City of Alameda

2015 Community-Wide Greenhouse Gas Inventory and Projection to 2020 Goal

Acknowledgments

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Inventory Update

As the City of Alameda faces major climate impacts such as sea-level rise, extreme weather events, and diminishing air quality, Alameda is working to reduce city-wide emissions of greenhouse gasses while creating a more livable and healthy city. In February of 2008, Alameda City Council adopted a resolution to set a citywide greenhouse gas reduction goal of 25 percent below 2005 baseline levels by 2020. This goal is in line with California's Assembly Bill (AB) 32 goal, a statewide target to reduce emissions back to 1990 levels by 2020. As data for 1990 emissions levels were not available for the city at that time, the City instead uses 2005 as a baseline year. The equivalent goal was approximated to be 25 percent below 2005 levels by 2020.

Greenhouse gas inventories are a very important tool used to understand the City's progress towards emissions reduction, and to understand the most effective means of greenhouse gas mitigation. The City of Alameda plans to continue updating the community greenhouse gas inventory every three years to ensure targets are met.

2015 Emissions, 2020 Goal, and 2030 Estimate

The City's emissions compared to the 2005 baseline decreased by 2% in 2010, increased by 11% in 2015, and are on track to reduce by 18 percent by 2020. To reduce emissions towards the 2020 goal of a 25% reduction from the 2005 baseline, the City has committed to providing carbon neutral electricity to all commercial and residential users and assumes other improvements in non-solo driving and waste diversion continue according to their trend.

By 2020, the City expects to see 95 percent of the final electricity delivered to come from carbon neutral sources, and progress made towards 2030 goals. By 2030, the City has the potential to decrease emissions by 47 percent below baseline through a collection of actions. A portion of this is the state's action to promote electric vehicles and increase fuel efficiency. The City also considers a phase-out of natural gas appliances in 90 percent of commercial and 50 percent of residential infrastructure. Given the City's unique carbon neutral power source, such a switch is worth considering. The 2030 estimate also assumes a 14 percent increase in non-drive alone trips and reaching 95 percent waste diversion.

Figure 1 shows past inventory data as well as emissions reduction potential through planned measures. These are compared to a "business as usual" (BAU) forecast. BAU assumes the City does not implement any reduction goals; it solely reflects emissions reductions that will trickle down from State reduction efforts.

Figure 1: Greenhouse Gas Emissions and Population Forecasts

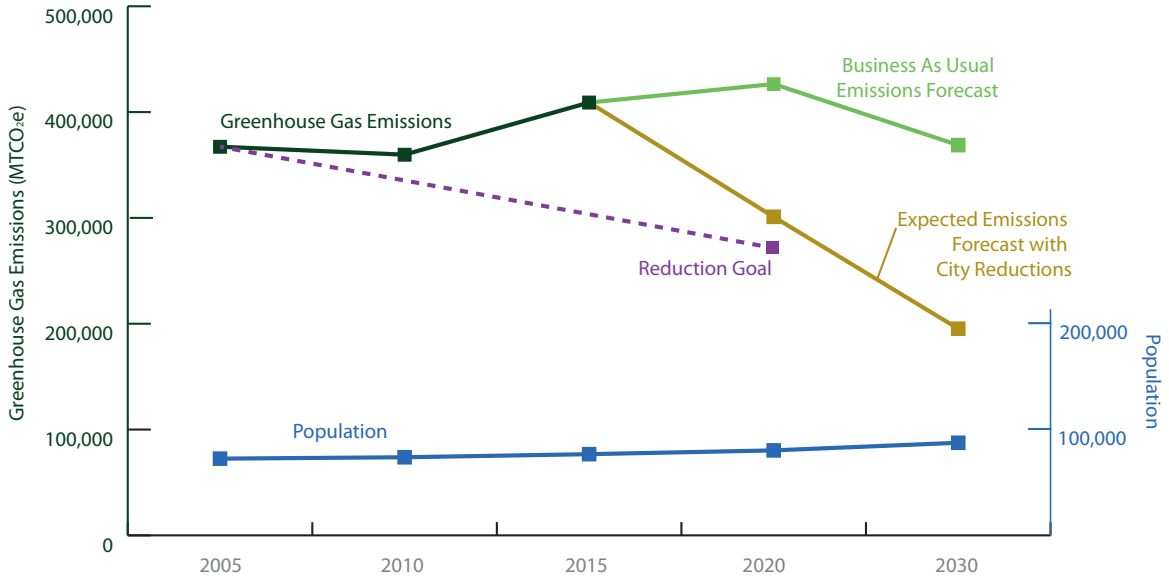


Table 1 gives details pertaining to **Figure 1** on emissions totals and percent reductions for both the "business as usual" (BAU) scenario as well as the scenario based actions the City plans to take to reduce its greenhouse gas emissions. The BAU scenario only incorporates emissions reductions that will trickle down from State reduction efforts. The forecast based on planned City actions is an estimate of future emissions incorporating reductions from the City's commitments to carbon neutral electricity, transportation improvements and mode shift away from single occupant vehicles, waste diversion, and natural gas phase-off.

Table 1: Overall GHG Emission Trends from Baseline

Year	$MTCO_2e$	% Change from Baseline
2005	367,294	--
2010	359,776	-2%
2015	409,039	11%
2020 Forecast without City Action (BAU)	426,527	16%
2020 Forecast with Planned City Reductions	**301,014**	**-18%**
2030 Forecast without City Action (BAU)	368,790	0.4%
2030 Forecast with Planned City Reductions	**195,282**	**-47%**

Cities track emission reduction goals as an overall "Emissions Cap," – that is, a fixed allowable level of emissions that does not change with population or employment growth. Since Alameda's 2005 emissions totaled approximately 367,000 metric tons of carbon dioxide equivalent ($MTCO_2e$)[1], the emissions cap to reach the 2020 reduction goal is set at 275,000 MTCO2e.

Methods for reaching that goal are laid out in the City's Local Action Plan for Climate Protection, adopted in February 2008. The City is in the process of updating the Local Action Plan for Climate Protection, with completion expected in 2019. For more information, please refer to the following web page for the plan update: https://alamedaca.gov/go-green-public-works/local-action-plan-climate-protection.

Per Capita Emissions as Compared to Similar Cities

The City has and will continue to see success in reducing per capita emissions. **Table 2** shows how the population has increased relative to baseline, using projections out to 2030 provided by Plan Bay Area. **Table 2** also shows per capita emissions forecasted out to 2030, accounting for the City's planned reductions. With the City's planned reductions, per capita emissions are expected to decrease by 26% by 2020 and 56% by 2030.

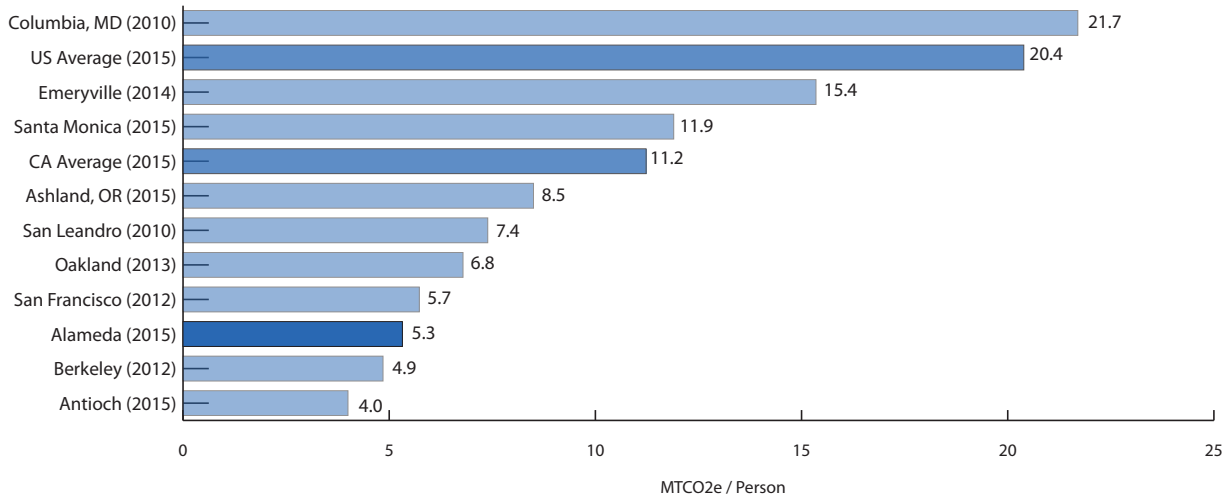
Table 2: Per Capita GHG Emission Trends from Baseline

	2005	2010	2015	2020	2030
Population	72,512	73,812	76,733	80,300	87,500
% Change from Baseline	--	2%	6%	11%	21%
Per Capita Emission with Planned City Reductions	**5.07**	**4.87**	**5.33**	**3.75**	**2.23**
% Change from Baseline	**--**	**-4%**	**5%**	**-26%**	**-56%**

1. Metric Tonnes of Carbon Dioxide Equivalent ($MTCO_2e$) is a unit used to compare the warming potential of different greenhouse gasses. For a greenhouse gas other than carbon dioxide, the tonnage of the greenhouse gas is multiplied by a Global Warming Potential (GWP), or how much a gram of the gas warms the planet when compared to carbon dioxide, to get an equivalent metric to one ton of carbon dioxide emitted into the atmosphere.

