City of Cupertino 2015 Community-wide and Municipal Operations Greenhouse Gas Emissions Inventory Report

DNV·GL

January 2018

Acknowledgements

This 2015 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 2015 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. This 2015 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 2015 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 2015 was chosen as the year for this inventory because it was the most recent calendar year with complete data available.

1.1 2015 Community-wide Emissions Inventory

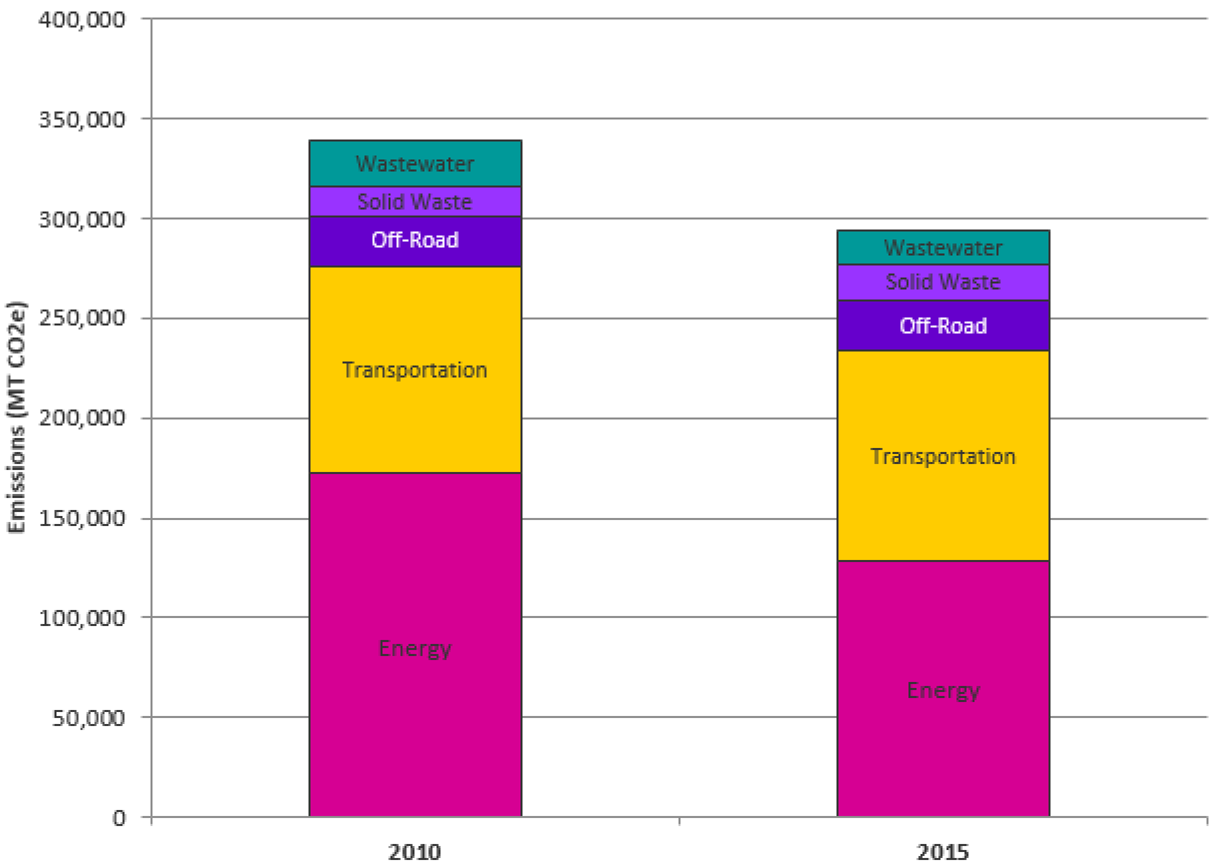
1.1.1 Summary of Community-wide Emissions Inventory Results

Our findings indicate that Cupertino emitted community-wide emissions of 294,281 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2015 from the energy, transportation, off-road sources,

[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.

solid waste and wastewater sectors.[2] This represents a 13.1% decrease from 2010 community-wide emissions of 338,673 $MTCO_2e$. Figure 1 and Table 1 provide a comparison of 2010 and 2015 community-wide emissions and trends by sector and subsector.

Figure 1: Cupertino community-wide emissions by sector – 2010 vs. 2015



[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 vs. 2015

Sector/Subsector	2010 Emissions (MT CO2e/yr)	2015 Emissions (MT CO2e/yr)	Percent Change
Energy	172,289	128,266	-26%
Electricity Subtotal	85,451	54,318	-36%
Residential	25,427	22,396	-12%
Non-residential[3]	60,025	31,922	-47%
Natural Gas Subtotal	86,837	73,948	-15%
Residential	49,986	40,594	-19%
Non-residential[3]	34,109	31,012	-9%
Fugitive Nat. Gas	2,742	2,342	-15%
Transportation	104,112	105,225	+1%
Off-Road Sources	24,496	25,165	+3%
Solid Waste	15,185	18,219	+20%
Wastewater	22,591	17,405	-23%
Total	**338,673**	**294,281**	**-13.1%**

Table 2 provides a sector-by-sector analysis of key factors driving trends in community-wide emissions from 2010-2015.

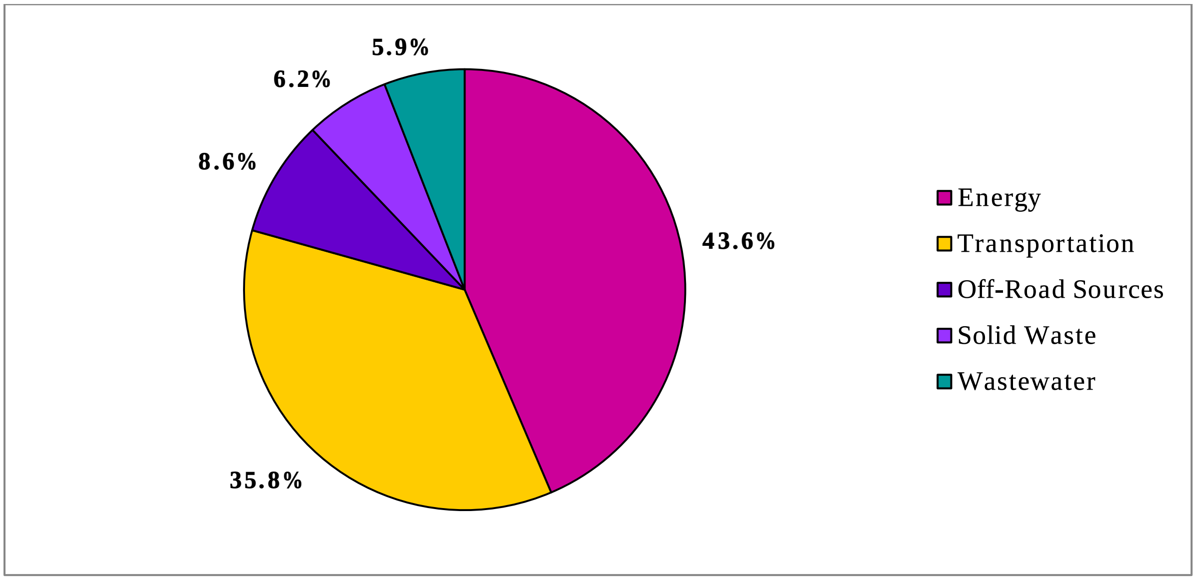
Table 2: Summary of key 2010-2015 community-wide emissions trends

