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

DNV·GL

June 2017

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. SUMMARY OF FINDINGS

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.

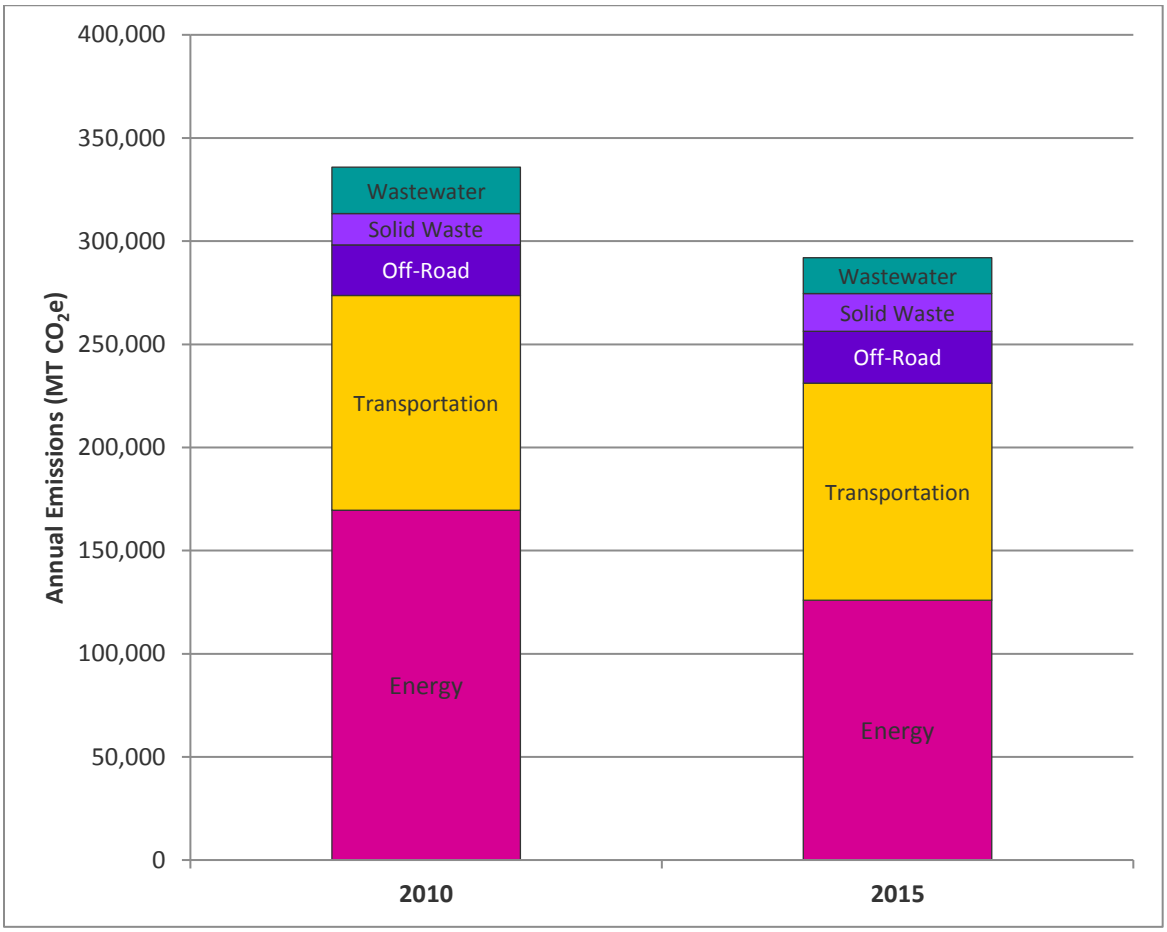
1.1 2015 Community-wide Emissions Inventory

Our findings indicate that Cupertino emitted community-wide emissions of 291,939 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 335,931 $MTCO_2e$. 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