When compared to other cities in the Bay Area and similarly sized cities in the United States, Alameda ranks well with per capita emissions. For comparability purposes, all cities chosen for this comparison used the International Council for Local Environmental Initiative (ICLEI) U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Community Protocol).

Figure 2: Per Capita Greenhouse Gas Emissions Comparison



To reach the City's mitigation goals, it is important to understand which sectors the emissions come from and how the emissions have changed from year to year. **Figure 3** shows the 2015 breakdown of emissions by sector. Electricity and natural gas (primarily building energy use) have almost an equal share to transportation, while direct emissions from waste, water, and wastewater only constitute approximately 2 percent. **Figure 4** shows how emissions from each of these sectors have changed from the 2005 and 2010 inventories, and the remaining gap between 2015 emissions levels and Alameda's 2020 emissions reduction goal. It also shows California's 2050 goal from Executive Order S-03-05, which requires the State to reduce emissions to 80 percent below 1990 levels by 2050. While this goal has not been adopted by the City, it shows the direction the State is heading.

Figure 3: 2015 Emission By Sector

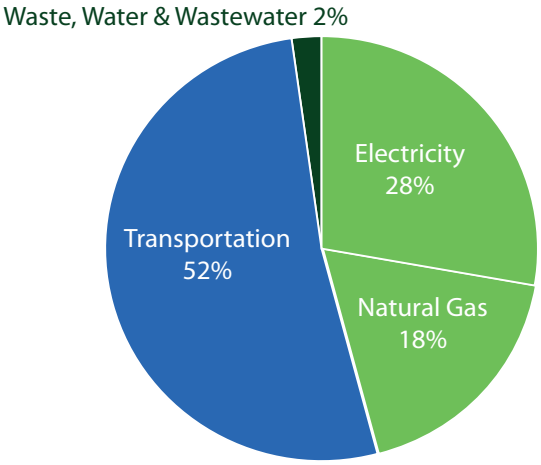
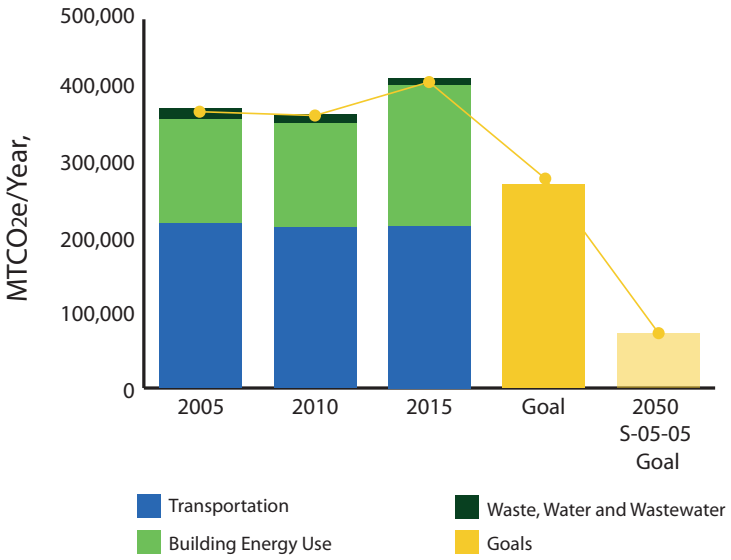


Figure 4: Progress to Goal



A summary of total emissions by sector is shown in **Figure 5.** The City has seen slight decreases in transportation and waste emissions, a steady sequestration rate from the tree canopy, and an increase to building energy use emissions which will be explained more thoroughly in the "Building and Energy Use" section. Sector totals and trends are also shown in **Table 3**.

This document will take a deeper look at each sector in the following pages as well as analyze how city greenhouse gas reduction efforts will bring the City towards its reduction goal by 2020 and into 2030.

Figure 5: Emissions By Sector from 2010 - 2015

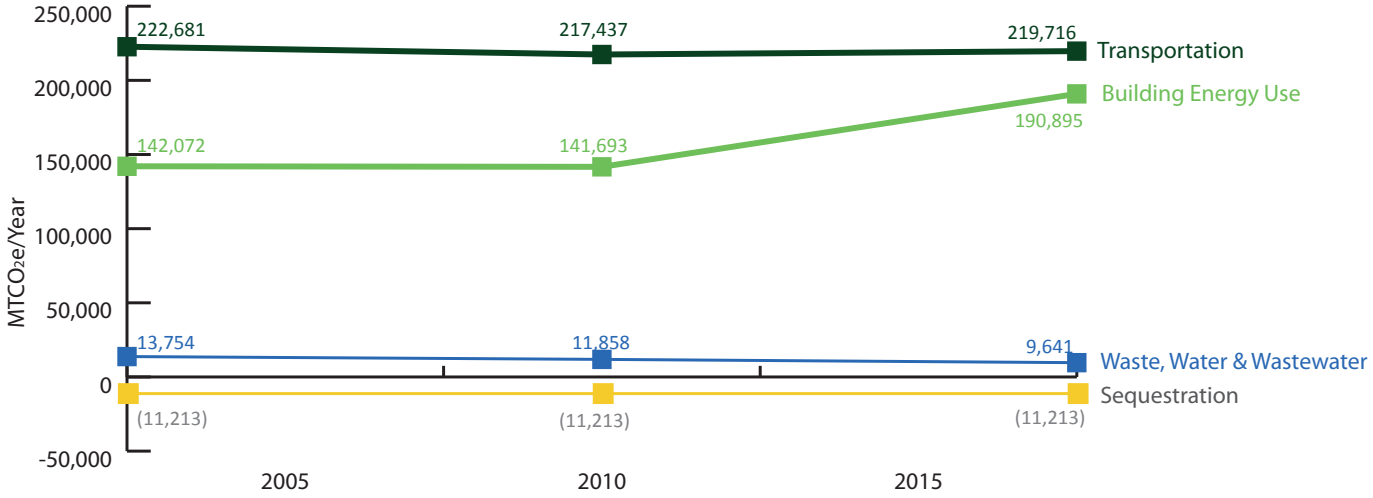


Table 3: GHG Inventory Trends from Baseline by Sector

Metric	2005 $MTCO_2e$	2010 $MTCO_2e$	2015 $MTCO_2e$	% Change
Citywide GHG Emissions	367,294	359,776	409,039	**11%**
Transportation	222,681	217,437	219,716	**-1%**
Building Energy Use	142,072	141,693	190,895	**34%**
Waste, Water, & Wastewater	13,754	11,858	9,641	**-30%**
Sequestration	(11,213)	(11,213)	(11,213)	**0%**

Carbon Credits and Sequestration

This year, the City of Alameda started tracking carbon sequestration from the City's tree canopy as well as carbon credits from recycling and composting efforts. Sequestration from trees within the community can be counted towards City mitigation, as the emissions reduction activity is taking place within city boundaries. Carbon credits from recycling and composting efforts, which reduce the need for extracting and producing raw materials, are not counted towards a reduction in city emissions as the emissions reductions occur outside of city boundaries. This concept is explained further in the **Methodology** section. Carbon credits are important to understand and continue to increase as climate change is a global issue; credits are therefore calculated and listed as an informational item. These credits include emissions reductions from fertilizer production and landfill avoidance from composting as well as extraction of virgin materials and landfill avoidance from recycling.