Emissions Sector	Summary of 2010-2015 Trends
Energy	Energy emissions decreased 26% from 2010 to 2015. This trend in the energy sector is largely driven by a 47% decrease in commercial electricity emissions. Apple's campus, which consumes a large portion of total commercial grid electricity in Cupertino and sources 100% of their electricity from renewable sources, is a major contributing factor to this decrease in emissions.
Transportation	Transportation emissions increased 1% from 2010 to 2015. Improvements in on-road vehicle fuel efficiency were offset by a 6% increase the total vehicle miles travelled (VMT).
Off-Road Sources	Off-road emissions increased 3% from 2010 to 2015. 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 20% from 2010 to 2015. A 20% increase in the amount of waste sent to landfills drove the increase in emissions.
Wastewater	Wastewater emissions decreased 23% from 2010 to 2015. This decrease is driven by a 26% decrease in the biochemical oxygen demand (BOD) treated per day at the San José-Santa Clara Regional Wastewater Facility. 4.3% 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.

Figure 2 displays the relative contribution of each sector to overall 2015 community-wide emissions.

Figure 2: Cupertino 2015 community-wide emissions by sector



Energy (43.6%) and transportation (35.8%) continue to make up the vast majority of community-wide emissions in Cupertino. Off-road sources (8.6%), solid waste (6.2%) and wastewater (5.9%) make up the remaining community-wide emissions.

1.1.2 Energy Sector

As summarized in Table 3 below, community-wide emissions in the energy sector decreased 26% from 2010 to 2015. The energy sector made up 43.6% of Cupertino's total community-wide emissions in 2015.

Table 3: Cupertino community-wide energy sector consumption and emissions by fuel type – 2010 vs. 2015

Category	2010 Consumption (kWh or therms)	2015 Consumption (kWh or therms)	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Consump.	% Change Emissions
Electricity	409,319,124	404,190,175	85,451	54,318	-1%	-36%
Natural Gas	15,805,499	13,498,530	84,095	71,606	-15%	-15%
Nat. Gas Fugitive			2,742	2,342		-15%
Total			**172,289**	**128,266**		**-26%**

The overall decrease in energy sector emissions was driven by a 36% decrease in total electricity emissions and a 15% decrease in natural gas emissions.

As summarized in Table 4 below, community-wide electricity emissions decreased 36% from 2010 to 2015. Electricity emissions made up 19% of Cupertino's total community-wide emissions in 2015.

Table 4: Cupertino community-wide electricity consumption and emissions by subsector – 2010 vs. 2015

Category	2010 Electricity Consumption (kWh)	2015 Electricity Consumption (kWh)	2010 Electricity Emissions (MT CO_2e)	2015 Electricity Emissions (MT CO_2e)	% Change Consump.	% Change Emissions
Residential	124,926,651	112,974,425	25,427	23,396	-10%	-12%
Non-Residential	284,392,473	291,215,750	60,025	31,935	+2%	-47%
PG&E Non-Residential	274,446,308	123,878,787	55,859	24,557	-55%	-56%
Direct Access Non-Residential	9,946,165	167,336,963	4,166	7,377	+1,582%	+77%
Total	**409,319,124**	**404,190,175**	**85,451**	**54,318**	**-1%**	**-36%**

Total residential electricity consumption decreased 10% and total residential electricity emissions decreased 12%. Residential electricity emissions decreased at a greater rate than residential electricity consumption due to a lower emission factor associated with PG&E grid electricity. Total non-residential electricity consumption increased 2%, but total non-residential electricity emissions decreased 47%. Non-residential electricity emissions decreased substantially despite an increase in non-residential electricity consumption due to a lower emission factor associated with PG&E grid electricity and large, non-residential electricity consumers switching to low emissions direct access electricity.

As summarized in Table 5 below, community-wide natural gas emissions decreased 15% from 2010 to 2015. Natural gas emissions made up 25% of Cupertino's total community-wide emissions in 2015.

Table 5: Cupertino community-wide natural gas consumption and emissions by subsector – 2010 vs. 2015

Category	2010 Natural Gas Consumption (Therms)	2015 Natural Gas Consumption (Therms)	2010 Natural Gas Emissions (MT CO_2e)	2015 Natural Gas Emissions (MT CO_2e)	% Change Consump.	% Change Emissions
Residential	9,394,725	7,652,362	49,986	40,594	-19%	-19%
Non-Residential	6,410,774	5,846,168	34,109	31,012	-9%	-9%
Nat. Gas Fugitive			2,742	2,342		-15%
Total	**15,805,499**	**13,498,530**	**86,837**	**73,948**	**-15%**	**-15%**

Total residential natural gas consumption decreased 19% and total residential natural gas emissions decreased 19%. Total non-residential natural gas consumption decreased 9% and total non-residential natural gas emissions decreased 9%.

1.1.3 Transportation Sector

As summarized in Table 6 below, community-wide emissions in the transportation sector increased 1% from 2010 to 2015. The transportation sector made up 36% of Cupertino's total community-wide emissions in 2015.

