 Cities Climate Leadership Group (C40), ICLEI – Local Governments for Sustainability (ICLEI) and the United Cities and Local Governments (UCLG) –with support from UN-Habitat, the UN's lead agency on urban issues.

1.1 2018 Community-wide Emissions Inventory

1.1.1 Summary of Community-wide Emissions Inventory Results

Our findings indicate that Cupertino emitted community-wide emissions of 258,659 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2018 from the energy, transportation, off-road sources, solid waste and wastewater sectors.[2] This represents a 24% decrease from 2010 community-wide emissions of 338,673 $MTCO_2e$ and a 12% decrease from 2015 community-wide emissions of 294,281 $MTCO_2e$. Figure 1 and Table 1 provide a comparison of 2010-2018 community-wide emissions and trends by sector and subsector.

Figure 1: Cupertino community-wide emissions by sector – 2010-2018



[2] Carbon dioxide equivalent (CO_2e) is a unit of measure that normalizes the varying climate warming potencies of all six GHG emissions, which are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). For example, one metric ton of methane is equivalent to 28 metric tons of CO_2e. One metric ton of nitrous oxide is 265 metric tons of CO_2e.

Table 1: Cupertino community-wide emissions by sector & subsector – 2010-2018

Sector/Subsector	2010 Emissions (MT CO2e/yr)	2015 Emissions (MT CO2e/yr)	2018 Emissions (MT CO2e/yr)	2010-2018 Percent Change
Energy	172,289	128,266	103,361	-40%
Electricity Subtotal	85,451	54,318	4,515	-95%
Residential	25,427	22,396	454	-98%
Non-residential[3]	60,025	31,922	4,061	-93%
Natural Gas Subtotal	86,837	73,948	98,846	+14%
Residential	49,986	40,594	43,428	-13%
Non-residential[3]	34,109	31,012	52,287	+53%
Fugitive Nat. Gas	2,742	2,342	3,130	+14%
Transportation	104,112	105,225	93,987	-10%
Off-Road Sources	24,496	25,165	25,967	+6%
Solid Waste	15,185	18,219	15,709	+3%
Wastewater	22,591	17,405	19,635	-13%
Total	**338,673**	**294,281**	**258,659**	**-24%**

Table 2 provides a sector-by-sector analysis of key factors driving trends in community-wide emissions from 2010-2018.

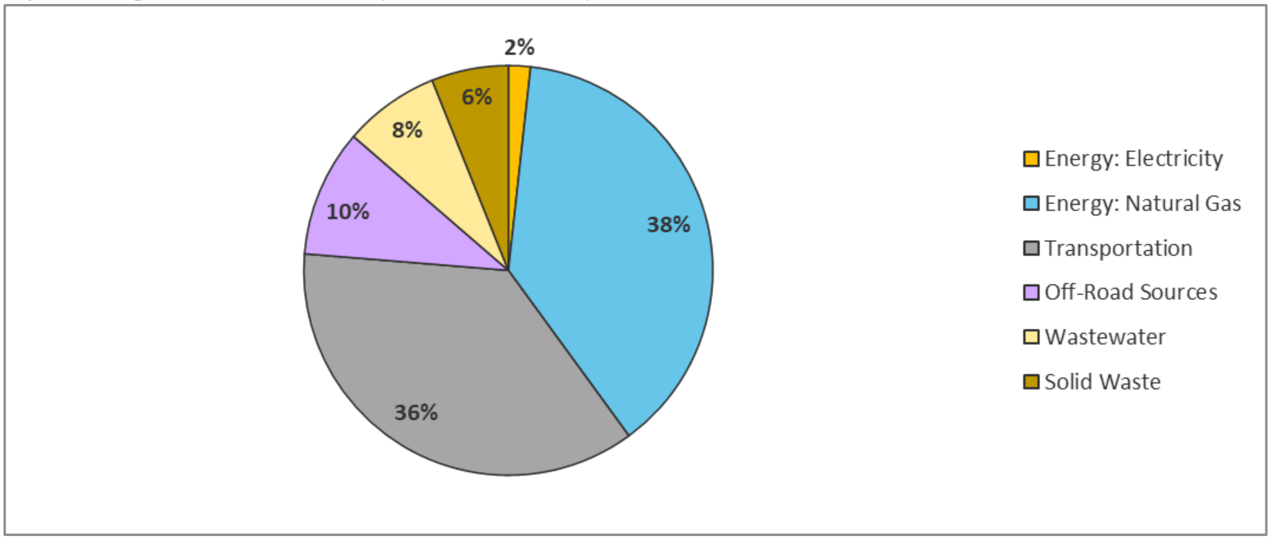
Table 2: Summary of key 2010-2018 community-wide emissions trends

Emissions Sector	Summary of 2010-2018 Trends
Energy	Energy emissions decreased 40% from 2010 to 2018. This trend in the energy sector is largely driven by a 95% decrease in total electricity emissions. The launch of Silicon Valley Clean Energy (SVCE) is largely responsible for this decrease in electricity emissions.
Transportation	Transportation emissions decreased 10% from 2010 to 2018. An 8% increase in total vehicle miles travelled (VMT) was offset by a 17% improvement in on-road vehicle fuel efficiency.
Off-Road Sources	Off-road emissions increased 6% from 2010 to 2018. Modest increases in off-road emissions associated with construction and industrial equipment, which make up the majority of off-road emissions, drove the increase.
Solid Waste	Solid waste emissions increased 3% from 2010 to 2018. A 9% increase in the amount of waste sent to landfills drove the increase in emissions.
Wastewater	Wastewater emissions decreased 13% from 2010 to 2018. This decrease is driven by a 16% decrease in the biochemical oxygen demand (BOD) treated per day at the San José-Santa Clara Regional Wastewater Facility. 4% of the total plant emissions were allocated to Cupertino based on population served.

[3] The "Non-residential" subsector includes commercial, industrial, municipal and institutional customers. For electricity, this also includes direct access customers – a retail electric service where customers purchase electricity from a competitive provider called an Electric Service Provider (ESP), instead of from a regulated electric utility or community choice aggregator.

Figure 2 displays the relative contribution of each sector to overall 2018 community-wide emissions.

Figure 2: Cupertino 2018 community-wide emissions by sector



Energy: natural gas (38%) and transportation (36%) continue to make up the vast majority of community-wide emissions in Cupertino. Energy: electricity (2%), off-road sources (10%), solid waste (8%) and wastewater (6%) make up the remaining community-wide emissions.

Increases in population and jobs in Cupertino over time have the potential to significantly influence total community emissions. Table 3 below summarizes the increase in population, jobs and "service population", the sum of population and jobs, from 2010-2018 based on data in the Cupertino GPA EIR. Table 3 also summarizes total historic community-wide emissions for 2010-2018. Using this information, historic per resident and per service population emissions for 2010-2018 were calculated.

Table 3: Historic Growth in Cupertino in Relation to Historic Emissions

	2010	2015	2018	2010-2018 % Change	2015-2018 % Change
Population [4]	58,739	60,833	62,089	+6%	+2%
Jobs [5]	26,220	29,224	31,026	+18%	+6%
Service Population [6]	84,959	90,057	93,115	+10%	+3%
Total Emissions (MT CO_2e) [7]	338,673	294,281	258,659	-24%	-12%
Emissions Per Resident (MT CO_2e)	5.77	4.84	4.17	-28%	-14%
Emissions Per Service Population (MT CO_2e)	3.99	3.27	2.78	-30%	-15%

Since 2010, when the baseline GHG inventory was established, Cupertino has experienced an estimated 6% increase in population, 18% increase in jobs, and a 10% increase in service population. Because community emissions are driven by both residential and commercial activity occurring within Cupertino, service population is a valuable metric for measuring overall community growth in relation to community-wide emissions. Despite a 10% increase in service population from 2010-2018, total emissions have decreased 24% over the same time period. As the community has grown, per service population emissions have decreased at a faster rate (30% decrease) than total emissions (24% decrease) since 2010.

1.1.2 Energy Sector

As summarized in Table 4 below, community-wide emissions in the energy sector decreased 40% from 2010 to 2018 and 19% from 2015 to 2018. The energy sector made up 40% of Cupertino's total community-wide emissions in 2018.

[4] 2010 population values from Cupertino GPA EIR Volume 1, Page 4. 11-7, Table 4.11-1 Population, Household and Employment Projections. 2040 population values from Page 3-12 were used to estimate 2015 and 2018 values. Linear extrapolation used to calculate 2015 and 2018 values (i.e. straight line growth from 2010 to 2040).

[5] 2010 employment values from Cupertino GPA EIR Volume 1, Page 4. 11-7, Table 4.11-1 Population, Household and Employment Projections. 2040 employment values from Page 3-12 were used to estimate 2015 and 2018 values. Linear extrapolation used to calculate 2015 and 2018 values (i.e. straight line growth from 2010 to 2040).

[6] Service population is sum of population and employment estimates.

[7] 2010, 2015 and 2018 total emissions are based on community-wide GHG inventories completed.