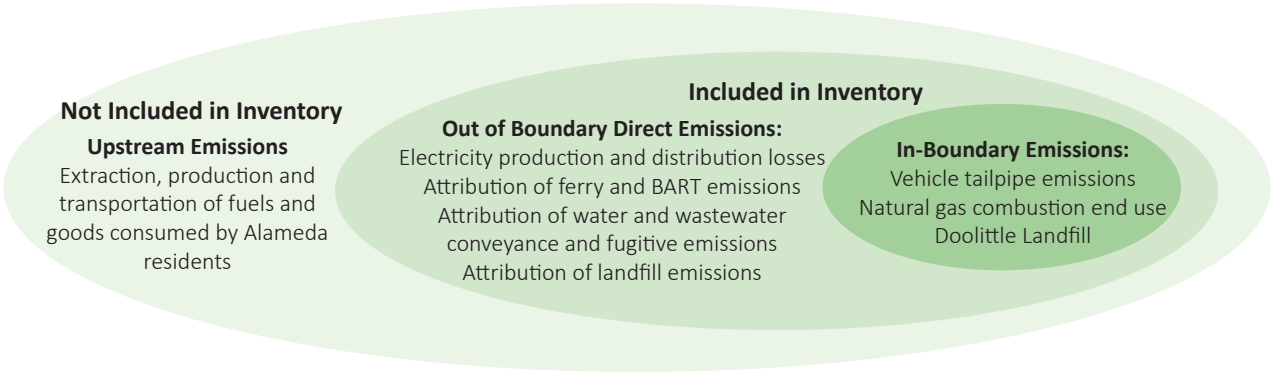
Alameda has been working towards measuring and increasing the City's tree canopy. In the recent Tree Canopy Assessment[2], it was found that the tree canopy sequesters over 11,000 metric tonnes of carbon dioxide annually along with other air pollutants that affect the health of the community. While the City did plant 200 trees in 2015, the carbon sequestration benefits are low for young trees and equated to less than one metric ton. As the trees grow, the sequestration potential will increase substantially throughout maturity and will prove beneficial in greenhouse gas inventory updates. As the Tree Canopy Assessment determined the canopy covering using satellite imagery and is only available for 2015 and no major tree planting efforts were taken up by the City since 2005, it is assumed that the growth and aging of trees has kept sequestration rates constant since the baseline year of 2005. Moving forward, the City will see increases to sequestration rates as tree planting measures are put in place.

2. *City of Alameda Tree Canopy Assessment:* https://alamedaca.gov/sites/default/files/department-files/2017-08-01/alamedacanopystudy-hs-7-25-17.pdf

Methodology

This inventory used the International Council for Local Environmental Initiative (ICLEI) U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Community Protocol) to estimate emissions. This methodology is consistent with most other cities in the United States as well as with the City of Alameda's previous inventories. Emissions typically calculated using this methodology include "downstream" or "post-consumer" emissions from direct activities located within city limits. For example, in the case of vehicle emissions only emissions from the tailpipe of the car driven within city limits are included in the inventory and not the extraction, production, and transportation of the fuel, nor the tailpipe emissions of the resident driving the vehicle completely outside of city boundaries. Downstream emissions are always used, though there are slight exceptions to the city boundaries rule in the cases of electricity consumption and waste generation. Electricity consumption and waste generation can be directly attributed to residents in Alameda, yet the emissions will likely occur at power plants and landfills outside of city boundaries. These are illustrated as "out of boundary direct emissions" in **Figure 6** and are included in the inventory. The other exception to this, for the case of Alameda, is the inclusion of BART and ferry emissions as the emissions and the activity both occur outside of city boundaries. BART and ferry emissions are still included as it is a main method of transportation for Alameda residents and through ridership surveys a portion of emissions can be attributed to Alameda.

Figure 6: Emissions Included in Inventory



Upstream emissions are not calculated in this inventory as the methodology can be seen as highly speculative as estimating global emissions from consumption habits and city activities may not be possible for all products and services. As methodologies and data improve, the City may consider including upstream emissions or creating a combined approach for future inventory updates.

Emissions are measured as metric tons of carbon dioxide equivalent ($MTCO_2e$). Carbon dioxide being the most prevalent heat-trapping gas emitted by cities, all other heat-trapping gasses are mathematically manipulated to be shown as if they, too, would warm the planet as if they were molecules of carbon dioxide. To do this, we use a global warming potential, typically set over a lifespan of 100-years which measures the effectiveness of warming of one gram of a greenhouse gas when compared to a gram of carbon dioxide. To maintain comparability to Alameda's past inventories as well as other cities' inventories, the standard $MTCO_2e$ (over 100-years, using Intergovernmental Panel on Climate Change (IPCC) 4th Assessment global warming potential values) are used in this document (**Table 4**).

Table 4: Global Warming Potentials

Greenhouse Gas	Global Warming Potential
Carbon Dioxide	1
Methane	21
Nitrogen Dioxide	310

Source: Intergovernmental Panel on Climate Change, 4th Assessment

Consumption and Emissions Trends

From a consumption perspective (**Figure 7**), Alameda has been successful in reducing passenger vehicle miles traveled, electricity and natural gas consumption, and waste to landfill. From an emissions perspective (**Figure 8**), these consumption reductions have reduced emissions in all cases except electricity. Consumption and emission trends will be discussed for each sector in the following pages. Not every activity is included in the graphs below as unit systems in some sectors do not correlate; however, details of consumption activity and emissions can be found in **Appendix A**.

Figure 7: Consumption Changes By Sector from 2005 - 2015

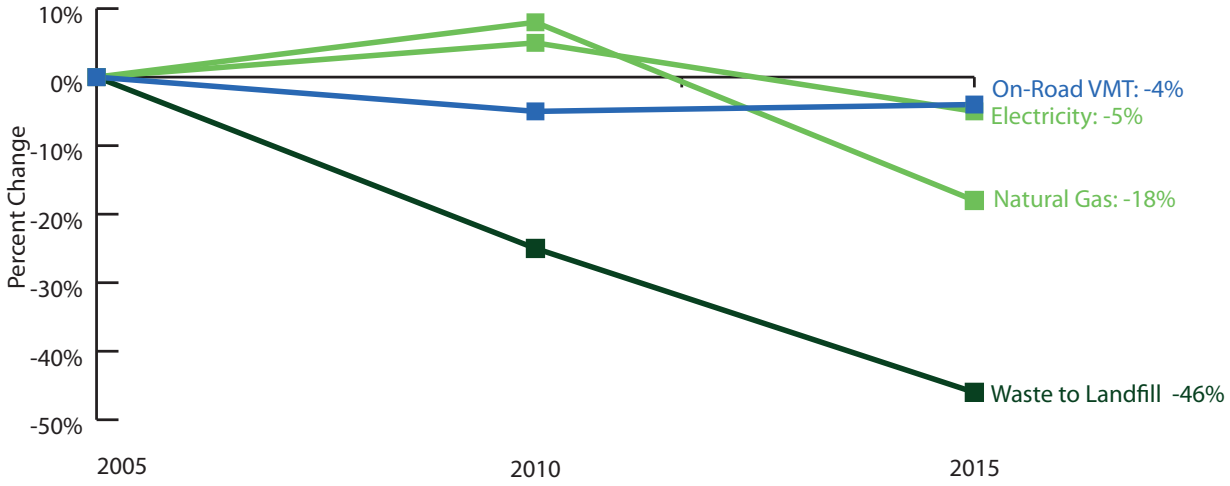
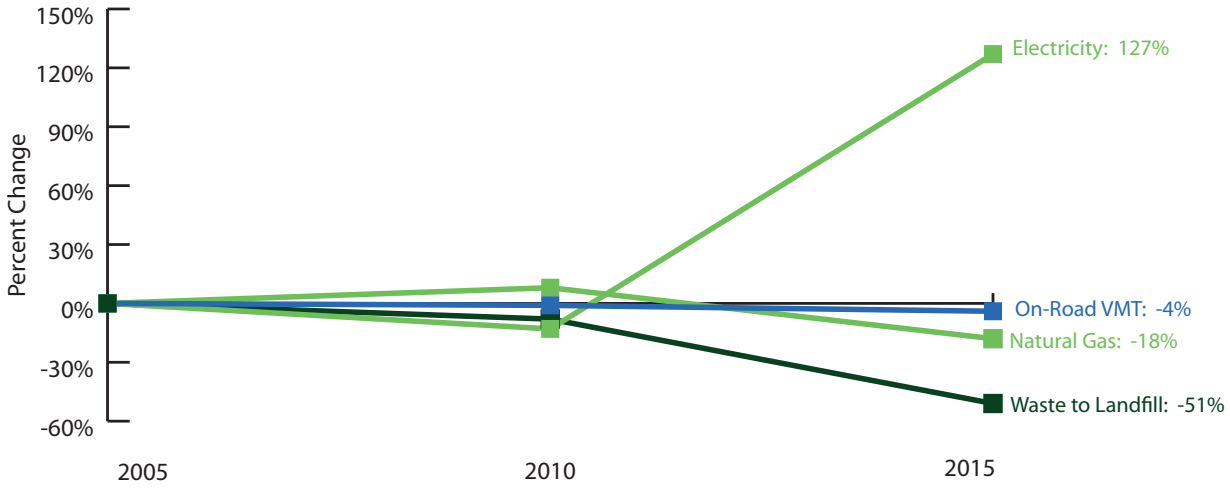