Table 6: Cupertino community-wide transportation sector vehicle miles travelled and emissions – 2010 vs. 2015

Sector	2010 Vehicle Miles Travelled	2015 Vehicle Miles Travelled	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change VMT	% Change Emissions
Transportation	282,971,589	301,079,036	104,112	105,225	+6%	+1%

Despite vehicle-miles-travelled (VMT) by on-road vehicles increasing 6% from 2010 to 2015, emissions associated with VMT only increased 1%. This is a result of efficiency improvements to on-road vehicles between 2010 and 2015, reducing the emissions associated with each mile of travel.

As summarized in Table 7 below, the vast majority of VMT (98.4%) and transportation emissions (97.0%) came from gasoline vehicles. Transportation emissions made up 36% of Cupertino's total community-wide emissions in 2015.

Table 7: 2015 Cupertino community-wide transportation miles travelled and emissions by fuel type

Vehicle Fuel Type	2015 Vehicle Miles Travelled	2015 Percent of Total Vehicle Miles Travelled	2015 Emissions (MT CO_2e)	2015 Percent of Total Transportation Emissions
Gasoline	296,334,462	98.4%	102,023	97.0%
Diesel	3,754,430	1.2%	3,137	3.0%
Electric	990,145	0.3%	65	0.1%
Total	**301,079,036**	**100%**	**105,225**	**100%**

1.1.4 Off-road Sector

As summarized in Table 8 below, community-wide emissions in the off-road sector increased 3% from 2010 to 2015. The off-road sector made up 8.6% of Cupertino's total community-wide emissions in 2015.

Table 8: Cupertino community-wide off-road emissions – 2010 vs. 2015

Sector	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Emissions
Off-road	24,496	25,165	+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 9 below, community-wide emissions in the solid waste sector increased 20% from 2010 to 2015. The solid waste sector made up 6.2% of Cupertino's total community-wide emissions in 2015.

Table 9: Cupertino community-wide solid waste landfilled and emissions – 2010 vs. 2015

Sector	2010 Waste Landfilled (Tons)	2015 Waste Landfilled (Tons)	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Waste Landfilled	% Change Emissions
Solid Waste	30,685	36,817	15,185	18,219	+20%	+20%

Both the amount of solid waste sent to landfills and the emissions associated with landfilled waste increased 20% from 2010 to 2015.

1.1.6 Wastewater Sector

As summarized in Table 10 below, community-wide emissions in the wastewater sector decreased 23% from 2010 to 2015. The wastewater sector made up 5.9% of Cupertino's total community-wide emissions in 2015.

Table 10: Cupertino community-wide wastewater emissions – 2010 vs. 2015

Sector	2010 5-day Biochemical Oxygen Demand (kgBOD5/day)	2015 5-day Biochemical Oxygen Demand (kgBOD5/day)	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Biochemical Oxygen Demand	% Change Emissions
Wastewater	161,756	119,418	22,591	17,405	-26%	-23%

A 26% 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 2015 was the main driver behind the decrease in wastewater emissions.

1.2 2015 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 1,440 $MTCO_2e$ in 2015 from the facilities, vehicle fleet, solid waste and water services sectors. This represents a 22.8% decrease from 2010 municipal operations emissions of 1,865 $MTCO_2e$.

Figure 3 and Table 11 provide a comparison of 2010 and 2015 municipal operations emissions and trends by sector and subsector.

Figure 3: Cupertino municipal operations emissions by sector – 2010 vs. 2015

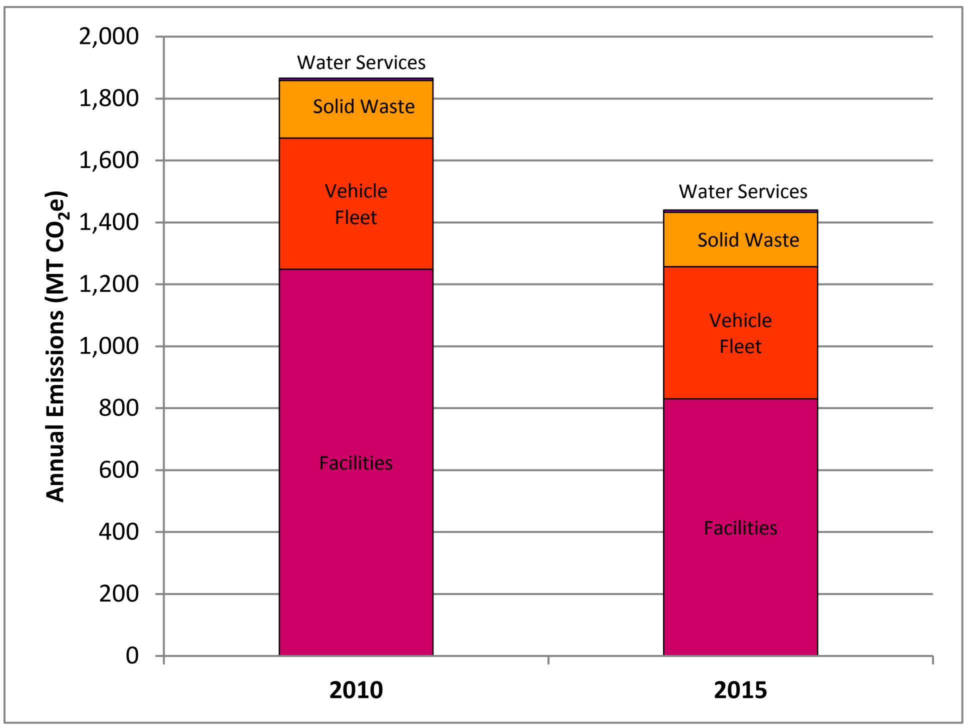


Table 11: Cupertino municipal operations emissions by sector & subsector – 2010 vs. 2015

Sector/Subsector	2010 Emissions (MT CO_2e/yr)	2015 Emissions (MT CO_2e/yr)	Percent Change
Facilities	1,249	830	-34%
Building Energy and Refrigerants	837	599	-28%
Public Lighting	412	231	-44%
Vehicle Fleet	424	427	+1%
Solid Waste	186	175	-6%
Water Services	6.6	6.9	+5%
Total	**1,865**	**1,440**	**-22.8%**