Emissions Sector	2010 Emissions (MT CO_2e/yr)	2015 Emissions (MT CO_2e/yr)	Percent Change
Energy	169,547	125,924	-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	84,095	71,606	-15%
Residential	49,986	40,594	-19%
Non-residential[3]	34,109	31,012	-9%
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	**335,931**	**291,939**	**-13.1%**

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

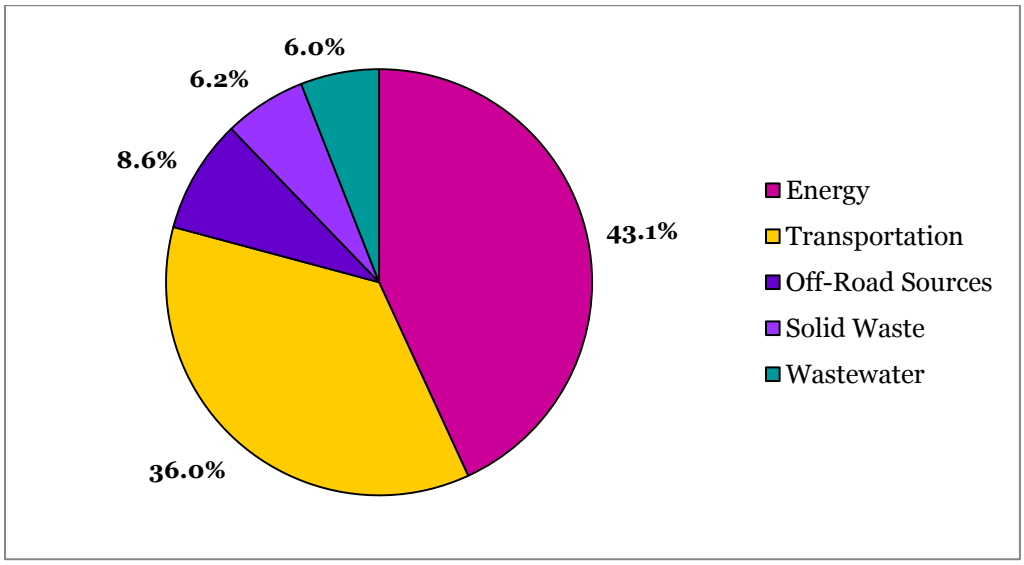
Table 2: Summary of key 2010-2015 community-wide emissions trends

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 Water Pollution Control Plant. 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 (43.1%) and transportation (36.0%) continue to make up the vast majority of community-wide emissions in Cupertino. Off-road sources (8.6%), solid waste (6.2%) and wastewater (6.0%) make up the remaining community-wide emissions.

1.2 2015 Municipal Operations Emissions Inventory

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 3 provide a comparison of 2010 and 2015 municipal operations emissions and trends by sector.