Table 4: Cupertino community-wide energy sector emissions by fuel type – 2010-2018

Category	2010 Emissions ($MT\ CO_2e$)	2015 Emissions ($MT\ CO_2e$)	2018 Emissions ($MT\ CO_2e$)	2010-2018 % Change	2015-2018 % Change
Electricity	85,451	54,306	4,515	-95%	-92%
Natural Gas	84,095	71,606	95,715	+14%	+34%
Nat. Gas Fugitive	2,742	2,342	3,130	+14%	+34%
Total	**172,289**	**128,254**	**103,361**	**-40%**	**-19%**

Table 5: Cupertino community-wide energy sector consumption by fuel type – 2010-2018

Category	2010 Consumption (kWh or therms)	2015 Consumption (kWh or therms)	2018 Consumption (kWh or therms)	2010-2018 % Change	2015-2018 % Change
Electricity	409,319,124	404,128,093	419,554,868	+3%	+4%
Natural Gas	15,805,499	13,498,530	18,043,356	+14%	+34%

The overall decrease in energy sector emissions since 2010 was driven by an 95% decrease in total electricity emissions that offset a 14% increase in natural gas emissions. As summarized in Table 6 below, community-wide electricity emissions decreased 95% from 2010 to 2018 and decreased 92% from 2015 to 2018. Electricity emissions made up 1.7% of Cupertino's total community-wide emissions in 2018.

Table 6: Cupertino community-wide electricity emissions by subsector – 2010-2018

Category	2010 Electricity Emissions (MT CO_2e)	2015 Electricity Emissions (MT CO_2e)	2018 Electricity Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Residential	**25,427**	**22,396**	**454**	**-98%**	**-98%**
Residential: SVCE	0	0	197		
Residential: PG&E	25,427	22,448	271	-99%	-99%
Residential: Direct Access	0	0	6		
Residential: EV Adjustment[8]	0	-52	-20		
Non-Residential	**60,025**	**31,910**	**4,061**	**-93%**	**-87%**
Non-Residential: SVCE	0	0	215		
Non-Residential: PG&E	55,859	24,545	287	-99%	-99%
Non-Residential: Direct Access.	4,166	7,377	3,564	-14%	-52%
Non-Residential: EV Adjust.[8]	0	-12	-5		
Total	**85,451**	**54,306**	**4,515**	**-95%**	**-92%**

Table 7: Cupertino community-wide electricity consumption by subsector – 2010-2018

Category	2010 Electricity Consumption (kWh)	2015 Electricity Consumption (kWh)	2018 Electricity Consumption (kWh)	2010-2018 % Change	2015-2018 % Change
Residential	**124,926,651**	**112,974,425**	**102,880,466**	**-18%**	**-9%**
Residential: SVCE	0	0	103,334,075		
Residential: PG&E	124,926,651	113,239,091	2,821,024	-98%	-98%
Residential: Direct Access	0	0	24,521		
Residential: EV Adjustment[8]	0	-264,666	-3,299,154		
Non-Residential:	**284,392,473**	**291,153,668**	**316,674,402**	**+11%**	**+9%**
Non-Residential: *SVCE*	0	0	112,588,606		
Non-Residential: *PG&E*	274,446,308	123,878,787	2,980,736	-99%	-98%
Non-Residential: *Direct Access*	9,946,165	167,336,963	201,878,936	+1,930%	+21%
Non-Residential: *EV Adjust.[8]*	0	-62,082	-773,876		
Total	**409,319,124**	**404,128,093**	**419,554,868**	**+3%**	**+4%**

[8] Electricity consumption and electricity emissions associated with charging electric vehicles is not allocated to the Energy sector. It is allocated to the Transportation sector. For this reason, estimated electricity consumption and emissions associated with electric vehicles is subtracted from the electricity consumption and emissions data associated with the Energy sector.

Total residential electricity consumption decreased 18% since 2010 and total residential electricity emissions decreased 98%. Residential electricity emissions decreased at a greater rate than residential electricity consumption largely due to residential customers switching to low carbon electricity provided by SVCE. Total non-residential electricity consumption increased 11%, but total non-residential electricity emissions decreased 93%. Non-residential electricity emissions decreased substantially despite an increase in non-residential electricity consumption largely due to a non-residential customer switching to low carbon electricity provided by SVCE and large, non-residential electricity consumers switching to low emissions direct access electricity.

As summarized in Table 8 below, community-wide natural gas emissions increased 14% from 2010 to 2018 and increased 34% from 2015 to 2018. Natural gas emissions made up 38% of Cupertino's total community-wide emissions in 2018.

Table 8: Cupertino community-wide natural gas emissions by subsector – 2010-2018

Category	2010 Natural Gas Emissions (MT CO_2e)	2015 Natural Gas Emissions (MT CO_2e)	2018 Natural Gas Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Residential	49,986	40,594	43,428	-13%	+7%
Non-Residential	34,109	31,012	52,287	+54%	+69%
Nat. Gas Fugitive	2,742	2,342	3,130	+14%	+34%
Total	**86,837**	**73,948**	**98,846**	**+14%**	**+34%**

Table 9: Cupertino community-wide natural gas consumption by subsector – 2010-2018

Category	2010 Natural Gas Consumption (Therms)	2015 Natural Gas Consumption (Therms)	2018 Natural Gas Consumption (Therms)	2010-2018 % Change	2015-2018 % Change
Residential	9,394,725	7,652,362	8,186,706	-13%	+7%
Non-Residential	6,410,774	5,846,168	9,856,650	+54%	+69%
Total	**15,805,499**	**13,498,530**	**18,043,356**	**+14%**	**+34%**

Total residential natural gas consumption decreased 13% since 2010 and total residential natural gas emissions decreased 13%. Total non-residential natural gas consumption increased 69% since 2010 and total non-residential natural gas emissions increased 69%.

1.1.3 Transportation Sector

As summarized in Table 10 below, community-wide emissions in the transportation sector decreased 10% from 2010 to 2018 and decreased 11% from 2015 to 2018. The transportation sector made up 36% of Cupertino's total community-wide emissions in 2018.

Table 10: Cupertino community-wide transportation sector emissions – 2010-2018

Sector	2010 Emissions ($MT\ CO_2e$)	2015 Emissions ($MT\ CO_2e$)	2018 Emissions ($MT\ CO_2e$)	2010-2018 % Change	2015-2018 % Change
Transportation	104,112	105,225	93,987	-10%	-11%

Table 11: Cupertino community-wide transportation sector vehicle miles travelled – 2010-2018

Sector	2010 Vehicle Miles Travelled	2015 Vehicle Miles Travelled	2018 Vehicle Miles Travelled	2010-2018 % Change	2015-2018 % Change
Transportation	282,971,589	301,079,036	306,984,796	+8%	+2%

Despite vehicle-miles-travelled (VMT) by on-road vehicles increasing 8% from 2010 to 2018, emissions associated with VMT decreased 10%. This is a result of efficiency improvements to on-road vehicles and an increase in the number of electric vehicles between 2010 and 2018, reducing the emissions associated per mile of travel.

As summarized in Table 12 below, the vast majority of VMT (94%) and transportation emissions (97%) came from gasoline vehicles.

Table 12: 2018 Cupertino community-wide transportation miles travelled and emissions by fuel type

Vehicle Fuel Type	2018 Vehicle Miles Travelled	2018 Percent of Total Vehicle Miles Travelled	2018 Emissions ($MT\ CO_2e$)	2018 Percent of Total Transportation Emissions
Gasoline	289,694,791	94%	90,890	97%
Diesel	4,151,198	1%	3,073	3%
Electric	13,138,807	4%	25	0%
Total	**306,984,796**	**100%**	**93,987**	**100%**

1.1.4 Off-road Sector

As summarized in Table 13 below, community-wide emissions in the off-road sector increased 6% from 2010 to 2018. The off-road sector made up 10% of Cupertino's total community-wide emissions in 2018.

Table 13: Cupertino community-wide off-road emissions – 2010-2018

Sector	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	2018 Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Off-road	24,496	25,165	25,967	+6%	+3%

A modest increase in off-road emissions associated with construction and industrial equipment, which make up the majority of off-road emissions, drove the increase in overall off-road emissions.

1.1.5 Solid Waste Sector

As summarized in Table 14 below, community-wide emissions in the solid waste sector increased 3% from 2010 to 2018 but decreased 14% from 2015 to 2018. The solid waste sector made up 6% of Cupertino's total community-wide emissions in 2018.

Table 14: Cupertino community-wide solid waste emissions – 2010-2018

Sector	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	2018 Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Solid Waste	15,185	18,219	15,709	+3%	-14%

Table 15: Cupertino community-wide solid waste landfilled – 2010-2018

Sector	2010 Waste Landfilled (Tons)	2015 Waste Landfilled (Tons)	2018 Waste Landfilled (Tons)	2010-2018 % Change	2015-2018 % Change
Solid Waste	30,685	33,399	33,587	+9%	+1%

Despite the volume of waste sent to landfills increasing 9% from 2010-2018, emissions from waste sent to landfills only increased 3%. This is a result of a lower percentage of the waste sent to landfills containing organic material that releases methane gas in landfills.

1.1.6 Wastewater Sector

As summarized in Table 16 below, community-wide emissions in the wastewater sector decreased 13% from 2010 to 2018 but increased 13% from 2015 to 2018. The wastewater sector made up 7.6% of Cupertino's total community-wide emissions in 2018.