Figure 8: Emission Changes By Sector from 2005 - 2015



Transportation

Figure 9: 2015 Transportation Emissions

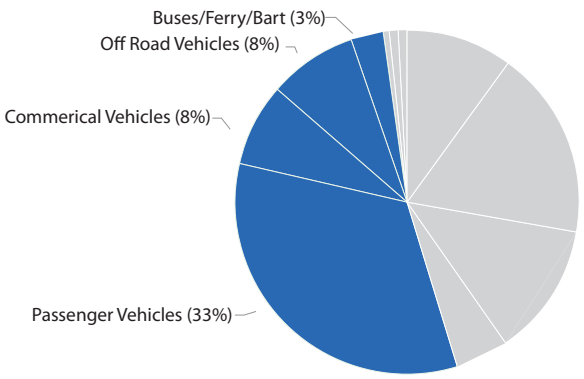
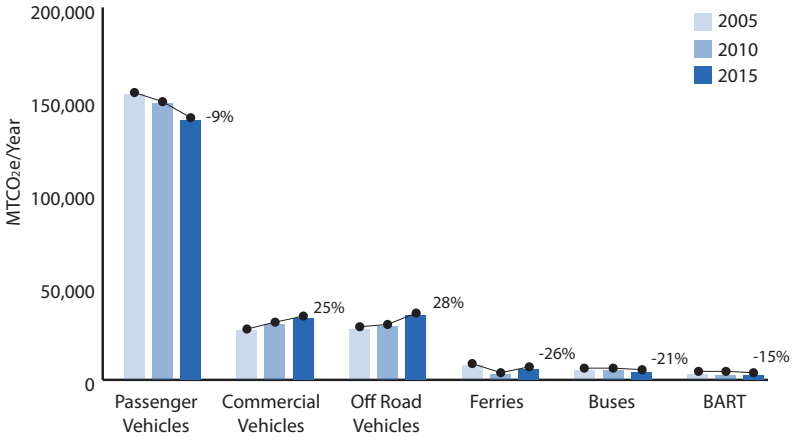


Figure 10: Transportation Emissions Changes 2005 - 2015



Figures 9 and 10 show the breakdown and year to year change of emissions by activity. Details on both miles traveled or gallons consumed and correlating emissions for all activities is listed below in **Table 5**. This table notes that overall emissions from the transportation sector have decreased one percent since baseline. This comes from both the reduction in vehicle miles traveled (VMT) in Alameda as well as the improvement in fuel efficiency. Similarly, a 6 percent decrease in passenger vehicle VMT and a correlating 9 percent decrease in emissions from passenger vehicles is seen, the remainder stemming from improving fuel efficiency standards. It was found that commercial vehicle VMT and emissions rose since the baseline year, likely attributed to the increase in construction and other truck jobs within the city and county as the economy improved.

Emissions from the ferry fluctuated over the time period, likely due to changes to ferry scheduling from ownership changes and demand shifts. The newer ferry vessels are less polluting and reduce single-occupancy passenger vehicle miles, though they do run more often. Offroad vehicles also increased by 28 percent, likely from increases in construction activities. While BART does not run through the City of Alameda, a portion of BART emissions were allocated to Alameda residents based on ridership surveys. Emissions from BART have remained relatively steady though the transit organization has been working to reduce electricity demand through solar procurement and increasing train car occupancy.

Table 5: Transportation Consumption and Emissions 2005 - 2015

Sector	2005 Consumption	2010 Consumption	2015 Consumption	Units	Change from Baseline	2005 $MTCO_2e$	2010 $MTCO_2e$	2015 $MTCO_2e$	Change from Baseline
Transportation									
Passenger Vehicles	356,899,666	336,152,086	337,191,036	VMT	**-6%**	153,155	148,299	139,585	**-9%**
Commercial Vehicles	16,688,455	18,895,100	21,239,908	VMT	**27%**	26,409	29,877	33,039	**25%**
Off Road Vehicles			3,272,235	Gallons		26,981	28,962	34,565	**28%**
Ferries	741,803	263,192	547,239	Gallons	**-26%**	7,675	2,723	5,662	**-26%**
Buses	2,573,085	2,457,899	2,190,748	VMT	**-15%**	5,345	4,989	4,223	**-21%**
BART	14,051,365	14,086,069	14,380,025	kWh	**2%**	3,116	2,587	2,641	**-15%**
Transportation Subtotal						**222,681**	**217,437**	**219,767**	**-1%**

Electricity and Natural Gas: Building Energy Use

Figure 11: 2015 Building Energy Use Emissions

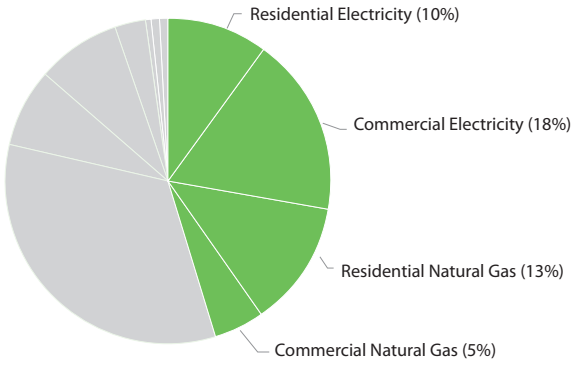
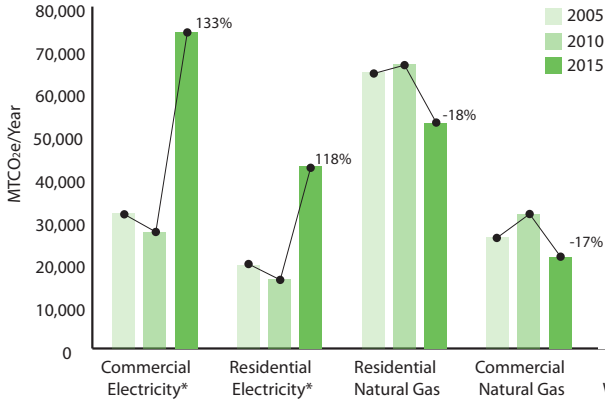


Figure 12: Building Energy Use Emissions Changes 2005 - 2015



*Includes distribution loss and SF6 emissions related to electricity

Alameda's electricity is provided by a community-owned utility, Alameda Municipal Power (AMP). Electricity consumption from both residential and commercial (including municipal) sectors declined from 2010 to 2015 likely due to State and AMP energy efficiency actions as well as a reduced need for heating due to rising temperatures. Residential electricity consumption declined by 9 percent and commercial electricity declined by 10 percent from baseline. Emissions from electricity have increased from the baseline by 125 percent and 123 percent, respectively **(Table 6)**. **Figure 11 and 12** show the breakdown of emission categories and how those categories have changed since baseline.

AMP's power mix has become more carbon-intensive between 2010 and 2015. A portion of the carbon-neutral electricity mix was replaced with "unspecified sources" - or electricity that is not traceable to a specific generating facility and consists of a mix of resource types throughout California. The change in power mix was due to the short-term sale of a portion of the utility's excess renewable energy. Excess renewable energy here refers to qualified renewables that exceed California's Renewable Portfolio Standard (RPS). Proceeds from the short-term sale of some of AMP's excess renewable energy have funded greenhouse gas (GHG)-reducing projects that benefit the entire city. Therefore, overall GHG emissions will be lower after 2019 due to these efficiencies.

AMP continues to own the same generation resources, which include geothermal, biomass, small and large hydroelectric and wind. Once the short-term sale concludes in 2019, AMP will once again have a portfolio that is nearly 100 percent carbon neutral and nearly 70 percent renewable. With this clean power mix in 2020, the emissions due to electricity, as shown in **Figure 12**, will be nearly zero.

Natural gas is supplied by Pacific Gas and Electric Company. Residential and commercial entities also decreased natural gas consumption by 18 percent and 17 percent respectively since the baseline year leading to correlating emissions decreases.