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

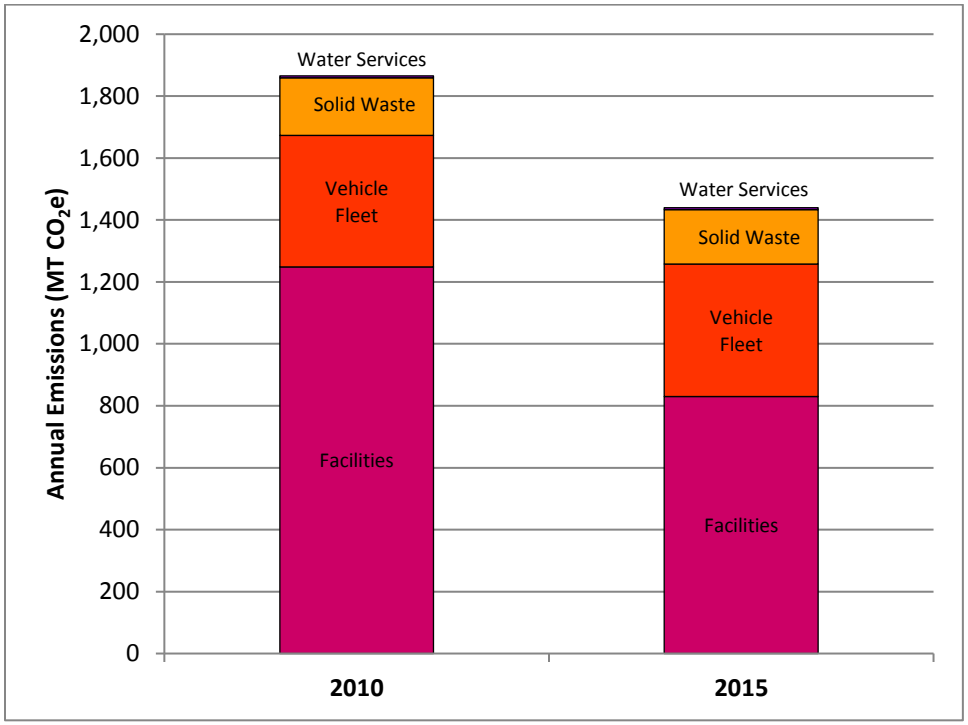


Table 3: Cupertino municipal operations emissions by sector & subsector – 2010 vs. 2015

Emissions Sector	2010 Emissions (MT CO2e/yr)	2015 Emissions (MT CO2e/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%**

in emissions from 2010-2015.

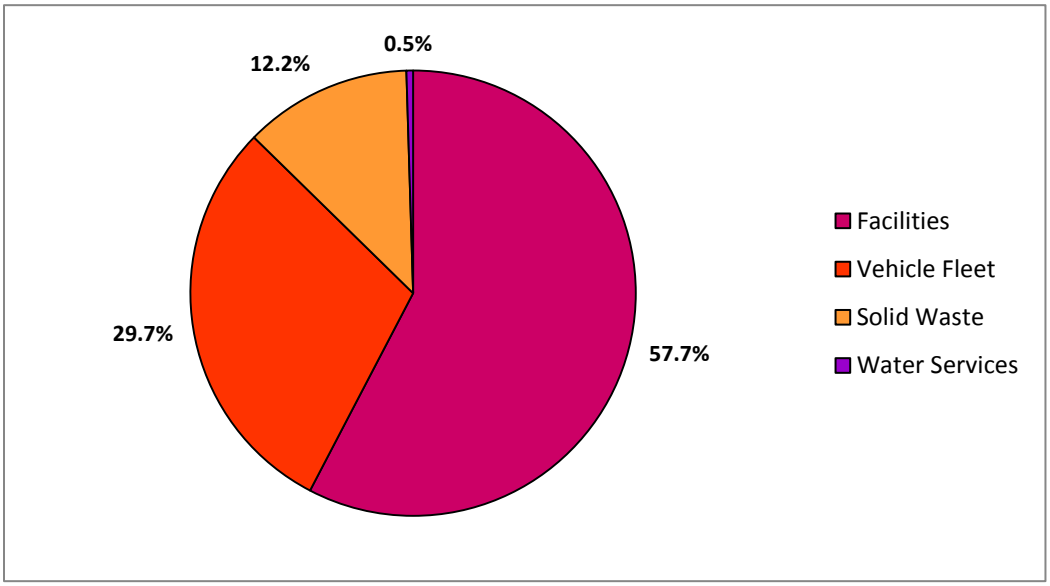
Table 4 provides a sector-by-sector analysis of key factors driving trends in emissions from 2010-2015.

Table 4: 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, combined with a lower emissions factor for grid electricity.

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%), solid waste (6.2%) 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 5.

Table 5: Cupertino municipal employee commute trends - 2010 vs. 2015

Description	2010	2015	Percent Change
All employees total driving commute emissions (MT CO2e)	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.