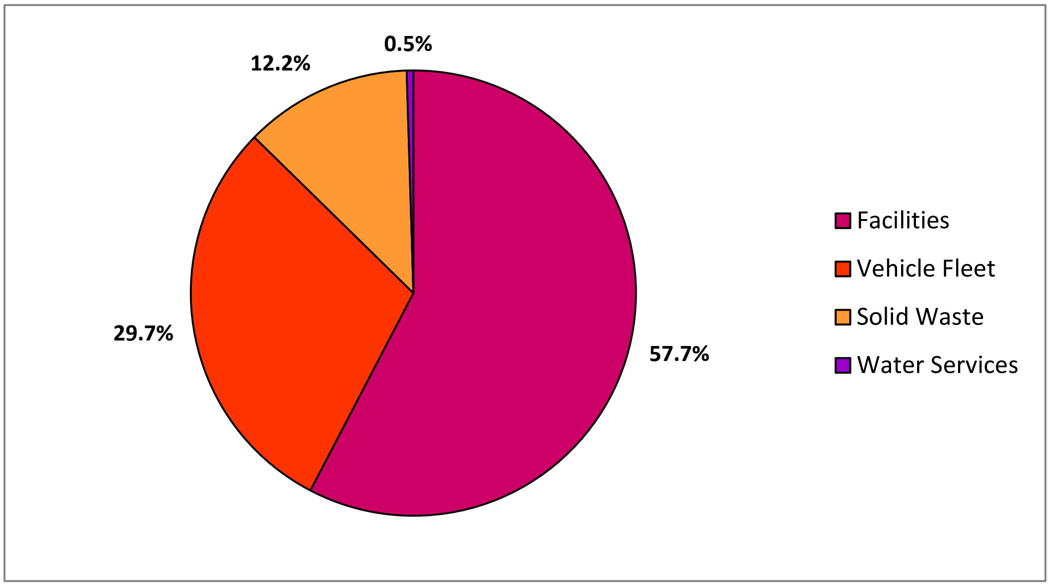
Table 12 provides a sector-by-sector analysis of key factors driving trends in municipal operations emissions from 2010-2015.

Table 12: Summary of key 2010-2015 municipal operations emissions trends

Emissions Sector	Summary of 2010-2015 Trends
Facilities Sector	Facilities emissions decreased 34% from 2010 to 2015. This trend in the facilities sector is driven by a 30% decrease in natural gas consumption and a 24% decrease in electricity consumption, combined with a lower emissions factor for grid electricity.
Vehicle Fleet	Vehicle fleet emissions increased 1% from 2010 to 2015. An 11% decrease in gasoline consumption was offset by a 45% increase in diesel consumption.
Solid Waste	Solid waste emissions decreased 6% from 2010 to 2015. This decrease is driven by a 6% decrease in the amount of waste sent to landfills.
Water Services	Water services emissions increased 5% from 2010 to 2015. This increase is driven by a 10.2% increase in electricity consumption associated with water services including irrigation controls, sprinkler controls and water pumps.

Figure 4 displays the relative contribution of each sector to overall 2015 municipal operations emissions.

Figure 4: 2015 municipal operations emissions by sector



Facilities (57.7%) and vehicle fleet (29.7%) continue to make up the vast majority of municipal operations emissions in Cupertino. Solid waste (12.2%), and water services (0.5%) 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 or 2015 municipal operations inventories. However, employee commute surveys were conducted for both 2010 and 2015. The results are presented below in Table 13.

Table 13: Cupertino municipal employee commute trends - 2010 vs. 2015

Description	2010	2015	Percent Change
All employees total driving commute emissions (MT CO_2e)	463	443	-4.4%
All employees total driving commute distance (miles/year)	1,244,509	1,272,985	+2.3%

Despite the total distance employees drove to work increasing 2.3% from 2010 to 2015, emissions associated with employees driving to work decreased 4.4%. This is a result of employees driving more fuel efficient vehicles to work in 2015.

1.1.8 Facilities Sector

As summarized in Table 14 below, municipal operations emissions in the facilities sector decreased 34% from 2010 to 2015. The facilities sector made up 58% of Cupertino's total municipal operations emissions in 2015.

Table 14: Cupertino municipal operations facilities sector consumption and emissions by subsector – 2010 vs. 2015

Category	Consump. Units	2010 Consump.	2015 Consump.	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Consump.	% Change Emissions
Facilities Electricity	kWh	2,833,091	2,143,386	256	178	-24%	-28%
Facilities Natural Gas	Therms	48,232	33,580	577	417	-30%	-30%
Facilities Generators	Gallons	52	116	0.5	1.4	+123%	+197%
Facilities Refrigerants				3.6	2.8		-22%
Public Lighting Electricity	kWh	2,022,966	1,185,901	412	231	-41%	-44%
Total				**1,249**	**830**		**-34%**

The overall decrease in facilities sector emissions was driven by a 44% decrease in total public lighting emissions, a 30% decrease in facilities natural gas emissions and 28% decrease in facilities electricity emissions. Emissions associated with electricity consumption declined at a greater rate than electricity consumption itself due to a lower emissions factor for grid electricity.

1.1.9 Vehicle Fleet Sector

As summarized in Table 15 below, municipal operations emissions in the vehicle fleet sector increased 1% from 2010 to 2015. The vehicle fleet sector made up 30% of Cupertino's total municipal operations emissions in 2015.

Table 15: Cupertino municipal operations vehicle fleet sector consumption and emissions by subsector – 2010 vs. 2015

Category	Consump. Units	2010 Consump.	2015 Consump.	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Consump.	% Change Emissions
Vehicle Fleet Fuel	Gallons	41,025	41,721	379	393	+2%	+4%
Vehicle Fleet Refrigerants				45	34		-23%
Total				**424**	**427**		**+1%**

The overall increase in facilities sector emissions was driven by a 4% increase in vehicle fleet fuel emissions. An 11% decrease in vehicle fleet gasoline consumption was offset by a 45% increase in diesel consumption.

1.1.10 Solid Waste Sector

As summarized in Table 16 below, municipal operations emissions in the solid waste sector decreased 6% from 2010 to 2015. The solid waste sector made up 12% of Cupertino's total municipal operations emissions in 2015.

Table 16: Cupertino municipal operations solid waste sector consumption and emissions – 2010 vs. 2015

Sector	2010 Waste Landfilled (Tons)	2015 Waste Landfilled (Tons)	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Waste Landfilled	% Change Emissions
Solid Waste	376	355	186	175	-6%	-6%

The 6% decrease in solid waste sector emissions is directly correlated with a 6% decrease in solid waste landfilled.

1.1.11 Water Services Sector

As summarized in Table 17 below, municipal operations emissions in the water services sector increased 5% from 2010 to 2015. The water services sector made up 0.5% of Cupertino's total municipal operations emissions in 2015.