Table 6: Building Energy Use Consumption and Emissions 2005 - 2015

Sector	2005 Consumption	2010 Consumption	2015 Consumption	Units	Change from Baseline	2005 $MTCO_2e$	2010 $MTCO_2e$	2015 $MTCO_2e$	Change from Baseline
Residential									
Electricity	137,906,700	141,336,935	125,431,220	kWh	**-9%**	18,114	15,349	40,749	**125%**
Electrical System Dist Loss	-	7,337,379	5,694,577	kWh		1,466	797	1,850	**26%**
Natural Gas	12,180,175	12,520,503	9,957,908	Therms	**-18%**	64,745	66,554	52,836	**-18%**
Residential Subtotal						**84,325**	**82,700**	**95,436**	**13%**
Commercial									
Electricity	223,590,100	239,017,888	216,771,565	kWh	**-3%**	29,367	25,956	70,423	**140%**
Electrical System Dist Loss	-	12,408,398	9,841,429	kWh		2,376	1,347	3,197	**35%**
Electrical System Dist SF6	1	7	13	g SF6		28	197	367	**1200%**
Natural Gas	4,886,714	5,924,692	4,046,835	Therms	**-17%**	25,976	31,493	21,472	**-17%**
Commercial Subtotal						**57,737**	**58,850**	**95,460**	**65%**
Building Energy Use Subtotal						**142,072**	**141,693**	**190,895**	**34%**

Waste, Water, and Wastewater

Figure 13: 2015 Waste Emissions

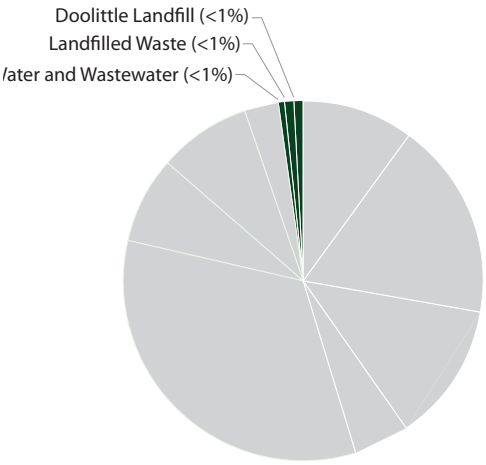
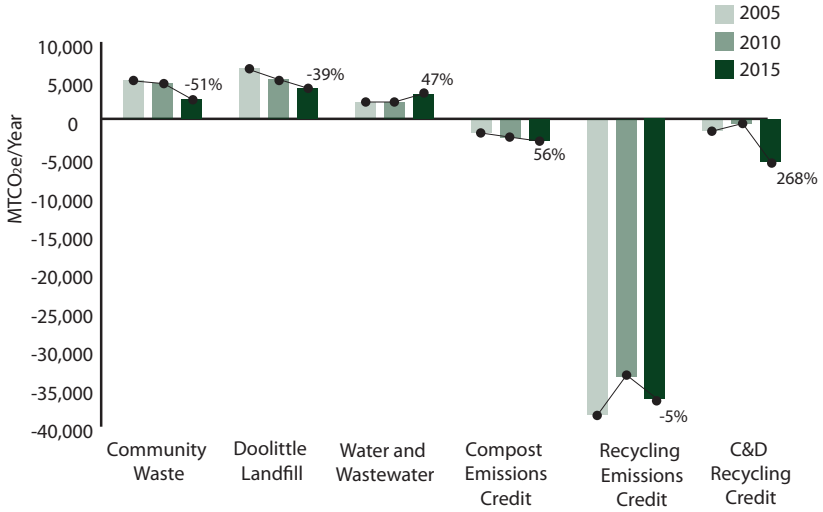


Figure 14: Waste Emissions Changes 2005 - 2015



Emissions from the waste sector have decreased by 51% and 39% for community waste set to landfill and emissions from Doolittle Landfill, respectively, as shown in **Table 7.** The portion of waste emissions compared to the overall inventory is shown in **Figure 13** and the breakdown of each emission categories, including informational carbon credits and their changes year to year are shown in **Figure 14.**

Community waste is the waste generated by Alameda residential and commercial entities and sent to landfills outside of city limits. Emissions quantified are that of landfill items that decompose and off-gas methane minus the methane captured by the facility. The Doolittle Landfill, even though this landfill closed down in 1985, is still off-gassing methane and is incorporated into the inventory. Annual emissions were estimated using US EPA's LandGEM modeling software.

As stated in the **Carbon Credits and Sequestration** section, carbon credits do not count towards overall city emissions or emissions reductions goals, but are important to note as recycling and composting have a very large emissions reduction effect on the global scale. **Figure 14** shows the success the recycling and composting programs have had. The construction and demolition (C&D) recycling program has increased by 268%, offsetting more than the emissions generated by community waste. Commercial and residential recycling programs have also been very successful, offsetting the emissions from almost seven times that of both community waste and the Doolittle Landfill.

Table 7: Waste Consumption and Emissions 2005 - 2015

Sector	2005 Consumption	2010 Consumption	2015 Consumption	Units	Change from Baseline	2005 $MTCO_2e$	2010 $MTCO_2e$	2015 $MTCO_2e$	Change from Baseline
Waste									
Community Waste	49,962	37,310	27,175	Tons	**-46%**	5,049	4,621	2,477	**-51%**
Doolittle Landfill						6,524	5,081	3,957	**-39%**
Waste Subtotal						**11,574**	**9,703**	**6,434**	**-44%**
Water/Wastewater									
EBMUD Operations.						2,180	2,156	3,207	**47%**
Water and Wastewater Subtotal						**2,180**	**2,156**	**3,207**	**47%**
Waste, Water, and Wastewater Subtotal						**13,754**	**11,858**	**9,641**	**-30%**
Carbon Credits - Information Only									
Compost Emission Credits	7,873	10,273	12,278	Tons	**56%**	(1,832)	(2,391)	(2,857)	**56%**
Recycling Emissions Credits	12,480	10,875	11,814	Tons	**-8%**	(38,437)	(33,495)	(36,386)	**-5%**
C&D Recycling Credits	657	259	2,422	Tons	**134%**	(1,516)	(598)	(5,584)	**268%**
Carbon Credits Subtotal						**(41,785)**	**(36,484)**	**(44,827)**	**7%**

Estimating Emissions to 2020 and 2030

The City of Alameda has ambitions goals to reduce emissions into 2020 and 2030. This section will look at two possible emissions scenarios: emissions forecasts with no action by the City (termed "business as usual"), and emissions forecasts with mitigation action by the City. Using this information, the City can see how their efforts bring them towards their goals and determine what next steps are necessary to further create a livable, sustainable city.

Forecasting emissions into a "business as usual" (BAU) projection took into account population growth, job growth, and legislative actions to reduce emissions such as energy efficiency improvements from Title 24 standards, Pavley fuel efficiency standards, and Air Resource's Board (ARB) estimates on increased electric vehicle adoption. This BAU projection also takes into account the reduction in Doolittle landfill emissions, these estimations can be seen in **Appendix C**.

If no action is taken by the city, emissions are expected to peak by 2020 as population and job growth increase and then start to decrease as growth is offset by energy efficiency requirements, fuel efficiency standards, and electric vehicle adoption increases. However, even with State legislative action contributing to emission reductions, the City's goal will still not be met. By 2020 the emissions without City action are expected to reach approximately 427,000 $MTCO_2e$, a 16 percent increase from baseline before leveling out to approximately 2005 levels by 2030. **(Table 8)**

The City has or is considering committing to several actions that are estimated to reduce emissions 18% from baseline by 2020 and 32% from baseline by 2030. The list of City actions and correlating emissions reduction estimations can be seen in **Table 9.**