1.3 2015 – 2050 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 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 by 2035 and 83% below by 2050.

Figure 5 and Table 7 summarize the results of the emissions forecast. 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 – 2010-2050

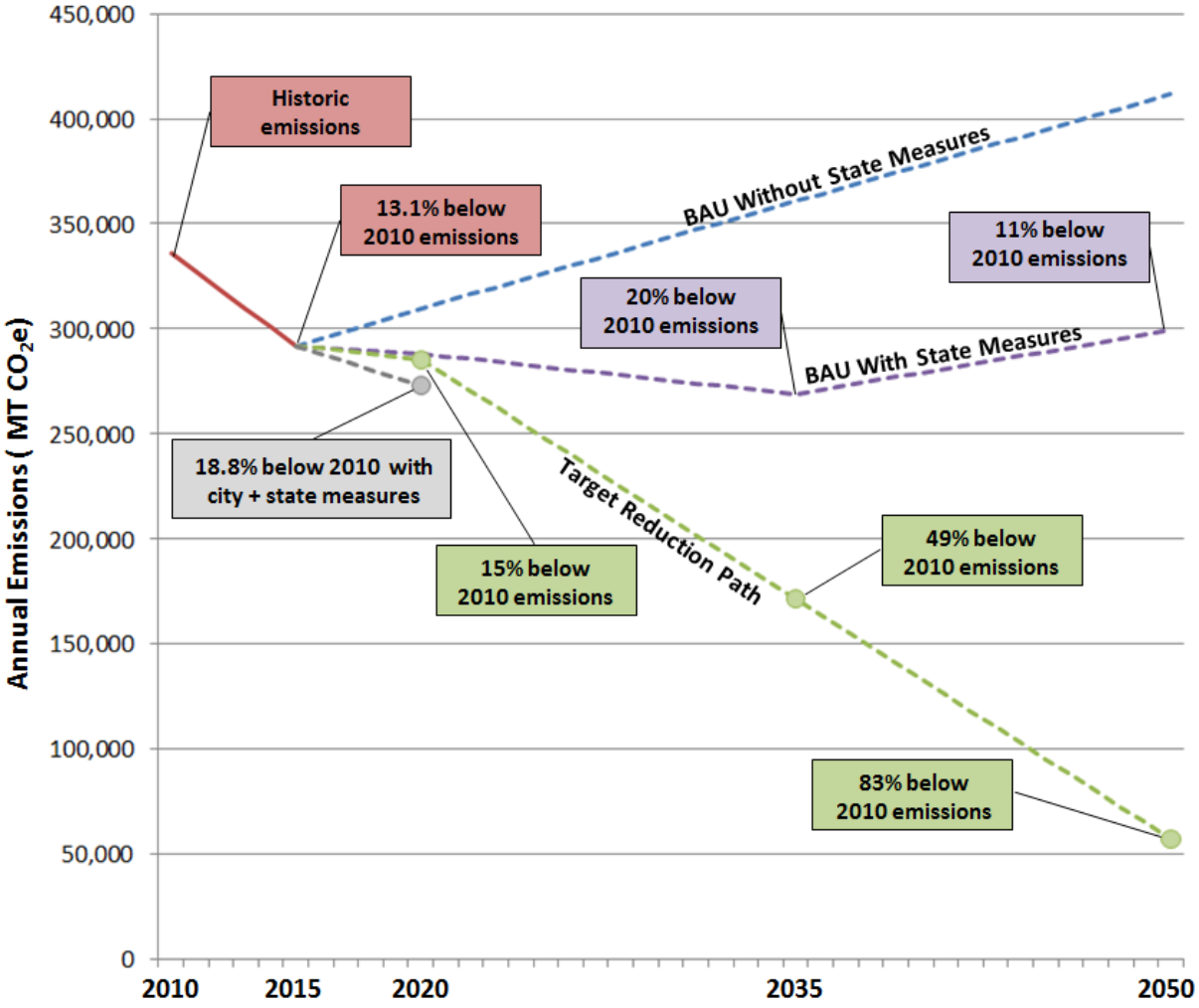


Table 6. Description of different emissions forecasts trend lines

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 7: Cupertino community-wide emissions forecast – 2010-2020