Table 17: Cupertino municipal operations water services sector consumption and emissions – 2010 vs. 2015

Sector	2010 Electricity Consump. (kWh)	2015 Electricity Consump. (kWh)	2010 Emissions (MT CO_2e)	2015 Emissions (MT CO_2e)	% Change Electricity Consump.	% Change Emissions
Water Services	32,278	35,675	6.6	6.9	+10%	+5%

The 5% increase in water services sector emissions was driven by a 10% increase in water services electricity consumption. Emissions associated with electricity consumption rose at a lesser rate than electricity consumption itself due to a lower emissions factor for grid electricity.

1.3 2015 – 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 (2015) 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 18 through Table 21Table 19 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 13.1% between 2010 and 2015 and, with implementation of measures identified in the CAP, is on pace to meet the City's emissions reduction target of 15% below 2010 emissions by 2020.

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

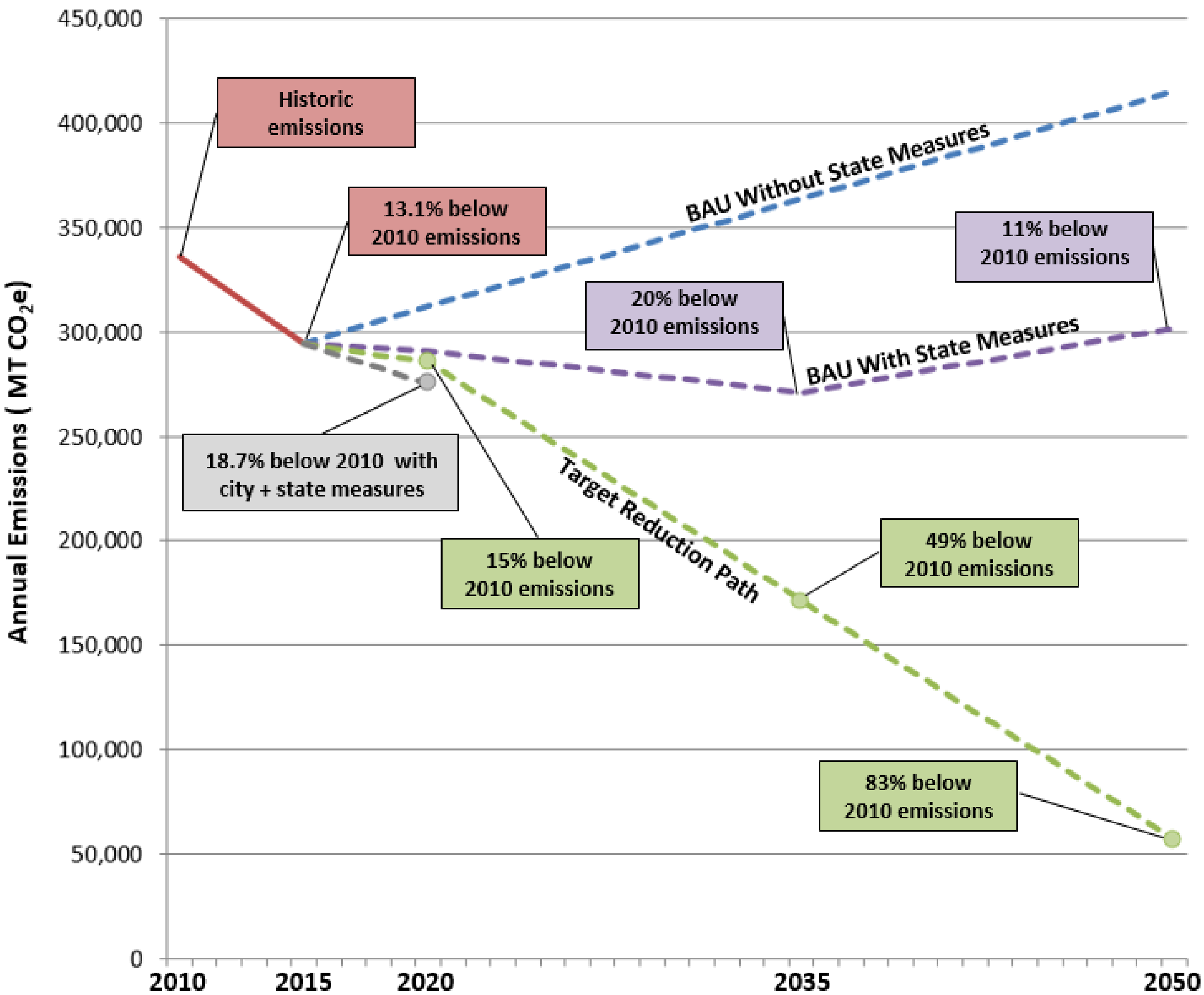


Table 18: Description of different emissions forecasts trend lines

Historic Emissions	Based on Cupertino's 2010 and 2015 community-wide inventories. Linear decrease between 2010 and 2015 assumed.
Business-as-usual Without State Measures	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 (Clean Car Standards, Low Carbon Fuel Standard, Renewable Portfolio Standard and New Residential Zero Net Energy Action Plan).
Target Reduction Path	The minimum linear emissions reduction trajectory Cupertino would need to take to meet the City's emissions reduction targets of 15% below 2010 by 2020, 49% below 2010 by 2035 and 83% below 2010 by 2050.
Projected Emissions	Cupertino's projected emissions taking into consideration all variables: business-as-usual forecast, emissions avoided impact of state measures and emissions avoided impact of city measures identified in Climate Action Plan.