Table 8: Emissions Summary with Forecasting Estimates

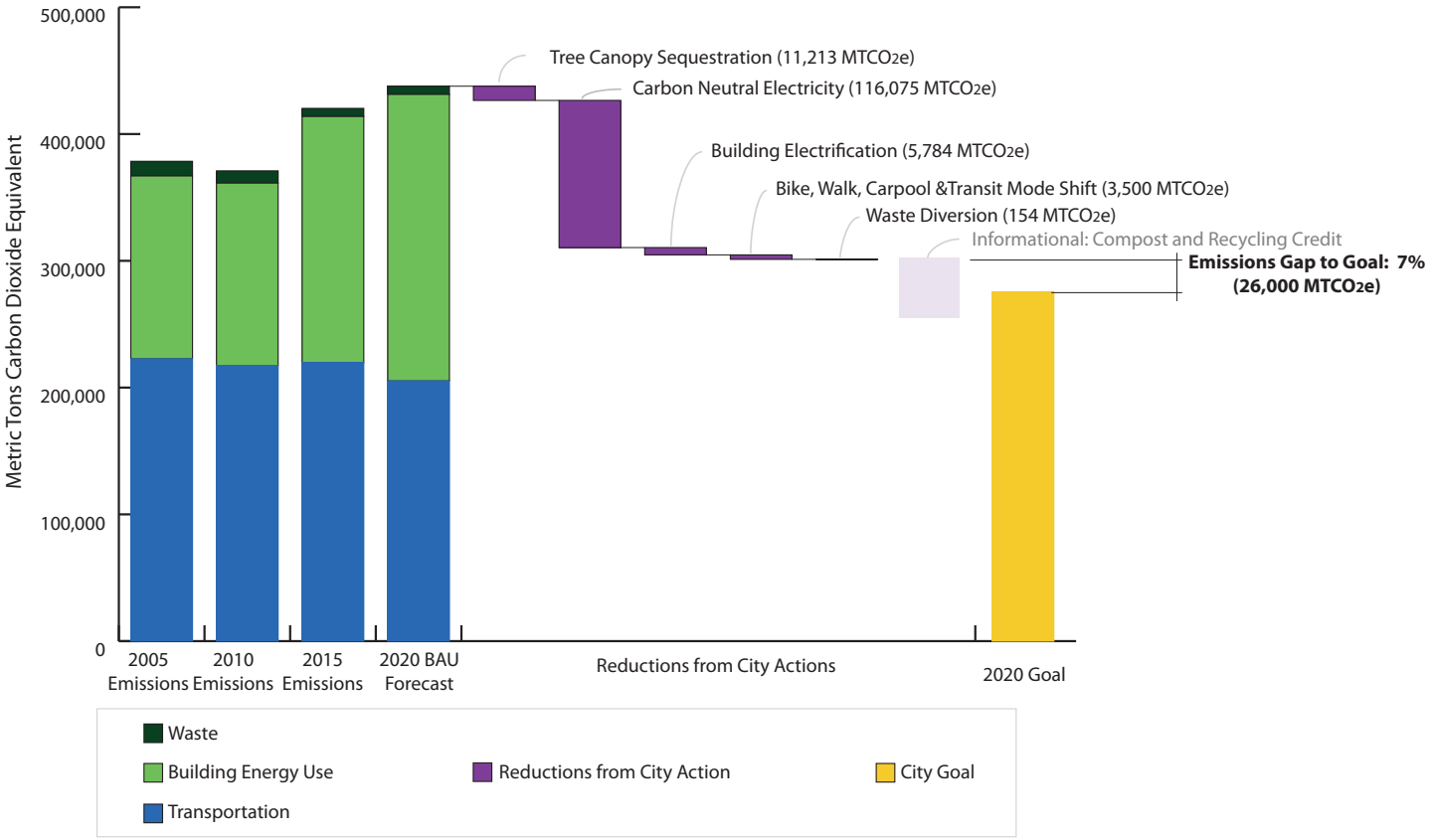
	Emissions Forecasts ($MTCO_2e$)				
	2005	**2010**	**2015**	**2020**	**2030**
No City Action (BAU)	367,294	359,776	409,039	426,527	368,790
% Change	0%	-2%	11%	16%	0.4%
With Planned City Action	**367,294**	**359,776**	**409,039**	**301,014**	**195,282**
% Change	**0%**	**-2%**	**11%**	**-18%**	**-47%**

Table 9: Planned City Action and Correlating Emissions Reduction Estimates

	Emissions Reduction Estimation ($MTCO_2e$)	
City Action	**2020**	**2030**
Provide carbon neutral electricity to all residential and commercial end users in Alameda (Due to the nature of electricity distribution, 95% carbon neutrality can be achieved)	(116,075)	(105,179)
Achieve 90% electrification of commercial building stock and 50% electrification of residential building stock by 2030 (Assume to achieve 10% of both goals by 2020; assume AMP to provide carbon neutral electricity for increased load from electrification in 2030)	(5,784)	(51,087)
Achieve 14% increase in non-drive alone trips by 2030 through the success of the Transportation Choices Plan (Assume even ramp up of programs until 2030)	(3,500)	(14,000)
Achieve 95% diversion of all divertable waste materials by 2030 (Assume linear success rate until 2030)	(154)	(3,226)
Plant 2,000 Trees by 2030 (Assume trees reach age of 13 by 2030. Sequestration will increase as they grow)		(16)
Total Emissions Reduction from City Actions	**(125,513)**	**(173,508)**
Remaining Emissions Reduction Needed to Reach Goal	**25,543**	**No Goal Adopted**

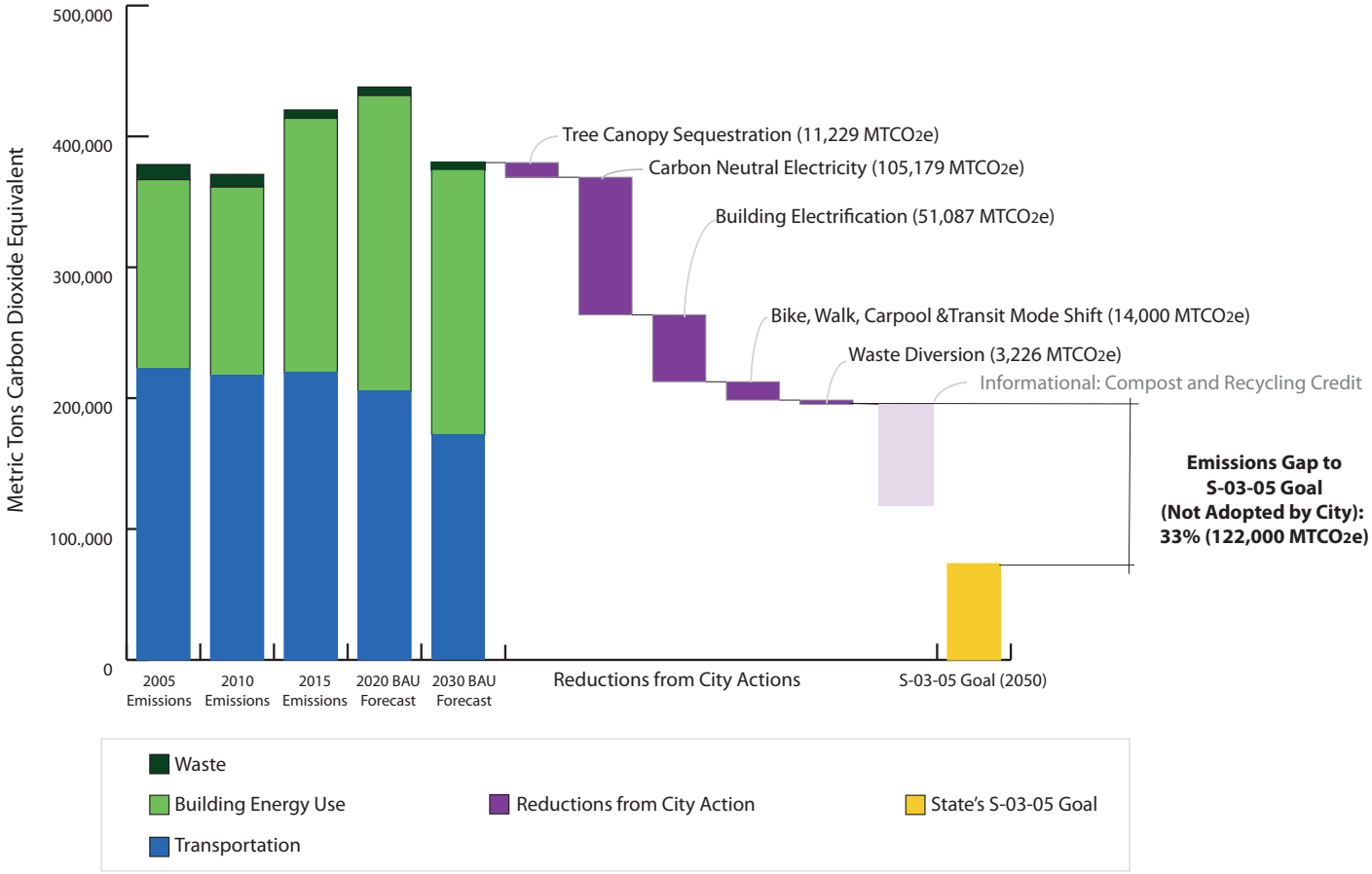
The following graphs compare the "business as usual" forecasted estimations to each emissions reduction action planned by the City. **Figure 15** shows these City actions bring the city's emissions profile closer to the 2020 goal - the City is only about 26,000 $MTCO_2e$ (7 percent) away from reaching the 2020 goal. Each figure also shows an estimate of emissions credits from recycling and composting as in informational item.