Table 16: Cupertino community-wide wastewater emissions – 2010-2018

Sector	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	2018 Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Wastewater	22,591	17,405	19,635	-13%	+13%

Table 17: Cupertino community-wide wastewater biochemical oxygen demand – 2010-2018

Sector	2010 5-day Biochemical Oxygen Demand (kgBOD5/day)	2015 5-day Biochemical Oxygen Demand (kgBOD5/day)	2018 5-day Biochemical Oxygen Demand (kgBOD5/day)	2010-2018 % Change	2015-2018 % Change
Wastewater	161,756	119,418	136,216	-16%	+14%

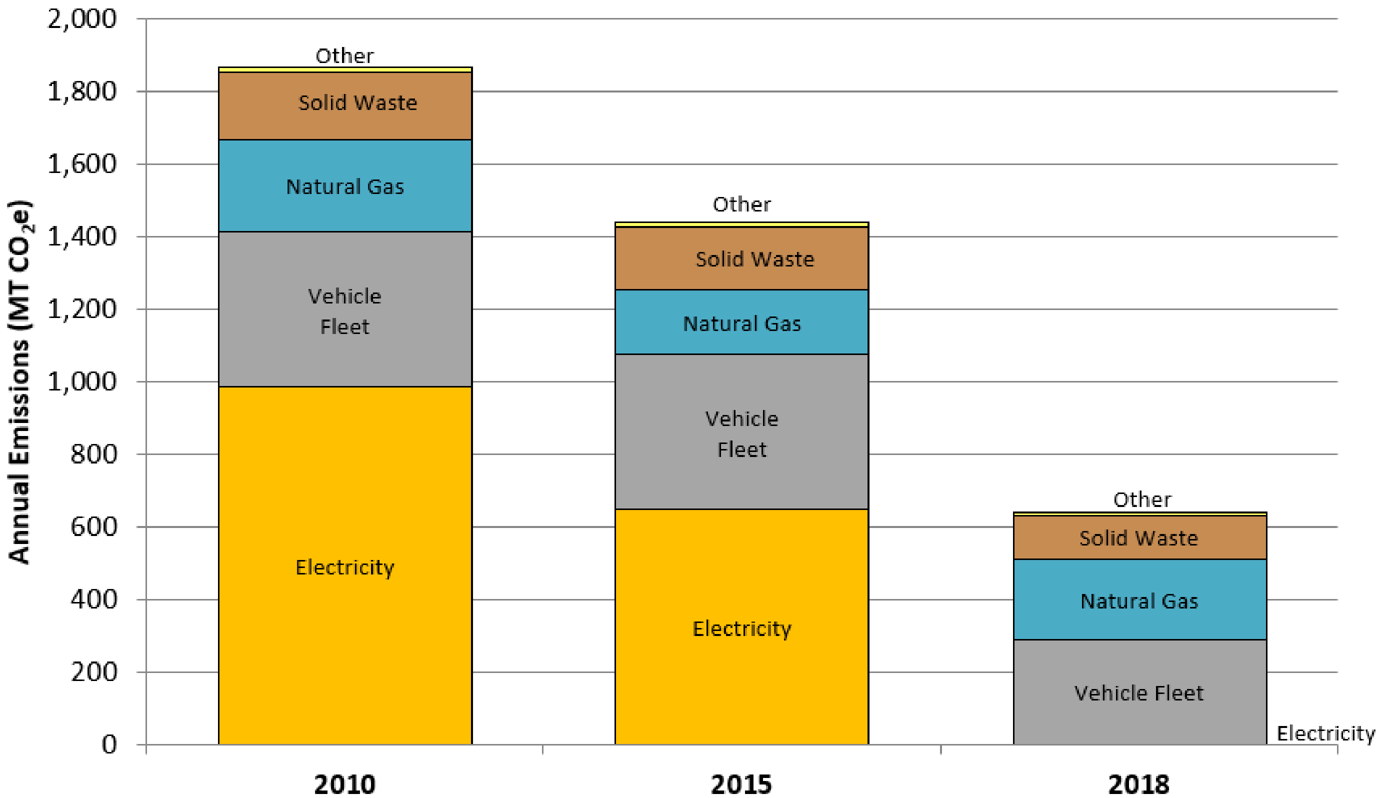
A 16% decrease in the 5-day biochemical oxygen demand (BOD5) – a measure used to evaluate the effectiveness of wastewater treatment - at the San José-Santa Clara Regional Wastewater Facility from 2010 to 2018 was the main driver behind the decrease in wastewater emissions.

1.2 2018 Municipal Operations Emissions Inventory

1.1.7 Summary of Municipal Operations Emissions Inventory Results

Our findings indicate that the City of Cupertino emitted municipal operations emissions of 645 $MTCO_2e$ in 2018 from the facilities, vehicle fleet, solid waste and water services sectors. This represents a 65% decrease from 2010 municipal operations emissions of 1,869 $MTCO_2e$ and a 55% decrease from 2015 municipal operations emissions of 1,442 $MTCO_2e$. Figure 3 provides a comparison of 2010-2018 municipal operations emissions and trends by sector and subsector.

Figure 3: Cupertino municipal operations emissions by sector – 2010-2018



Note: "Other" includes refrigerants, generators and water services.

Table 18: Cupertino municipal operations emissions by sector & subsector – 2010-2018

Sector/Subsector	2010 Emissions ($MT\ CO_2e/yr$)	2015 Emissions ($MT\ CO_2e/yr$)	2018 Emissions ($MT\ CO_2e/yr$)	2010-2018 % Change	2015-2018 % Change
Facilities	1,253	832	233	-81%	-72%
Building Energy and Refrigerants	841	601	233	-72%	-61%
Public Lighting	412	231	0	-100%	-100%
Vehicle Fleet	424	427	290	-32%	-32%
Solid Waste	186	175	122	-34%	-30%
Water Services	7	7	0	-100%	-100%
Total	**1,869**	**1,442**	**645**	**-65%**	**-55%**

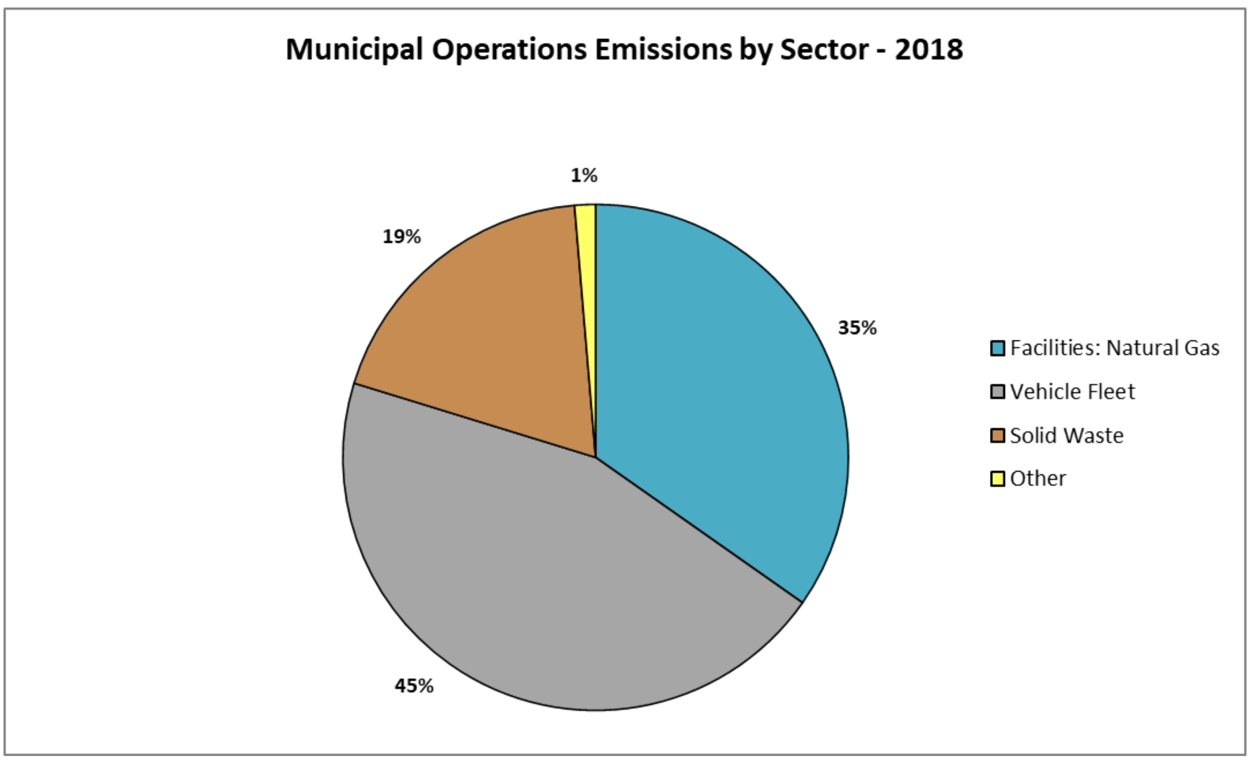
Table 19 provides a sector-by-sector analysis of key factors driving trends in municipal operations emissions from 2010-2018.