Historic Emissions and Current Progress	2010 Emissions:	335,931	MT CO2e
	2015 Emissions:	291,939	MT CO2e
	Percent Reduction Below 2010 Emissions by 2015:	**13.1%**	Percent
2020 Emissions Reduction Target	**2020 Emissions Target Percent Below 2010:**	**15.0%**	Percent
	2020 Emissions Target:	285,542	MT CO2e
2020 Business-as-usual Emissions and Emissions Reduction from State & City Measures	2020 Business-as-usual Emissions:	309,654	MT CO2e
	2020 Emissions Reduction from State Measures:	-21,460	MT CO2e
	2020 Emissions Reduction from City Measures:	-15,400	MT CO2e
2020 Projected Emissions	2020 Projected Emissions with State + City Measures:	272,793	MT CO2e
	2020 Projected Emissions Percent Below 2010:	**18.8%**	Percent

1.4 Adjustments to 2010 Baseline Inventories

One of the inherent challenges with GHG inventories is that inventory protocols and methodologies are constantly evolving. Additionally, global warming potentials (GWPs) of methane (CH_4) and nitrous oxide (N_2O) are also changing with each new Assessment Report released by the Intergovernmental Panel on Climate Change (IPCC). These two variables can make comparisons between past and current inventories challenging.

Adjustments to the 2010 community-wide inventory

Cupertino's original 2010 community-wide inventory was completed following the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Community Protocol), while this 2015 community-wide inventory was completed following the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (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 of Mayors.

Global warming potential (GWP) is a relative measures 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, the Fifth Assessment Report (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 1 below compares the original 2010 and revised 2010 community-wide inventories.

Table 8: Cupertino community-wide emissions – 2010 original vs. 2010 revised

Emissions Sector	2010 Original Emissions (MT CO2e/yr)	2010 Revised Emissions (MT CO2e/yr)	Percent Change
Energy	169,547	169,547	0%
Electricity Subtotal	85,451	85,451	0%
Residential	25,427	25,427	0%
Commercial	60,025	60,025	0%
Natural Gas Subtotal	84,095	84,095	0%
Residential	49,986	49,986	0%
Commercial	34,109	34,109	0%
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	N/A	N/A
Total	**307,288**	**335,931**	**9.3%**

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

The Off-Road Sources, Solid Waste, Wastewater and Potable Water sectors were adjusted in the revised 2010 community-wide inventory.

- **Off-road Sources:** Both inventories used the California Air Resources Board'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 a quantify 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 CH4, opposed to the AR4 GWP originally used.

- **Wastewater:** Both inventories used the same general approach of determining total San José / Santa Clara Water Pollution Control Plant (SJ/SC WPCP) 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 WPCP emissions from The Plant Master Plan (2013)[4]. This methodology was not compliant with the GPC because it did not account for methane emissions from lagoons, a substantial portion of SJ/SC WPCP'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 CH4 and N2O, opposed to the AR4 GWPs originally used.

- **Potable Water:** The U.S. 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.

[4] https://www.sanjoseca.gov/DocumentCenter/View/38425

Adjustments to the 2010 municipal operations inventory

Both the 2010 and 2015 municipal operations inventories followed the Local Government Operations Protocol (LGO). 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 was 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.[5] Additionally, the original 2010 municipal operations inventory used the AR2 GWP for CH_4 (21), while the 2015 inventory used the AR5 GWP for CH_4 (28). 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 9: 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%**

[5] 2014 Disposal-Facility-Based Characterization of Solid Waste in California, Table ES-3 "Composition of California's Overall Disposed Waste Stream by Material Type"

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