Figure 15: Emissions Forecasts to 2020 with Planned City Reduction Actions



While the City has not yet adopted a goal for 2030 or beyond, the State's goal through executive order S-03-05 is to reduce emissions 80% below 1990 levels by 2050, and cities will have a strong role in helping to achieve this goal. **Figure 16** shows the "business as usual" forecasted emissions into 2030 along with each emissions reduction action planned by the City into 2030 and compares to the State's executive order S-03-05 goal. While this goal is not adopted by the City and is set for the year 2050, it is the direction the State is heading and is included more as an informational item.

Figure 16: Emissions Forecasts to 2030 with Planned City Reduction Actions



These city actions to mitigate climate change are expected to bring Alameda's emissions within seven percent of the goal by 2020. Additional measures to reduce the remainder of emissions necessary to reach the goal will be outlined in the subsequent update to the Local Action Plan for Climate Protection with completion expected in 2019. Actions leading into 2030 are expected to bring Alameda's emissions down an impressive 47 percent, well on the way towards S-03-05 goals. For more information on the Local Action Plan for Climate Protection update, please refer to the following web page: https://alamedaca.gov/go-green-public-works/local-action-plan-climate-protection.

Appendix A: Summary Inventory Table

Sector	Scope	2005 Consumption	2010 Consumption	2015 Consumption	Consumption Units	2005 $MTCO_2e$	2010 $MTCO_2e$	2015 $MTCO_2e$	Change in consumption from Baseline	Change in Emissions from Baseline
Transportation										
Passenger Vehicles	Scope 1	356,899,666	336,152,086	337,191,036	VMT	153,155	148,299	139,585	-6%	-9%
Commercial Vehicles	Scope 1	16,688,455	18,895,100	21,239,908	VMT	26,409	29,877	33,039	27%	25%
Off Road Vehicles	Scope 1			3,272,235	Gallons	26,981	28,962	34,565		28%
Ferries	Scope 1	741,803	263,192	547,239	Gallons	7,675	2,723	5,662	-26%	-26%
Buses	Scope 1	2,573,085	2,457,899	2,190,748	VMT	5,345	4,989	4,223	-15%	-21%
BART	Scope 1	14,051,365	14,086,069	14,380,025	kWh	3,116	2,587	2,641	2%	-15%
Transportation Subtotal						**222,681**	**217,437**	**219,716**		**-1%**
Building Energy Use										
Residential										
Electricity	Scope 2	137,906,700	141,336,935	125,431,220	kWh	18,114	15,349	40,749	-9%	125%
Electrical System Distribution Losses	Scope 2		7,337,379	5,694,577	kWh	1,466	797	1,850		26%
Natural Gas	Scope 1	12,180,175	12,520,503	9,957,908	Therms	64,745	66,554	52,836	-18%	-18%
Residential Subtotal						*84,325*	*82,700*	*95,436*		*13%*
Commercial										
Electricity	Scope 2	223,590,100	239,017,888	216,771,565	kWh	29,367	25,956	70,423	-3%	140%
Electrical System Distribution Losses	Scope 2	-	12,408,398	9,841,429	kWh	2,376	1,347	3,197		35%
Electrical Distribu-tion SF6 Emissions	Scope 2	1	7	13	grams SF6	28	197	367		1200%
Natural Gas	Scope 1	4,886,714	5,924,692	4,046,835	Therms	25,976	31,493	21,472	-17%	-17%
Commercial Subtotal						*57,737*	*58,850*	*95,460*		*65%*
Building Energy Use Subtotal						**142,072**	**141,693**	**190,895**		**34%**
Waste, Water, and Wastewater										
Waste										
Community Waste	Scope 3	49,962	37,310	27,175	Tons	5,049	4,621	2,477	-46%	-51%
Doolittle Landfill	Scope 1					6,524	5,081	3,957		-39%
Waste Subtotal						*11,574*	*9,703*	*6,434*		*-44%*
Water and Wastewater										
EBMUD Operations						2,180	2,156	3,207		-47%
Water/Wastewater Subtotal						*2,180*	*2,156*	*3,207*		*47%*
Waste , Water and Wastewater Subtotal						**13,754**	**11,858**	**9,641**		**-30%**
Sequestration										
Mature Trees	Scope 1					(11,213)	(11,213)	(11,213)		0%
Newly Planted Trees	Scope 1			200	Trees			(0.04)		
Sequestration Subtotal						**(11,213)**	**(11,213)**	**(11,213)**		**0%**
TOTAL Community-Wide Emissions						**367,294**	**359,776**	**409,039**		**11%**
Carbon Credits - Information Only										
Compost Credits	Scope 3	7,873	10,273	12,278	Tons	-1,832	-2,391	-2,857	56%	56%
Recycling Credits	Scope 3	12,480	10,875	11,814	Tons	-38,437	-33,495	-36,386	-5%	-5%
C&D Recycle Credits	Scope 3	657	259	2,422	Tons	-1,516	-598	-5,584	268%	268%
Carbon Credits Subtotal						**39,175**	**33,874**	**42,952**	**26%**	**7%**

Appendix B: Changes to Previous Inventory

The City of Alameda's 2010 inventory shows an 8 percent decrease in emissions from 2005 to 2010. This looks only at "directly comparable numbers" which excludes electricity distribution system losses, SF_6 losses, offroad vehicles, BART, ferries, Doolittle Landfill emissions, and water and wastewater emissions. These activities are overlooked in the overall emissions reduction quantification as data for these activities was not found in the original 2005 inventory. This inventory aimed to be more comprehensive and representative of reaching State reduction goals, so all inventory activities are accounted for in overall reduction numbers which correlates to a 2 percent decrease in emissions from 2005 to 2010 within this update.

Slight changes to the original inventory data were made to the transportation and waste sectors due to changes in modeling capabilities or calculation methodologies. Passenger and commercial vehicle VMT data was updated to reflect changes made within the Air Resources Board EMission FACtor (EMFAC) mode which helps to breakdown the City's VMT between vehicle types. These modeling changes are thought to be more accurate. Raw data updates is shown in the table below and details on calculation procedures can be found in **Appendix D**.

The waste sector underwent changes to emissions quantification, as a methodology in the previous inventory was used that was not in line with the ICLEI methodology, which is described in more detail in **Appendix D**. No changes were made to the raw tonnage data, however, changes were made to the emissions calculation. Any other minor changes are described within the tables in **Appendix D.**

Sector	Raw Data Units	2005 Raw Data	2010 Raw Data	2005 Raw Data Updated	2010 Raw Data Updated
Transportation					
Passenger Vehicles	VMT	367,643,598	347,818,456	356,899,666	336,152,086
Commercial Vehicles	VMT	27,143,247	32,040,354	16,688,455	18,895,100
Ferries	Gallons	no raw data provided	no raw data provided	741,803	263,192
Buses	VMT	2,330,839	1,993,931	2,573,085	2,457,899
BART	kWh	no raw data provided	no raw data provided	14,051,365	14,086,069

Appendix C: Emissions BAU Forecasting

Sector	2005 $MTCO_2e$	2010 $MTCO_2e$	2015 $MTCO_2e$	2020 BAU Forecast	2030 BAU Forecast
Transportation					
Passenger Vehicles	153,155	148,300	139,585	121,006	83,357
Commercial Vehicles	26,409	29,877	33,039	37,449	42,984
Off Road Vehicles	26,981	28,962	34,565	35,221	34,838
Ferries	7,675	2,723	5,662	5,662	5,662
Buses	5,345	4,989	4,223	3,302	2,365
BART	3,116	2,587	2,641	2,641	2,641
Transportation Subtotal	**222,681**	**217,437**	**219,716**	**205,281**	**171,847**
Building Energy Use					
Residential					
Electricity	18,114	15,349	40,749	46,359	42,550
Electrical System Distribution Losses	1,466	797	1,850	2,105	1,932
Natural Gas	64,745	66,554	52,836	66,250	58,538
Residential Subtotal	*84,325*	*82,700*	*95,436*	*114,714*	*103,020*
Commercial					
Electricity	29,367	25,956	70,423	77,069	69,250
Electrical System Distribution Losses	2,376	1,347	3,197	3,499	3,144
Electrical Distribution SF6 Emissions	28	197	367	-	-
Natural Gas	25,976	31,493	21,472	27,462	24,242
Commercial Subtotal	*57,747*	*58,993*	*95,460*	*108,030*	*96,636*
Building Energy Use Subtotal	**142,072**	**141,693**	**190,895**	**222,744**	**199,656**
Waste					
Waste					
Community Waste	5,049	4,621	2,477	3,397	3,396
Doolittle Landfill	6,524	5,081	3,957	3,082	1,869
Waste Subtotal	*11,574*	*9,703*	*6,434*	*6,479*	*5,265*
Water and Wastewater					
EBMUD Operations	2,180	2,156	3,207	3,236	3,235
Water/Wastewater Subtotal	*2,180*	*2,156*	*3,207*	*3,236*	*3,235*
Waste, Water & Wastewater Subtotal	**13,754**	**11,858**	**9,641**	**9,715**	**8,500**
Sequestration					
Mature Trees	(11,213)	(11,213)	(11,213)	(11,213)	(11,213)
Newly Planted Trees			(0.04)	(0.04)	(0.04)
Subtotal	(11,213)	(11,213)	(11,213)	(11,213)	(11,213)
TOTAL Community-Wide Emissions	**367,294**	**359,776**	**409,039**	**426,526**	**368,790**