Table 19: Summary of key 2010-2018 municipal operations emissions trends

Emissions Sector	Summary of 2010-2018 Trends
Facilities Sector	Facilities emissions decreased 81% from 2010 to 2018. This trend in the facilities sector is largely driven by the procurement of carbon free electricity from SVCE. It is also driven by a 14% decrease in natural gas consumption.
Vehicle Fleet	Vehicle fleet emissions decreased 32% from 2010 to 2018. This decrease was largely driven by transitioning all diesel fleet vehicle from traditional to renewable diesel fuel and partially driven by the introduction of four electric vehicles into the fleet.
Solid Waste	Solid waste emissions decreased 34% from 2010 to 2018. This decrease is driven by a 31% decrease in the amount of waste sent to landfills.
Water Services	Water services emissions decreased 100% from 2010 to 2018. This decrease is driven by the procurement of carbon free electricity from SVCE.

Figure 4 displays the relative contribution of each sector to overall 2018 municipal operations emissions.

Figure **4**: 2018 municipal operations emissions by sector



"Other" includes refrigerants, generators, water services (electricity) and public lighting (electricity).

Facilities: natural gas (35%) and vehicle fleet (45%) make up the vast majority of municipal operations emissions in Cupertino. Solid waste (19%), and "other" (1%), which includes emissions from building refrigerants, generators, water services, and public lighting, make up the remaining municipal operations emissions.

Emissions associated with municipal employees commuting to work are scope 3 emissions from the perspective of a municipal operations inventory, because they are not directly controlled by the city government. For this reason, employee commute emissions were not included in either the 2010, 2015, or 2018 municipal operations inventories. However, employee commute surveys were conducted for both 2010 and 2015. Data from the 2015 employee commute survey was used to estimate 2018 employee emissions by accounting for an increase in the efficiency of vehicles and an increase in the number of municipal employees from 2015 to 2018. The results are presented below in Table 20 and Table 21.

Table 20: Cupertino municipal employee commute emissions – 2010-2018

Sector	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	2018 Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Employee Commute	463	443	423	-9%	-4%

Table 21: Cupertino municipal employee commute vehicle miles travelled – 2010-2018

Sector	2010 employees total driving commute distance (miles/year)	2015 employees total driving commute distance (miles/year)	2018 employees total driving commute distance (miles/year)	2010-2018 % Change	2015-2018 % Change
Employee Commute	1,224,509	1,272,985	1,331,179	+7%	+5%

Despite the total distance employees drove to work increasing an estimated 7% from 2010 to 2018, emissions associated with employees driving to work decreased an estimated 9%. This is mainly the result of employees driving more fuel-efficient vehicles to work in 2018.

1.1.8 Facilities Sector

As summarized in Table 22 below, municipal operations emissions in the facilities sector decreased 81% from 2010 to 2018 and 72% from 2015 to 2018. The facilities sector made up 36% of Cupertino's total municipal operations emissions in 2018.

Table 22: Cupertino municipal operations facilities sector emissions by subsector – 2010-2018

Category	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	2018 Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Facilities Electricity	577	417	0	-100%	-100%
Facilities Natural Gas	260	180	224	-14%	+24%
Facilities Generators	0	1	0	-5%	-68%
Facilities Refrigerants	4	3	8	+126%	+189%
Public Lighting Electricity	412	231	0	-100%	-100%
Total	**1,253**	**832**	**233**	**-81%**	**-72%**

Table 23: Cupertino municipal operations facilities sector consumption by subsector – 2010-2018

Category	Consump. Units	2010 Consump.	2015 Consump.	2018 Consump.	2010-2018 % Change	2015-2018 % Change
Facilities Electricity	kWh	2,833,091	2,143,386	2,065,695	-27%	-4%
Facilities Natural Gas	Therms	48,940	33,947	42,261	-14%	+24%
Facilities Generators	Gallons	52	116	116	+123%	0%
Public Lighting Electricity	kWh	2,022,966	1,185,901	1,048,043	-48%	-12%

The overall 81% decrease in facilities sector emissions since 2010 was driven by a 100% decrease in facilities electricity emissions, a 100% decrease in public lighting electricity emissions, and a 14% decrease in natural gas emissions. The dramatic decrease in electricity emissions is the result of the City transitioning all electricity accounts, with the exception of a few public lighting accounts, to carbon free electricity from SVCE. Despite a 24% increase in natural gas emissions from 2015 to 2018, total facilities sector emissions over that same time period decreased 72%.

1.1.9 Vehicle Fleet Sector

As summarized in Table 24 below, municipal operations emissions in the vehicle fleet sector decreased 32% from 2010 to 2018 and decreased 32% from 2015 to 2018. The vehicle fleet sector made up 45% of Cupertino's total municipal operations emissions in 2018.

Table 24: Cupertino municipal operations vehicle fleet sector emissions by subsector – 2010-2018

Category	2010 Emissions ($MT\ CO_2e$)	2015 Emissions ($MT\ CO_2e$)	2018 Emissions ($MT\ CO_2e$)	2010-2018 % Change	2015-2018 % Change
Vehicle Fleet Fuel	379	393	249	-34%	-37%
Vehicle Fleet Refrigerants	45	34	41	-9%	+19%
Total	**424**	**427**	**290**	**-32%**	**-32%**

Table 25: Cupertino municipal operations vehicle fleet sector consumption by subsector – 2010-2018

Category	Consump. Units	2010 Consump.	2015 Consump.	2018 Consump.	2010-2018 % Change	2015-2018 % Change
Vehicle Fleet Fuel	Gallons	41,025	41,721	39,993	-3%	-4%

The overall 32% decrease in vehicle fleet sector emissions since 2010 was driven by transitioning all diesel fleet vehicles from traditional to renewable diesel. Renewable diesel releases 96% less non-biogenic emissions per gallon compared to traditional diesel. Renewable diesel accounted for 31% of the total gallons of fuel consumed by the vehicle fleet, while gasoline accounted for the remaining 69%. The four electric vehicles in the fleet consumed a combined 4,339 kWh of electricity in 2018.

1.1.10 Solid Waste Sector

As summarized in Table 26 below, municipal operations emissions in the solid waste sector decreased 34% from 2010 to 2018 and 30% from 2015 to 2018. The solid waste sector made up 19% of Cupertino's total municipal operations emissions in 2018.

Table 26: Cupertino municipal operations solid waste sector emissions – 2010-2018

Sector	2010 Emissions ($MT\ CO_2e$)	2015 Emissions ($MT\ CO_2e$)	2018 Emissions ($MT\ CO_2e$)	2010-2018 % Change	2015-2018 % Change
Solid Waste	186	175	122	-34%	-30%

Table 27: Cupertino municipal operations solid waste sector consumption – 2010-2018

Sector	2010 Waste Landfilled (Tons)	2015 Waste Landfilled (Tons)	2018 Waste Landfilled (Tons)	2010-2018 % Change	2015-2018 % Change
Solid Waste	376	355	261	-31%	-26%

The 34% decrease in solid waste sector emissions since 2010 is correlated with a 31% decrease in solid waste landfilled since 2010.

1.1.11 Water Services Sector

As summarized in Table 28 below, municipal operations emissions in the water services sector decreased 100% from 2010 to 2018 and decreased 100% from 2015 to 2018. The water services sector made up 0% of Cupertino's total municipal operations emissions in 2018.

Table 28: Cupertino municipal operations water services sector emissions – 2010-2018

Sector	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	2018 Emissions (MT CO_2e)	2010-2018 % Change	2015-2018 % Change
Water Services	7	7	0	-100%	-100%

Table 29: Cupertino municipal operations water services sector consumption– 2010-2018

Sector	2010 Electricity Consump. (kWh)	2015 Electricity Consump. (kWh)	2018 Electricity Consump. (kWh)	2010-2018 % Change	2015-2018 % Change
Water Services	32,378	35,675	32,522	0%	-9%

The 100% decrease in water services sector emissions since 2010 is the result of the City procuring carbon free electricity from SVCE. Electricity consumption associated with water services increased 0.4% from 2010 to 2018.

1.3 2018 – 2050 Community-wide Emissions Forecast

Conducting an emissions forecast is an essential step in developing strategies to reduce emissions and tracking progress towards established emissions reduction targets. Comparing projected emissions according to growth scenarios for jobs, housing, and population against future potential emissions reductions provides insight into whether a specific target level of reduction will be achieved by a particular year based on policies currently in place.

As part of the community-wide inventory, emissions forecasts were created to estimate future emissions out to 2020, 2035, and 2050 using the latest inventory (2018) as a starting point. These forecast years were selected because they align with the following emissions reduction goals Cupertino has established:

- 15% below 2010 emissions levels by 2020
- 49% below 2010 emissions levels by 2035
- 83% below 2010 emissions levels by 2050

Figure 5 and Table 30 through Table 34 summarize historic emissions, the business-as-usual emissions forecast, the City's emissions reduction targets, emissions avoided from State measures and the remaining emissions reductions that will be needed to achieve the emissions reduction targets. Cupertino reduced its community-wide emissions 24% between 2010 and 2018, achieving the target of a 15% reduction below 2010 levels by 2020 two years ahead of schedule.