Table 19: 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
	Percent Reduction Below 2010 by 2015:	**13.1%**	Percent
2020 Emissions Reduction Target	**Percent Reduction Below 2010 Target 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:	312,152	MT CO_2e
	2020 Emissions Reduction from State Measures:	-21,565	MT CO_2e
	2020 Emissions Reduction from City Measures:	-15,400	MT CO_2e
2020 Projected Emissions	2020 Projected Emissions with State + City Measures:	275,187	MT CO_2e
	Projected Percent Reduction Below 2010 by 2020:	**18.7%**	Percent

Table 20: Cupertino community-wide emissions reduction target and emissions forecast – 2015-2035

Category	Description	Data	Units
2035 Emissions Reduction Target	**Percent Reduction Below 2010 Target 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:	363,744	MT CO_2e
	2035 Emissions Reduction from State Measures:	-92,605	MT CO_2e
	2035 Emissions Reduction from City Measures:		MT CO_2e
2035 Projected Emissions	2035 Projected Emissions with State + City Measures:	271,139	MT CO_2e
	Projected Percent Reduction Below 2010 by 2035:	**19.9%**	Percent

Table 21: Cupertino community-wide emissions reduction target and emissions forecast – 2015-2050

Category	Description	Data	Units
2050 Emissions Reduction Target	**Percent Reduction Below 2010 Target by 2035:**	**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:	415,145	MT CO_2e
	2050 Emissions Reduction from State Measures:	-113,408	MT CO_2e
	2050 Emissions Reduction from City Measures:		MT CO_2e
2050 Projected Emissions	2050 Projected Emissions with State + City Measures:	301,736	MT CO_2e
	Projected Percent Reduction Below 2010 by 2050:	**10.9%**	Percent

Table 22 summarizes the estimated emissions avoided from State measures in 2020, 2035 and 2050.

Table 22 : 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)
Clean Car Standards	On-road transportation	-15,150	-52,229	-60,900
Low Carbon Fuel Standard	Off-road	-667	-848	-1,028
Renewable Portfolio Standard	All electricity	-5,748	-33,888	-39,359
Zero Net Energy Action Plan	Residential buildings	0	-5,640	-12,121
Total		**-21,565**	**-92,605**	**-113,408**

1.4 Community-wide Inventory Methodology

The 2015 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).[4]

1.1.12 Stationary Energy

1.1.12.1 Stationary Energy: Buildings

Activity Data

2015 community-wide natural gas and electricity consumption data was obtained through PG&E's Green Community website.[5] PG&E electricity and natural gas consumption was broken out by the residential, commercial and industrial sectors. However, with the exception of a few "district" accounts, commercial and industrial energy consumption was combined into the commercial sector. This is a result of CPUC energy data privacy rules that require PG&E to aggregate data when customer privacy is at risk. The PG&E data also broke out total direct access electricity consumption. Apple provided data on total direct access electricity consumption associated with their Cupertino campus.[6]

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 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

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

[5] File downloaded from PG&E Green Community website titled "Cupertino_EXTNoNDA_PGE_CommunityGHG_2015".

[6] 2015 Apple Cupertino direct access electricity consumption provided by Rick Freeman of Apple's Global Energy Team via email on 5/30/17.

occurs at home[7], 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.

Emission Factors

This inventory uses The Climate Registry (TCR) natural gas emission factor of 0.00530 MT CO_2/therm[8] and a PG&E-specific electricity CO_2 emission factor of 0.000197 MT CO_2/kWh.[9] 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 2014 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.[10] 2015 emission factors were not available through eGRID, so 2014 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 2014[11] by the total California electricity-related GHG emissions in 2014.[12] The resulting direct access emission factors were 0.0002970315 MT CO_2/kWh, 0.000000033 MT CH_4/kWh and 0.0000000028 MT N_2O/kWh. These direct access emission

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7 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/

8 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

9 2015 PG&E The Climate Registry Electric Power Sector Report 1.2
www.theclimateregistry.org/tools-resources/reporting-protocols/general-reporting-protocol/

10 Emissions & Generation Resource Integrated Database (eGRID), 2014
www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

11 California Energy Commission Total System Electric Generation, “2014 Total System Electric Generation in Gigawatt Hours”
www.energy.ca.gov/almanac/electricity_data/system_power/2014_total_system_power.html

12 California Air Resources Board, “Greenhouse Gas Emission Inventory - Query Tool for years 2000 to 2014 (9th Edition)”
www.arb.ca.gov/app/ghg/2000_2014/ghg_sector.php

factors were applied to all direct access electricity consumption in Cupertino, with the exception of direct access electricity purchase by Apple which is known to be 100% renewable.[13]

1.1.12.2 Stationary Energy: Off-Road

Activity Data

All off-road emissions were calculated using the ARB's OFFROAD2007 Model.[14]

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).

[13] Apple Environmental Responsibility Report, "Scopes 1 & 2 Building Carbon Emissions (metric tons CO2e)" table, pages 30-31 https://images.apple.com/environment/pdf/Apple_Environmental_Responsibility_Report_2016.pdf

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

Table 23 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.

Table 23: 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 2015 population[15] and Santa Clara County's 2015 population[16] are from the US Census. 2015 employment data for Santa Clara County and Cupertino was not available at the time this inventory was published. As a result, Cupertino's 2011 employment[17] and Santa Clara County's 2010 employment[18] were used as a proxy to estimate the percent of total employment in Santa Clara County occurring in Cupertino.

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

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

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

17 California, State of, 2011. Employment Development Department. Monthly Labor Force Data for Cities and Census Designated Places, September 2011-Preliminary. https://s3.amazonaws.com/Apple-Campus2-DEIR/Apple_Campus_2_Project_EIR_Public_Review_5c-PopHousing.pdf

18 Bay Area Census, County of Santa Clara. www.bayareacensus.ca.gov/counties/SantaClaraCounty.htm

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 publically available Cupertino-specific origin-destination VMT data available through the Metropolitan Transportation Commission (MTC) to estimate a 2010-2015 VMT annual growth rate in Cupertino.[19] This annual growth rate was applied to the Hexagon 2013 VMT to estimate the 2015 VMT.

Methodology

Similar to the 2010 inventory, 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 2015 Santa Clara County VMT travelled by fuel type from the ARB's EMFAC Web Database was used.[20] This process assumes that the percent of total VMT attributable to electric vehicles in Santa Clara County is equal to the percent of total Cupertino VMT attributable to electric vehicles.

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 three best-selling electric vehicles in 2015 was used.[21] See section 1.1.12.1 for an explanation of the electricity emission factor used in this inventory.

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.[22] EMFAC groups fuel efficiencies by vehicle type.[23] Consistent with the 2010 inventory, 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.

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[19] MTC Cupertino origin-destination VMT data for calendar years 2010 and 2015 provided by Harold Brazil of MTC (HBrazil@mtc.ca.gov).

[20] EMFAC Web Database EMFAC2014 (v1.0.7). For the model run the calendar year selected was "2015", the season selected was "annual" and the vehicle classification selected was "EMFAC2011 Categories".