Figure 5: Cupertino community-wide emissions forecast summary – 2010-2050

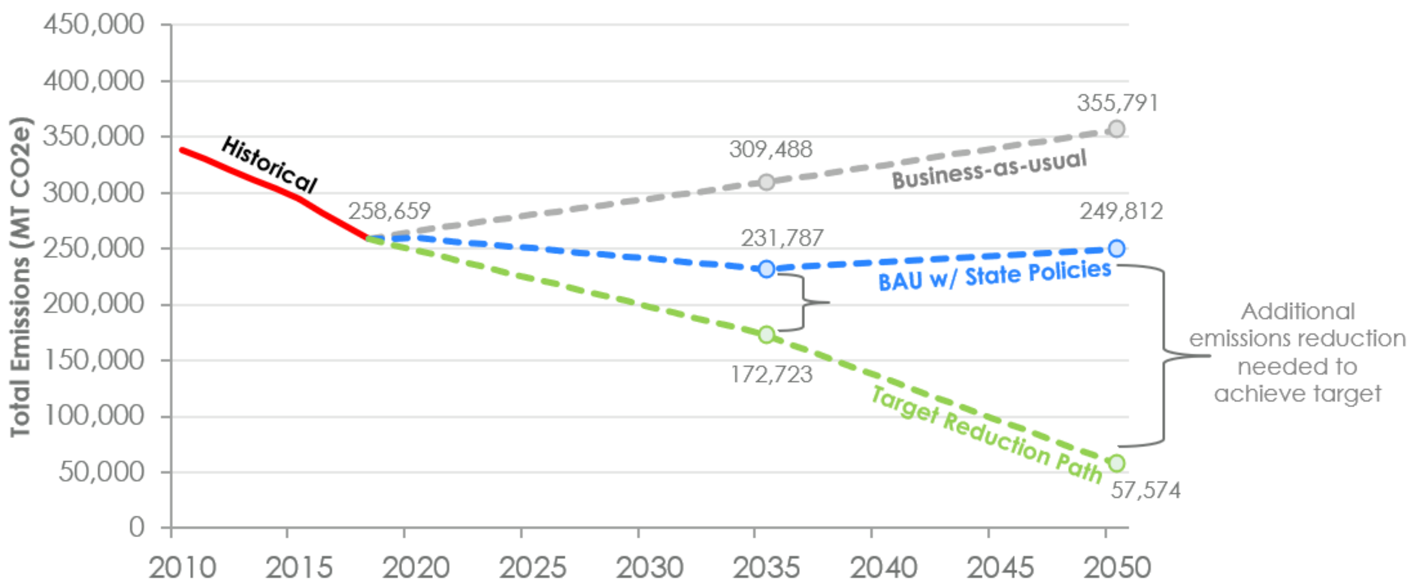


Table 30: Description of different emissions forecasts trend lines

Historic	Based on Cupertino's 2010, 2015, and 2018 community-wide inventories. Linear decrease between 2010 and 2015 assumed.
Business-as-usual	Assumes future conditions remain the same (vehicle efficiency, efficiency of buildings, etc.) but that Cupertino experiences growth. Based on growth projections in Cupertino's General Plan.
Business-as-usual With State Measures	Similar to Business-as-usual without state measures but also takes into consideration the emissions avoided impact of state policies (Advanced Clean Car Standards, Low Carbon Fuel Standard, Renewable Portfolio Standard, Zero Net Energy New Construction targets, and Organic Waste Diversion targets).
Target Reduction Path	The minimum linear emissions reduction trajectory Cupertino would need to take to meet the City's emissions reduction targets of 49% below 2010 by 2035 and 83% below 2010 by 2050. The 2020 target has already been achieved and is not factored in to this trajectory.

Table 31: Cupertino community-wide historic emissions, emissions reduction target and emissions forecast – 2010-2020

Category	Description	Data	Units
Historic Emissions and Current Progress	2010 Emissions:	338,673	MT CO_2e
	2015 Emissions:	294,281	MT CO_2e
	2018 Emissions:	258,659	MT CO_2e
	Percent Reduction Below 2010 by 2018:	**24%**	Percent
2020 Emissions Reduction Target	**Target Percent Reduction Below 2010 by 2020:**	**15%**	Percent
	2020 Emissions Target:	287,872	MT CO_2e
2020 Business-as-usual Emissions and Emissions Reduction from State & City Measures	2020 Business-as-usual Emissions:	265,855	MT CO_2e
	2020 Emissions Reduction from State Measures:	-6,207	MT CO_2e
	2020 Emissions Reduction from City Measures:		MT CO_2e
2020 Projected Emissions	2020 Projected Emissions with State + City Measures:	259,648	MT CO_2e
	Projected Percent Reduction Below 2010 by 2020:	**23%**	Percent

Table 32: Cupertino community-wide emissions reduction target and emissions forecast – 2018-2035

Category	Description	Data	Units
2035 Emissions Reduction Target	**Target Percent Reduction Below 2010 by 2035:**	**49%**	Percent
	2035 Emissions Target:	172,723	MT CO_2e
2035 Business-as-usual Emissions and Emissions Reduction from State & City Measures	2035 Business-as-usual Emissions:	309,488	MT CO_2e
	2035 Emissions Reduction from State Measures:	-77,701	MT CO_2e
	2035 Emissions Reduction from City Measures:		MT CO_2e
2035 Projected Emissions	2035 Projected Emissions with State + City Measures:	231,787	MT CO_2e
	Projected Percent Reduction Below 2010 by 2035:	**32%**	Percent

Table 33: Cupertino community-wide emissions reduction target and emissions forecast – 2018-2050

Category	Description	Data	Units
2050 Emissions Reduction Target	**Target Percent Reduction Below 2010 by 2050:**	**83%**	Percent
	2050 Emissions Target:	57,574	MT CO_2e
2050 Business-as-usual Emissions and Emissions Reduction from State & City Measures	2050 Business-as-usual Emissions:	355,791	MT CO_2e
	2050 Emissions Reduction from State Measures:	-105,980	MT CO_2e
	2050 Emissions Reduction from City Measures:		MT CO_2e
2050 Projected Emissions	2050 Projected Emissions with State + City Measures:	249,812	MT CO_2e
	Projected Percent Reduction Below 2010 by 2050:	**26%**	Percent

Table 34 summarizes the estimated emissions avoided from State measures in 2020, 2035 and 2050.

Table 34 : Cupertino community-wide estimated emissions avoided from State measures in 2020, 2035, and 2050

State Measure	Sector Impacted	2020 Emissions Avoided (MT CO_2e)	2035 Emissions Avoided (MT CO_2e)	2050 Emissions Avoided (MT CO_2e)
Advanced Clean Cars Program	On-road Transportation	5,652	37,527	46,634
Low Carbon Fuel Standard	Off-road Transportation	555	4,479	6,365
Renewable Portfolio Standard	All Electricity	0	2,926	7,151
ZNE Residential New Construction: 100% by 2020	Residential Energy	N/A	2,551	5,425
ZNE Non-residential New Construction: 100% by 2030	Non-residential Energy	N/A	2,373	8,717
ZNE Non-residential Existing Construction: 50% by 2030	Non-residential Energy	N/A	13,238	14,151
Organic Waste Diversion: SB 1383	Generated Waste	N/A	14,606	17,537
	Total	**6,207**	**77,701**	**105,980**

1.4 Community-wide Inventory Methodology

The 2018 community-wide inventory follows GPC recommended methodologies and uses Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) 100-year without climate-carbon feedbacks global warming potentials (GWPs).[9]

1.1.12 Stationary Energy

1.1.12.1 Stationary Energy: Buildings

Activity Data:

2018 community-wide natural gas and electricity consumption data was obtained through a combination of sources. PG&E provided data on PG&E residential electricity consumption and residential natural gas consumption via email attachment. All other energy consumption data

[9] Greenhouse Gas Protocol, "Global Warming Potentials" www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

(SVCE residential electricity, direct access residential electricity, PG&E non-residential electricity, non-residential natural gas, SVCE non-residential electricity, and non-residential direct access) was provided by SVCE via email attachment. Electricity and natural gas consumption were broken out by providers and by sector (residential and non-residential). Apple provided data on total direct access electricity consumption associated with their Cupertino campus.[10]

Methodology:

For the purposes of the GHG inventory, and to be in compliance with the GPC, all non-residential energy consumption was placed into the "commercial & institutional buildings & manufacturing industries & construction" subsector. All residential energy consumption was placed into the "residential buildings" subsector. The emissions associated with the electricity consumed by electric vehicles are accounted for in the transportation sector of the inventory, according to the GPC guidance. However, electricity consumption associated with charging electric vehicles is bundled into the electricity consumption data provided by SVCE and PG&E. In order to avoid double counting of electricity consumption and associated emissions in the stationary energy sector, the estimated electricity consumption and emissions associated with electric vehicle charging were subtracted from the stationary energy sector. Since an estimated 81% of electric vehicle charging occurs at home[11], 81% of total electricity consumption associated with electric vehicle charging was subtracted from the residential buildings subsector and the remaining 19% was subtracted from the commercial & institutional buildings & manufacturing industries & construction subsector. See methodology description for the transportation sector for more details on how total electricity consumption associated with electric vehicle charging was estimated.

[10] 2018 Apple Cupertino direct access electricity consumption provided by Rick Freeman of Apple's Global Energy Team via email.