[21] Average efficiency of 2015 Nissan Leaf, 2015 Chevrolet Volt and 2015 Toyota Prius plug-in from Department of Energy's www.fueleconomy.gov www.fueleconomy.gov/feg/findacar.shtml

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

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

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 2015 from CalRecycle's Disposal Reporting System (DRS): Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility web portal.[24] Data on waste composition is from CalRecycle's *2014 Disposal-Facility-Based Characterization of Solid Waste in California.*[25]

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.

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

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

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.[26] Data on Cupertino's 2015 population form the US Census was used.[27] Data on the 5-day biochemical oxygen demand[28] and average total nitrogen per day[29] of the San José-Santa Clara Regional Wastewater Facility from the San José-Santa Clara Regional Wastewater Facility 2015 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.[30] Available data for wastewater treatment plants varies considerably from plant to plant, and as a 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.[31] 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.

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

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

[28] San José-Santa Clara Regional Wastewater Facility 2015 Annual Self Monitoring Report, "BOD Loadings 2015 (kg/d)" table, page 8 www.sanjoseca.gov/ArchiveCenter/ViewFile/Item/2797

[29] San José-Santa Clara Regional Wastewater Facility 2015 Annual Self Monitoring Report, page 19 www.sanjoseca.gov/ArchiveCenter/ViewFile/Item/2797

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

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

1.5 Municipal Operations Inventory Methodology

The 2015 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).[32]

1.1.15 Facilities

1.1.15.1 Facilities: Building Energy

Activity Data:

2015 municipal operations natural gas and electricity consumption data was obtained through PG&E's Green Community website.[33] Data on fuel consumption by municipal generators was provided by the City.

Methodology:

Accounts associated with buildings and facilities were pulled from this 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 inventory. 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. Gasoline, diesel and propane emission factors used to calculate generator emissions are from the U.S. Energy Information Administration.[34]

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.

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

[33] See www.pge.com/en_US/business/save-energy-money/contractors-and-programs/community-partnerships/community-partners.page

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

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:

2015 municipal operations electricity consumption data was obtained through PG&E's Green Community website.[35]

Methodology:

Accounts associated with public lighting were pulled from this data and grouped into the public lighting subsector. Most accounts matched one-to-one to accounts labeled as public lighting accounts in the 2010 inventory. 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.

1.1.16 Water Services

Activity Data:

2015 municipal operations electricity consumption data was obtained through PG&E's Green Community website.[36]

Methodology:

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

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[35] See www.pge.com/en_US/business/save-energy-money/contractors-and-programs/community-partnerships/community-partners.page

[36] See www.pge.com/en_US/business/save-energy-money/contractors-and-programs/community-partnerships/community-partners.page

Emission Factors:

See section 1.1.12.1 for an explanation of the electricity emission factor used in this inventory.

1.1.17 Vehicle Fleet

1.1.17.1 Vehicle Fuel

Activity Data:

Monthly gasoline and diesel consumption for all vehicles in the City's fleet was provided by the City.

Methodology & Emission Factors:

Gasoline and diesel CO_2 emission factors used to calculate fleet fuel emissions are from the U.S. Energy Information Administration.[37] Gasoline and diesel 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.[38]

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.

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:

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

[38] Environmental Protection Agency's 2008 National Emissions Inventory (NEI) Data www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-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 inventory, 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.[39]

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.

[39] CalRecycle Solid Waste Characterization Home www2.calrecycle.ca.gov/WasteCharacterization/

1.6 2015-2050 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 24 below

Table 24: 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

Population and job projections for Cupertino for 2015, 2020, 2035 and 2050 from the CAP were used.[40] VMT projections for Cupertino for 2015 and 2035 from MTC were used.[41] Since VMT projections for 2020 and 2050 from MTC were not available, it was assumed that the linear growth rate in VMT between 2015 and 2035 would hold constant in order to estimate 2020 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. Four key state measures were considered – California's Clean Car Standards, the Low Carbon Fuel Standard (LCFS), the Renewable Portfolio Standard (RPS), and the New Residential Zero Net Energy Action Plan.

Clean Car Standards

Emissions avoided from California's Clean Car Standards 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 (2015) to the forecast year (e.g. 2020) was calculated in order to estimate emissions avoided from the Clean Car Standards in the forecast

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

[41] MTC Cupertino origin-destination VMT data for calendar years 2015 and 2035 provided by Harold Brazil of MTC (HBrazil@mtc.ca.gov).

year. Emissions reduction associated with Clean Car Standards 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 7.2% reduction in transportation emissions below 2005 levels by 2020 resulting from the policy.[42] This translates to a 2.4% reduction in transportation emissions below 2015 levels by 2020. Emissions reductions associated with the LCFS were only applied to forecasted off-road emissions. Emissions reductions were not applied to forecasted on-road transportation emissions to avoided double counting of emissions avoided from the Clean Car Standards.

Renewable Portfolio Standard (RPS)

Emissions avoided form the RPS were estimated using data from PG&E on the percent of 2015 electricity procured from renewable sources (30%) and the State's RPS targets for 2020 (33%) and 2030 (50%).[43] The percent increase in renewables between 2015 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.[44] The RPS was assumed to plateau at 50% renewables in 2030 since there is currently no RPS target in place beyond 2030. Emissions reductions associated with the RPS were applied to all forecasted electricity emissions.

New Residential Zero Net Energy Action Plan

Emissions avoided form the New Residential Zero Net Energy Action Plan were estimated using projections on the number of new households in Cupertino from 2010 to 2040 from the CAP.[45] 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 1.12% of the residential building stock would be replaced per year from 2020-2050 and the new homes built to a zero net energy standard would reduce energy consumption 55% compared to a

[42] California Air Resources Board, Proposed Regulation to Implement the Low Carbon Fuel Standard, 2009 www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf

[43] PG&E's 2015 Power Mix www.pge.com/pge_global/common/pdfs/your-account/your-bill/understand-your-bill/bill-inserts/2016/11.16_PowerContent.pdf

[44] 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

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

typical existing home in 2015.[46] Emissions reductions associated with zero net energy residential construction were applied to forecasted residential building emissions.

[46] Zero net energy residential building codes only apply to “regulated loads”, which make up approximately 55% of total residential energy use.

1.7 Adjustments to 2010 Baseline Inventories

One of the inherent challenges with GHG inventories is that inventory protocols and methodologies are constantly evolving. Additionally, GWPs of CH_4 and N_2O are also changing with each new Assessment Report released by the IPCC. These two variables can make comparisons between past and current inventories challenging.