[11] PlugInsights, "81% of Electric Vehicle Charging is Done at Home", December 2013
http://insideevs.com/most-electric-vehicle-owners-charge-at-home-in-other-news-the-sky-is-blue/

Emission Factors:

This inventory uses The Climate Registry (TCR) natural gas emission factor of 0.00530 MT CO_2/therm[12], a PG&E-specific electricity CO_2 emission factor of 0.0000953 MT CO_2/kWh[13], and SVCE-specific electricity CO_2 emission factors of 0.00000196 MT CO_2/kWh (SVCE GreenStart) and 0.0 MT CO_2/kWh (SVCE GreenPrime)[14]. A 2018 PG&E-specific electricity emission factor was not available at the time this inventory was completed, so the 2017 PG&E-specific electricity emission factor was used as a proxy. To account for fugitive natural gas emissions, the ICLEI ClearPath methodology was used. This methodology assumes a 0.3% natural gas leakage rate, a natural gas energy density of 1028 btu/scf, a natural gas density of 0.8 kg/m^3, 93.4% CH_4 content in natural gas and 1% CO_2 content in natural gas. PG&E does not provide an electricity emission factor for methane (CH_4) or nitrous oxide (N_2O), so 2016 Emissions & Generation Resource Integrated Database (eGRID) Western Electricity Coordinating Council (WECC) emission factors of 0.000000015 MT CH_4/kWh and 0.0000000018 MT N_2O/kWh were used.[15] 2018 emission factors were not available through eGRID, so 2016 emission factors were used as a proxy.

Since the emission factor associated with the purchase of direct access electricity varies from customer to customer, the average California statewide electricity emission factor was used as a proxy. A direct access electricity emission factor was calculated by dividing the total California electricity consumption in 2016[16] by the total California electricity-related GHG emissions in 2016.[17] The resulting direct access emission factors were 0.0002347507 MT CO_2/kWh, 0.000000028 MT CH_4/kWh and 0.0000000020 MT N_2O/kWh. Data was not available to calculate a 2018 direct access emission factor at the time the inventory was completed, so a 2016 emission factor was used as a proxy. These direct access emission factors were applied to all direct access electricity

[12] The Climate Registry, Table 12.1 U.S. Default Factors for Calculating CO2 Emissions from Fossil Fuel and Biomass Combustion
www.theclimateregistry.org/wp-content/uploads/2016/03/2015-TCR-Default-EFs.pdf

[13] 2017 PG&E electricity emission factor can be accessed through The Climate Registry's (TCR's) Climate Registry Information System (CRIS)
https://www.theclimateregistry.org/our-members/cris-public-reports/

[14] 2018 SVCE electricity emission factors were provided directly by SVCE via email.

[15] Emissions & Generation Resource Integrated Database (eGRID), 2016
www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

[16] California Energy Commission Total System Electric Generation, "2016 Total System Electric Generation in Gigawatt Hours"
www.energy.ca.gov/almanac/electricity_data/system_power/2016_total_system_power.html

[17] California Air Resources Board, "Greenhouse Gas Emission Inventory - Query Tool for years 2000 to 2017 (12th Edition)"
www.arb.ca.gov/app/ghg/2000_2017/ghg_sector.php

consumption in Cupertino, with the exception of direct access electricity purchase by Apple which is known to be 100% renewable.[18]

1.1.12.2 Stationary Energy: Off-Road

Activity Data:

All off-road emissions were calculated using the ARB's OFFROAD2007 Model.[19]

Methodology:

The OFFROAD2007 Model cannot be run on the city level. As a result, the model must be run at the County level and off-road emissions must be allocated to Cupertino based on the proportion of population or jobs in Santa Clara County (e.g. Santa Clara County's industrial equipment emissions multiplied by the percent of total Santa Clara County jobs in Cupertino). Table 35 below summarizes the type of off-road emissions in the OFFROAD2007 model output, whether the emissions were included or excluded from the inventory, the GPC subsector emissions were allocated to and the proxy (jobs or population) used to allocate Santa Clara County emissions to Cupertino. Off-road emissions associated with airport ground support equipment, agricultural equipment, pleasure craft, and oil drilling were excluded from the inventory because those activities do not take place in Cupertino.

[18] Apple Environmental Responsibility Report, Appendix A
https://www.apple.com/environment/pdf/Apple_Environmental_Responsibility_Report_2019.pdf

[19] Air Resources Board, "Off-Road Emissions Inventory Program"
www.arb.ca.gov/msei/offroad.htm

Table 35: Cupertino community-wide off-road emissions – included and excluded

OFFROAD 2007 Type of Emissions	Included or Excluded?	GPC Subsector	Percent of County Emissions Allocated to Cupertino By:
Construction and Mining Equipment	Included	Commercial & Institutional	Jobs
Industrial Equipment	Included	Commercial & Institutional	Jobs
Light Commercial Equipment	Included	Commercial & Institutional	Jobs
Railyard Operations	Included	Commercial & Institutional	Jobs
Transport Refrigeration Units	Included	Commercial & Institutional	Population
Entertainment Equipment	Included	Residential Buildings	Population
Lawn and Garden Equipment	Included	Residential Buildings	Population
Recreational Equipment	Included	Residential Buildings	Population
Airport Ground Support Equipment	Excluded		
Agricultural Equipment	Excluded		
Pleasure Craft	Excluded		
Oil Drilling	Excluded		

Cupertino's 2018 population[20] and Santa Clara County's 2018 population[21] are from the US Census. Cupertino's 2018 employment[22] and Santa Clara County's 2018 employment[23] are from the State of California Employment Development Department.

Emission Factors:

Emissions in terms of N_2O exhaust, CH_4 exhaust and CO_2 exhaust are a direct output of the OFFROAD2007 model. As a result, emission factors were not required to calculate emissions associated with the off-road sector.

1.1.13 Transportation

Activity Data:

The origin-destination methodology was used to estimate total VMT in Cupertino. As part of the General Plan, an origin-destination VMT model for 2013 was developed by Hexagon for

[20] United States Census QuickFacts, City of Cupertino
www.census.gov/quickfacts/table/PST045216/0617610

[21] United States Census QuickFacts, County of Santa Clara
www.census.gov/quickfacts/table/HCN010212/06085

[22] State of California Employment Development Department "Labor Force and Unemployment Rate for Cities and Census Designated Places"
www.labormarketinfo.edd.ca.gov/data/labor-force-and-unemployment-for-cities-and-census-areas.html

[23] State of California Employment Development Department "Labor Force and Unemployment Rate for Cities and Census Designated Places"
www.labormarketinfo.edd.ca.gov/data/labor-force-and-unemployment-for-cities-and-census-areas.html

Cupertino. This model was used to estimate 2010 VMT for the 2010 inventory. However, since the same model used to calculate 2010 and 2013 VMT was not available, this inventory relied on publicly available Cupertino-specific origin-destination VMT data available through the Metropolitan Transportation Commission (MTC) to estimate a 2010-2020 VMT annual growth rate in Cupertino.[24] This annual growth rate was applied to the Hexagon 2013 VMT to estimate the 2018 VMT.

Methodology:

Similar to the 2010 and 2015 inventories, total VMT was separated into two categories – passenger cars and trucks. All VMT associated with trucks was assumed to be non-electric. In order to estimate the percent of passenger car VMT from electric vehicles, data on 2018 Santa Clara County VMT travelled by fuel type from the ARB's EMFAC Web Database was used.[25] Data provided by the California DMV on vehicle registrations in Cupertino, Santa Clara County and surrounding Bay Area counties was used to estimate the percent of total origin-destination VMT in Cupertino attributable to electric vehicles.[26]

Emission Factors:

The EMFAC Web Database was also used to translate VMT travelled by specific vehicles types into GHG emissions through the utilization of EMFAC's vehicle-specific emission factors. However, EMFAC does not include assumptions regarding the emission factors/efficiency of electric vehicles. In order to translate electric vehicle VMT to electricity consumption, the average efficiency (kWh/mile) of the seven best-selling electric vehicles in 2018 was used.[27] See section 1.1.12.1 for an explanation of the electricity emission factor used in this inventory.

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[24] Non-commercial MTC Cupertino origin-destination VMT data for calendar years 2010 and 2020 obtained through MTC's Vehicle Miles Traveled Dataportal. Commercial MTC Cupertino origin-destination VMT data for calendar years 2010 and 2020 provided by Harold Brazil of MTC (HBrazil@mtc.ca.gov). http://capvmt.us-west-2.elasticbeanstalk.com/

[25] EMFAC Web Database EMFAC2017 (v1.0.2). For the model run the calendar year selected was "2018", the season selected was "annual" and the vehicle classification selected was "EMFAC2011 Categories".

[26] Data on electric vehicle registrations by city and county provided directly by California Department of Motor Vehicles.

[27] Average efficiency of 2018 model of the Nissan Leaf, Chevrolet Bolt, Chevrolet Volt, Prius Prime, Tesla Model X, Tesla Model 3 and Tesla Model S from Department of Energy's www.fueleconomy.gov

For non-electric passenger cars, EMFAC fuel efficiencies were used to translate VMT into CO_2 emissions. EMFAC does not include CH_4 and N_2O emission factors, so EPA emission factors by vehicle type for CH_4 and N_2O were used.[28] EMFAC groups fuel efficiencies by vehicle type.[29] Consistent with the 2010 and 2015 inventories, all passenger car VMT was assumed to be travelled by LDA, LDT1 and LDT2 vehicle types. The same process was used to translate truck VMT into emissions. Consistent with the 2010 inventory, all truck VMT was assumed to be travelled by LHD1, LHD2, PTO, SBUS, T6 Ag, T6 CAIRP heavy, T6 CAIRP small, T6 instate construction heavy, T6 instate construction small, T6 instate heavy, T6 instate small, T6 OOS heavy, T6 OOS small, T6 Public, T6 utility, T7 Ag, T7 CAIRP, T7 CAIRP construction, T7 NNOOS, T7 NOOS, T7 other port, T7 POAK, T7 Public, T7 Single, T7 single construction, T7 SWCV, T7 tractor, T7 tractor construction, T7 utility, T6TS, and T7IS vehicle types.

1.1.14 Waste

1.1.14.1 Waste: Solid Waste Disposal

Activity Data:

This inventory used data on the amount of Cupertino waste sent to landfills in 2018 from CalRecycle's Disposal Reporting System (DRS): Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility web portal.[30] Data on waste composition is primarily from CalRecycle's *2014 Disposal-Facility-Based Characterization of Solid Waste in California*[31] but is supplemented with data from on the composition of single-family residential waste from the City of Cupertino Residential Waste Pilot Study.[32] State-level waste composition was assumed for all building types with the exception of single-family residential buildings where Cupertino-specific waste composition data was used.

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[28] Environmental Protection Agency "Emission Factors for Greenhouse Gas Inventories" www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

[29] See following website for a complete list of EMFAC vehicle categories: www.arb.ca.gov/msei/vehicle-categories.xlsx

[30] Disposal Reporting System (DRS): Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility www.calrecycle.ca.gov/LGCentral/Reports/DRS/Destination/JurDspFa.aspx

[31] See Table ES-3 "Composition of California's Overall Disposed Waste Stream by Material Type". www.calrecycle.ca.gov/publications/Documents/1546/20151546.pdf

[32] Data on single-family residential waste composition from City of Cupertino Residential Waste Pilot Study, Table 5.

Methodology & Emission Factors:

The GPC methane commitment method for waste emissions was used. Tonnages of disposed waste sent to landfills and waste composition were input into GPC Equations 8.1, 8.3 and 8.4 to calculate CH_4 emissions associated with disposed waste. For Equation 8.1, the default carbon content values were used. For equation 8.3, the default fraction of methane recovered in landfill was used and an oxidation factor of 0.1 was selected because the landfills Cupertino sends waste to are managed. For equation 8.4, default values for the fraction of degradable organic carbon degraded and the fraction of methane in landfill gas were used. A methane correction factor of 1.00 was used because the landfills Cupertino sends waste to are actively managed.

1.1.14.2 Waste: Wastewater

Activity Data:

This inventory used data on population served by the San José-Santa Clara Regional Wastewater Facility from the San José Environment website.[33] Data on Cupertino's 2018 population form the US Census was used.[34] Data on the 5-day biochemical oxygen demand[35] and average total nitrogen per day[36] of the San José-Santa Clara Regional Wastewater Facility from the San José-Santa Clara Regional Wastewater Facility 2018 Annual Self Monitoring Report was used.

Methodology & Emission Factors:

The GPC, the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Community Protocol) and the LGO Protocol methodologies for calculating wastewater treatment emissions are all derived from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, chapter 6: Wastewater Treatment and Discharge.[37] Available data for wastewater treatment plants varies considerably from plant to plant, and as a

33 San Jose Environment, "San José-Santa Clara Regional Wastewater Facility" www.sanjoseca.gov/Index.aspx?NID=1663

34 United States Census QuickFacts, City of Cupertino. www.census.gov/quickfacts/table/PST045216/0617610

35 San José-Santa Clara Regional Wastewater Facility 2018 Annual Self Monitoring Report, "BOD Loadings 2018 (kg/d)" table, page 8 www.sanjoseca.gov/ArchiveCenter/ViewFile/Item/3507

36 San José-Santa Clara Regional Wastewater Facility 2018 Annual Self Monitoring Report, page 19 www.sanjoseca.gov/ArchiveCenter/ViewFile/Item/3507

37 See www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_6_Ch6_Wastewater.pdf

result inventories use the combination of available equations from these three protocols that match the data inputs available for the particular plant that serves their community. Cupertino is served by the San José-Santa Clara Regional Wastewater Facility, which is located in San José. Based on available data, San José's 2014 community inventory used a combination of LGOP Equation 10.2, Community Protocol Equation WW.2 (alt), Community Protocol Equation WW.6 and Community Protocol Equation WW.12 to calculate CH_4 emissions and N_2O emissions associated with the plant.[38] For this reason, and because these methodologies are derived from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and in compliance with the GPC, these same methodologies were used in this inventory. This approach not only ensures consistency with the GPC, but also ensures regional consistency with San José's inventory.

1.5 Municipal Operations Inventory Methodology

The 2018 municipal operations inventory follows LGOP recommended methodologies and uses Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) 100-year without climate-carbon feedbacks global warming potentials (GWPs).[39]

1.1.15 Facilities

1.1.15.1 Facilities: Building Energy

Activity Data:

2018 municipal operations electricity consumption data was obtained through SVCE.[40] 2018 municipal operations natural gas consumption data was obtained through PG&E.[41] Data on fuel consumption by municipal generators was provided by the City. 2018 data on generator fuel consumption was not available, so 2015 data was used as a proxy.

[38] San José's 2014 community inventory, pages A-10 and A-11
www.sanjoseca.gov/DocumentCenter/View/55505

[39] Greenhouse Gas Protocol, "Global Warming Potentials"
www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

[40] Data on municipal electricity consumption by account, including both electricity procured from PG&E and SVCE, was provided by SVCE via email.

[41] Data on municipal natural gas consumption by account was provided by PG&E via email.

Methodology:

Accounts associated with buildings and facilities were pulled from the SVCE and PG&E data and grouped into the building energy subsector. Most accounts matched one-to-one to accounts labeled as buildings and facilities accounts in the 2010 and 2015 inventory.[42] New accounts were identified as belonging to buildings based on account descriptions provided by PG&E.

Emission Factors:

See section 1.1.12.1 for an explanation of the electricity and natural gas emission factors used in this inventory. All municipal facilities use SVCE GreenPrime electricity. Gasoline, diesel and propane emission factors used to calculate generator emissions are from the U.S. Energy Information Administration.[43]

1.1.15.2 Facilities: Building Refrigerants

Activity Data:

Data on stationary refrigeration equipment name, type of equipment, the full charge capacity of the equipment, and the type of refrigerant consumed by the equipment was provided by the City. Table 6.4 from the LGOP was used to look up the operating emission factor of each piece of equipment.

Methodology & Emission Factors:

Emissions were calculated using the above inputs and Equation 6.35 from the LGOP. Global warming potential of various refrigerants are from table E.2 of the LGOP.

1.1.15.3 Facilities: Public Lighting

Activity Data:

2018 municipal operations electricity consumption data was obtained through SVCE.[44]

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42 The 2018 inventory was updated with a minor correction in the natural gas section to include a missing account. The 2010 and 2015 emissions totals and natural gas emissions were updated in this report with the additional usage for this account.

43 U.S. Energy Information Association, "Carbon Dioxide Coefficients" www.eia.gov/environment/emissions/co2_vol_mass.php

44 Data on municipal electricity consumption by account, including both electricity procured from PG&E and SVCE, was provided by SVCE via email.

Methodology:

Accounts associated with public lighting were pulled from the SVCE data and grouped into the public lighting subsector. Most accounts matched one-to-one to accounts labeled as public lighting accounts in the 2010 and 2015 inventories. New accounts were identified as belonging to public lighting based on account descriptions provided by PG&E. The public lighting subsector was further broken down into other outdoor lighting, park lighting, streetlights and traffic signals/controls.

Emission Factors:

See section 1.1.12.1 for an explanation of the electricity emission factor used in this inventory. The PG&E electricity emission factor was applied to accounts that procure PG&E electricity and the SVCE GreenPrime electricity emission factor was applied to accounts that procure SVCE electricity.

1.1.16 Water Services

Activity Data:

2018 municipal operations electricity consumption data was obtained through SVCE.[45]

Methodology:

Accounts associated with water services were pulled from this SVCE data and grouped into the water services subsector. Most accounts matched one-to-one to accounts labeled as water services accounts in the 2010 and 2015 inventories. New accounts were identified as belonging to water services based on account descriptions provided by PG&E.

Emission Factors:

See section 1.1.12.1 for an explanation of the electricity emission factor used in this inventory. All water services accounts use SVCE GreenPrime electricity.

45 Data on municipal electricity consumption by account, including both electricity procured from PG&E and SVCE, was provided by SVCE via email.

1.1.17 Vehicle Fleet

1.1.17.1 Vehicle Fuel

Activity Data:

Total annual gasoline, renewable diesel, and electricity consumption for all vehicles in the City's fleet was provided by the City. Both fuel consumption attributable to individual fleet vehicles and the remaining portion of fuel consumption attributable to other equipment such as lawn mowers was included.