1.1.21 Adjustments to the 2010 Community-wide Inventory

Cupertino's original 2010 community-wide inventory was completed following the Community Protocol, while this 2015 community-wide inventory was completed following the GPC. At the time the 2010 community-wide inventory was completed, the Community Protocol was the most commonly used protocol for cities completing GHG inventories. However, in recent years, the GPC has become the standard protocol, in part because it is required for those cities who have committed to the Global Covenant.

GWP is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of CO_2. At the time the 2010 community-wide inventory was completed, GWP values from the IPCC Fourth Assessment Report (AR4) were the current accepted standard. However, in 2014, AR5 was released. Between AR4 and AR5 the GWP of CH_4 increased from 25 to 28 and the GWP of N_2O decreased from 298 to 265. In order to make "apples-to-apples" comparisons between the 2010 and 2015 community-wide inventories and accurately track Cupertino's emissions reduction progress, it was necessary to revise the 2010 emissions to match the methodology and GWPs used in the 2015 inventory. Table 25 below compares the original 2010 and revised 2010 community-wide inventories. Rows highlighted in red indicate an adjustment to the original 2010 community-wide inventory.

Table 25: Cupertino community-wide emissions – 2010 original vs. 2010 revised

Sector/Subsector	2010 Original Emissions (MT CO_2e/yr)	2010 Revised Emissions (MT CO_2e/yr)	Percent Change
Energy	169,547	172,289	+2%
Electricity Subtotal	85,451	85,451	0%
Residential	25,427	25,427	0%
Commercial	60,025	60,025	0%
Natural Gas Subtotal	84,095	86,837	+3%
Residential	49,986	49,986	0%
Commercial	34,109	34,109	0%
Fugitive Nat. Gas	0	2,742	N/A
Transportation	104,112	104,112	0%
Off-Road Sources	22,390	24,496	+9%
Solid Waste	5,403	15,185	+181%
Wastewater	4,640	22,591	+387%
Potable Water	1,197		
Total	**307,288**	**338.673**	**10.2%**

Sector-by-sector adjustments to 2010 community-wide inventory

The energy, off-road sources, solid waste, wastewater and potable water sectors were adjusted in the revised 2010 community-wide inventory.

- **Energy:** The original 2010 inventory was based on the Community Protocol which does not require the inclusion of fugitive natural gas emissions. Since the GPC calls for the inclusion of fugitive natural gas emissions, the 2010 community-wide inventory was revised to include these emissions.
- **Off-road Sources:** Both inventories used ARB's OFFROAD2007 model to estimate emission from off-road sources. However, the original inventory excluded off-road emissions from transport refrigeration units, entertainment equipment, recreational equipment and railyard operations. The GPC calls for these emissions to be included, and, as a result, the 2010 community-wide inventory was revised to include these emissions.
- **Solid Waste:** There are two generally acceptable methods for estimating waste emissions - the methane commitment method and the first order of decay (FOD) method. The methane commitment method allocates emissions based on the quantity of waste disposed during the inventory year, while the FOD method allocates emissions based on the quantity of waste disposed during the inventory year as well as existing waste in landfills.

The original 2010 inventory used the FOD method to estimate waste emissions. However, after discussion with City staff, it was decided that the 2015 inventory should use the methane commitment method because emissions associated with the methane commitment method are more closely linked to current waste practices, rather than waste historically sent to landfills. As a result, the 2010 community-wide inventory was revised to estimate waste emissions using the methane commitment method. Additionally, 2010 waste emissions were adjusted to account for the AR5 GWP of CH_4, opposed to the AR4 GWP originally used.

- **Wastewater:** Both inventories used the same general approach of determining total San José-Santa Clara Regional Wastewater Facility emissions and then allocating a proportional amount of total plant emissions to Cupertino based on service population. However, the original 2010 community-wide inventory used total SJ-SC RWF emissions from The Plant Master Plan (2013)[47]. This methodology was not compliant with the GPC because it did not account for methane emissions from lagoons, a substantial portion of SJ-SC RWF's emissions. As a result, the 2010 community-wide inventory was revised to estimate wastewater emissions using the recommended GPC methodology. Additionally, 2010 waste emissions were adjusted to account for the AR5 GWPs of CH_4 and N_2O, opposed to the AR4 GWPs originally used.

- **Potable Water:** The Community Protocol called for cities to include emissions associated with water conveyance electricity consumption occurring outside the city boundary. However, since this electricity consumption occurs outside of city boundaries, the GPC does not instruct cities to report these emissions. As a result, emissions associated with water conveyance were not included in the 2015 community-wide inventory or the revised 2010 community-wide inventory.

[47] See www.sanjoseca.gov/DocumentCenter/View/38425

1.1.22 Adjustments to the 2010 Municipal Operations Inventory

Both the 2010 and 2015 municipal operations inventories followed the LGO protocol. However, assumptions related to the calculation of waste emissions in the original 2010 municipal operations inventory relied on a "USA default" waste composition variable and the complete methodology for estimating emissions was not fully documented. The 2015 municipal operations inventory used waste composition data from CalRecycle and followed recommended GPC methodologies for calculating waste emissions using the methane commitment method.[48] Additionally, the original 2010 municipal operations inventory used the AR2 GWP for CH_4, while the 2015 inventory used the AR5 GWP for CH_4. In order to make apples-to-apples comparisons between the 2010 and 2015 municipal operations inventories and track Cupertino's municipal emissions reduction progress, the original 2010 waste emissions were revised to reflect more accurate waste composition data and an updated CH_4 GWP. Table 1 below compares the original 2010 and revised 2010 municipal operations inventories.

Table 26: Municipal operations emissions – 2010 original vs. 2010 revised

Emissions Sector	2010 Original Emissions (MT CO_2e/yr)	2010 Revised Emissions (MT CO_2e/yr)	Percent Change
Facilities	1,249	1,249	0%
Building Energy and Refrigerants	837	837	0%
Public Lighting	412	412	0%
Vehicle Fleet	424	424	0%
Solid Waste	95.3	186	95%
Water Services	6.6	6.6	0%
Total	**1,775**	**1,865**	**5.1%**

[48] 2014 Disposal-Facility-Based Characterization of Solid Waste in California, Table ES-3 "Composition of California's Overall Disposed Waste Stream by Material Type"

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.