Methodology & Emission Factors:

Gasoline CO_2 emission factors used to calculate fleet fuel emissions are from the U.S. Energy Information Administration.[46] Gasoline CH_4 and N_2O emission factors used to calculate fleet fuel emissions are from the Environmental Protection Agency's 2008 National Emissions Inventory (NEI) Data.[47] Renewable diesel non-biogenic CH_4 and N_2O emission factors are from California's Greenhouse Gas Inventory by Sector & Activity Twelfth Edition: 2000 to 2017.[48] All CO2 emissions resulting from the combustion of renewable diesel are biogenic, meaning they result from the combustion of biomass materials that naturally sequester CO_2. For this reason, in accordance with the LGOP, these biogenic emissions are excluded from this inventory. See section 1.1.12.1 for an explanation of the electricity emission factors used in this inventory. All municipal fleet electric vehicles use SVCE GreenPrime electricity.

1.1.17.2 Vehicle Refrigerants

Activity Data:

Data on vehicle make and model, type of mobile equipment, and the type of refrigerant consumed by the equipment was provided by the City. Table 7.2 from the LGOP was used to look up the full charge capacity and operating emission factor of each piece of equipment.

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46 U.S. Energy Information Association, "Carbon Dioxide Coefficients"
www.eia.gov/environment/emissions/co2_vol_mass.php

47 Environmental Protection Agency's 2008 National Emissions Inventory (NEI) Data
www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-data

48 California's Greenhouse Gas Inventory by Sector & Activity Twelfth Edition: 2000 to 2017 "Economic Sector Categorization" workbook.
ww2.arb.ca.gov/ghg-inventory-data

Methodology & Emission Factors:

Emissions were calculated using the above inputs and Equation 7.13 from the LGOP. Global warming potential of various refrigerants are from table E.2 of the LGOP.

1.1.18 Solid Waste

Activity Data:

Data on waste collection sites, number of dumpsters at each site, volume of dumpsters at each site, and frequency of dumpster pick-ups was provided by the City. As with the 2010 and 2015 inventories, all dumpsters were estimated to be 75% full. In order to convert volume of waste landfilled to weight of waste landfilled, a CalRecycle waste volume to weight conversion factor specific to "government operations" waste was used.[49]

Methodology & Emission Factors:

The methodology for calculating waste emissions matches that used in the community-wide inventory. See section 1.1.14.1 of this document for a full description.

1.6 2018-2050 Community-wide Emissions Forecast Methodology

1.1.19 Business-as-usual Forecast Without State Measures

The first step in the emissions forecasting process is to create a business-as-usual forecast that does not factor in state measures. This scenario assumes that conditions remain the same (vehicle efficiency, efficiency of buildings, etc.) but that Cupertino experiences growth. Business-as-usual emissions growth rates in sector were based off projected growth rates in population, employment or VMT. See Table 36 below:

Table 36: Cupertino business-as-usual forecast emissions growth rate proxies by sector

Sector	Growth Rate Used as Proxy for Business-as-usual Emissions Growth in Sector
Residential	Population
Commercial/Industrial	Employment
Transportation	VMT
Waste & Wastewater	Average of Population & Employment

49 CalRecycle Solid Waste Characterization Home: www2.calrecycle.ca.gov/WasteCharacterization/

Population and job projections for Cupertino for 2020, 2035 and 2050 from the General Plan and CAP were used.[50] VMT projections for Cupertino for 2020, 2030 and 2040 from MTC were used.[51] Since VMT projections for 2035 and 2050 from MTC were not available, it was assumed that the linear growth rate in VMT between 2030 and 2040 would hold constant in order to estimate 2035 and 2050 VMT.

1.1.20 Business-as-usual Forecast With State Measures

The second step in the emissions forecasting process is to adjust the business-as-usual forecast to account for the emissions reduction impact of State measures. Seven key state measures were considered – California's Advanced Clean Cars Program, the Low Carbon Fuel Standard (LCFS), the Renewable Portfolio Standard (RPS), the Zero Net Energy Residential New Construction by 2020 target, the Zero Net Energy Non-residential New Construction by 2030 target, the 50% Zero Net Energy Non-residential Existing Construction by 2030 target, and Mandatory Commercial Organics Recycling Program.

Advanced Clean Cars Program

Emissions avoided from California's Advanced Clean Cars Program were estimated using the projected future fuel efficiencies for years 2020, 2035 and 2050 from ARB's EMFAC Web Database. The percent increase in fuel efficiency from the base year (2018) to the forecast year (e.g. 2035) was calculated in order to estimate emissions avoided from the Clean Car Standards in the forecast year. Emissions reduction associated with Advanced Clean Cars Program were applied to forecasted on-road transportation emissions.

Low Carbon Fuel Standard (LCFS)

Emissions avoided from the LCFS were estimated using ARB's projection of a 20% decline in the carbon intensity of diesel fuels below 2020 levels by 2030.[52] Emissions reductions associated with the LCFS were only applied to forecasted off-road emissions. Emissions reductions were

[50] City of Cupertino Climate Action Plan, Appendix B - GHG Inventory and Reductions Methodology page B-9, Table B-2

[51] MTC Cupertino origin-destination VMT data for calendar years 2010,2020,2030, and 2040 provided by Harold Brazil of MTC (HBrazil@mtc.ca.gov).

[52] California Air Resources Board, Low Carbon Fuel Standard, 2018.
https://ww3.arb.ca.gov/fuels/lcfs/background/basics-notes.pdf

not applied to forecasted on-road transportation emissions to avoided double counting of emissions avoided from the Advanced Clean Cars Program.

Renewable Portfolio Standard (RPS)

Emissions avoided form the RPS were estimated using data from PG&E on the percent of 2017 electricity procured from renewable sources (33%) and the State's RPS targets for 2020 (33%), 2026 (50%), 2030 (60%), and 2045 (100%).[53] Data from PG&E on the percent of 2018 electricity procured from renewable sources was not available, so 2017 data was used as a proxy. The percent increase in renewables between 2018 and each forecast year, as a result of the RPS, was translated to a percent decrease in electricity emissions using an analysis by E3 focused on this topic.[54] Emissions reductions associated with the RPS were applied to all forecasted electricity emissions.

Zero Net Energy Residential Targets

Emissions avoided form the State's targets of achieving all new residential buildings zero net energy by 2020 were estimated using projections on the number of new households in Cupertino from 2010 to 2040 from the General Plan and CAP.[55] This data was used to estimate the number of new residential construction projects that would be impacted between 2020 (when the policy goes into effect) and 2050. It was estimated that 1.13% of the total residential building stock would be new construction annually from 2020-2050 and the new homes built to a zero net energy standard would reduce natural gas consumption 30% and electricity consumption 60% compared to a typical existing home in 2018.[56] Emissions reductions associated with zero net energy residential construction were applied to forecasted residential building emissions.

Zero Net Energy Non-residential Targets

Emissions avoided form the State's target of achieving all new non-residential buildings zero

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53 PG&E's 2017 Power Mix
https://www.pge.com/pge_global/common/pdfs/your-account/your-bill/understand-your-bill/bill-inserts/2018/10-18_PowerContent.pdf

54 E3, "Investigating a Higher Renewables Portfolio Standard in California", 2014
www.ethree.com/wp-content/uploads/2017/01/E3_Final_RPS_Report_2014_01_06_with_appendices.pdf

55 City of Cupertino Climate Action Plan, Appendix B - GHG Inventory and Reductions Methodology page B-9, Table B-2

56 Estimates based on DNV GL expertise.

net energy by 2030 were estimated using projections on the number of jobs in Cupertino in 2020, 2035 and 2050 from the General Plan and CAP.[57] This data was used to estimate the percent increase in additional new non-residential building space between 2030 (when the policy goes into effect) and 2050. It was estimated that 1.54% of the total non-residential building stock would be new construction annually from 2020-2050 and the new non-residential buildings built to a zero net energy standard would reduce natural gas consumption 30% and electricity consumption 60% compared to a typical existing non-residential building in 2018.[58] Emissions avoided form the State's target of achieving 50% of existing non-residential buildings zero net energy by 2030 were also estimated. The analysis assumed that 50% of all existing non-residential buildings would be built to a zero net energy standard by 2030 and would reduce natural gas consumption 30% and electricity consumption 60% compared to a typical existing non-residential building in 2018.[59] Emissions reductions associated with zero net energy non-residential construction were applied to forecasted residential building emissions.

Mandatory Organics Recycling Program

Emissions avoided form the State's ordinance requiring a 50% reduction in organic material sent to landfill below 2015 levels by 2020 and 75% below 2015 levels by 2025[60] were estimated using 2015 GHG inventory data on emissions resulting from organic material sent to landfill. The analysis assumed that waste disposal emissions attributable to Cupertino resulting from sending organics to landfills would decrease 50% below 2015 levels by 2020 and 75% below 2015 levels by 2025. The analysis assumed the reduction would plateau at 75% below 2015 levels from 2025 to 2050 since the State has not yet committed to further reductions beyond 2025. Emissions reductions associated with the State's Organics Recycling Program were applied to forecasted waste emissions.

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57 City of Cupertino Climate Action Plan, Appendix B - GHG Inventory and Reductions Methodology page B-9, Table B-2

58 Estimates based on DNV GL expertise.

59 Estimates based on DNV GL expertise.

60 Cal Recycle, "Short-Lived Climate Pollutants (SLCP): Organic Waste Methane Emissions Reductions" www.calrecycle.ca.gov/climate/slcp