Appendix D: Calculation Notes

Transportation Sector Notes:

Activity	2015 Data Input	Data Entity	Changes to Previous Inventory Calculations
Passenger Vehicles	337,191,036 VMT	Metropolitan Transportation Commission - Travel One Model, Air Resources Board EMFAC Model	Updates to ARB's EMFAC model governed changes to previous inventories
Commercial Vehicles	21,239,908 VMT	Metropolitan Transportation Commission - Travel One Model, Air Resources Board EMFAC Model	Updates to ARB's EMFAC model governed changes to previous inventories
OffRoad Vehicles	3,272,235 Gallons	EPA OffRoad Model	none
Ferries	547,239 Gallons	National Transit Database (NTD)	Previous inventory data did not match NTD data - updated to match
Buses	2,190,748 VMT	Metropolitan Transportation Commission - Travel One Model, Air Resources Board EMFAC Model	Updates to EMFAC model governed changes to previous inventories
BART	14,380,025 kWh	National Transit Database, BART Ridership Survey	Ridership survey now available, updated emissions due to portion attributed to Alameda

Inventory Changes from Previous Years:
2005 and 2010 VMT data for passenger and commercial vehicles was updated to reflect changes made to the Air Resources Board EMission FACtor (EMFAC) model. See **Appendix B** for changes to the raw data. Updates to Ferry and BART data were made as more accurate data was released.

On-Road Vehicles Calculation Procedure:
Commercial vehicles, passenger vehicles, and buses are all considered "on-road vehicles." Data is collected from the Metropolitan Transportation Commission's (MTC) Travel One Model Climate Portal. On-road vehicle emissions are expressed in daily vehicle miles traveled (VMT) on city roads during a typical weekday and includes miles traveled by passenger vehicles, light and heavy-duty trucks, motorcycles, and buses as a lumped sum. To allocate VMT to different vehicle and fuel types, the Air Resources Board 2014 EMFAC model for the County of Alameda was run to understand the breakdown of fuel types and vehicle types and attributed the same breakdown to the City of Alameda. To estimate the number of commercial (heavy truck) VMT in the City of Alameda, the ratio of truck jobs in the city versus the county is applied to the EMFAC model of heavy truck VMT. This ratio of job types is found using NAICS onthemap data and is applied to MTC Travel One VMT data. ICLEI-assumed truck jobs are under the NAICS sectors of agriculture, forestry, fishing and hunting; mining, quarrying, and oil and gas extraction; utilities; construction; manufacturing; wholesale trade; retail trade; and transportation and warehousing. The EMFAC model is also used at the County level to find the fuel efficiencies of each vehicle type on the road by dividing estimated fuel consumption with vehicle miles traveled and assuming the same fuel efficiencies are seen on the city level as on the county.

Emissions from Transit Calculation Procedure:
BART: Electricity consumption data was collected from the National Transit Database and found in *Table 17 - Energy and Consumption*. Emissions intensity data was applied per Pacific Gas and Electric's electric power mix and correlating emission factors. BART emissions were allocated to Alameda residents per BART ridership surveys. For the year 2015, 5% of ridership was assumed to go to Alameda residents per BART-conducted rider surveys. This represents a change to previous inventories as in previous years a best-guess allocation was provided by StopWaste as no ridership surveys had been conducted at that time. Previous years emissions were re-calculated using the survey data.

WETA: Diesel consumption and emissions intensity data was collected from National Transit Database and found in ***Table 17 - Energy and Consumption***. Twenty-five percent of WETA emissions were applied to Alameda residents as the ferries run from Alameda and Oakland to San Francisco. With 2 stops in San Francisco, Oakland and Alameda are to split the remaining 50 percent of emissions. This attribution is in line with previous inventory estimations.

OffRoad:
The Air Resources Board OffRoad Emissions model was used to estimate emissions. The following information was entered into each tab:
Episode - 2015, Mon-Sun, Annual
Reporting - TOG, Report by County, Exhaust
Area - County, Alameda
Equipment - All
Fuel and HP - All Fuel Types, All Horsepower
Data Files - Population
Allocate City versus County emissions based on population.

Building Energy Sector Notes:

Activity	Data Input	Data Entity	Changes to Previous Inventory Calculations
Electricity	125,431,220 kWh	Alameda Municipal Power	none
Electrical System Distribution Losses	5,694,577 kWh	Alameda Municipal Power	none
Natural Gas	9,957,908 therms	Pacific Gas & Electric	none
Electricity	216,771,565 kWh	Alameda Municipal Power	none
Electrical System Distribution Losses	9,841,429 kWh	Alameda Municipal Power	none
Electrical Distribution SF6 Emissions	13 kg SF6	Alameda Municipal Power	Updated to reflect AMP estimations instead of estimating off energy provider's reports to CARB.
Natural Gas	4,046,835	Pacific Gas & Electric	none
EBMUD Operations	5.8 Million Gallons Water	East Bay Municipal Utility District	none

Consumption and emissions intensity from all electricity sectors (residential, commercial, distribution losses, and SF_6 emissions) came from Alameda Municipal Power. Natural gas consumption and emissions intensities came from Pacific Gas and Electric (PG&E). In 2015, Alameda Municipal Power's electric power mix was the following:

2015 AMP Electric Power Mix	
Percentage	**Source**
69%	Unspecified
14%	Biomass & Waste
10%	Large Hydroelectric
6%	Wind
1%	Natural Gas
1%	Small Hydroelectric

East Bay Municipal Utility District provided water consumption data, energy use for water and wastewater conveyance and treatment, and fugitive emissions from wastewater treatment. Emissions attribution to Alameda was based on population served for wastewater emissions, and gallons of water used for potable water conveyance emissions.

Waste Sector Notes:

Activity	Data Input	Data Entity	Changes to Previous Inventory Calculations
Community Waste to Landfill	27,175 tons	Alameda County Industries, Waste Management	Previous inventories used State tonnage data from CalRecycle and the EPA WARM model to estimate emissions. This model calculates pre- and post-consumer emissions attributed to waste and is not in line with the ICLEI methodology. The current inventory updated values to depict landfill methane emissions using a 60% methane capture rate.
Doolittle Landfill		US EPA LandGem Model	Used US EPA's LandGem model to estimate emissions. The previous inventory methodology was not reported and therefore previous years estimations were updated to reflect LandGem Model estimations
Compost Credit - Informational	12,278 tons	Alameda County Industries, Waste Management, Alameda Integrated Waste Program	Added category as information item only
Recycling Credit - Informational	11,814 tons	Alameda County Industries, Waste Management, Alameda Integrated Waste Program	Added category as information item only
C&D Recycling Credit - Informational	2,422 tons	Alameda County Industries, Waste Management, Alameda Integrated Waste Program	Added category as information item only

Community tonnage to landfill was collected from the waste haulers Alameda County Industries and Waste Management. The most recent waste composition study, from 2008, was tweaked to reflect changes in materials sent to landfill as seen by the 2015 StopWaste Benchmark Study. While not all waste streams were accounted for in these studies, it is used as a rough estimate as it is the best available data post-2008. Updated materials were then used as a proxy to estimate emission factors of each material type based on estimations given by the EPA WARM Model documentation for specifically post-consumer landfill emissions. A 60 percent methane capture rate from the landfill was also used. Emissions from the Doolittle landfill was estimated from the US EPA's LandGem model.

The compost, recycling, and C&D recycling credits are informational items listed to better understand how composting and recycling effect emissions on a larger scale than just the City of Alameda. These acts reduce pre-consumer emissions outside of Alameda city limits and therefore cannot be attributed to city emissions reductions. Regardless, the composting emissions credit calculates emissions reductions from fertilizer displacement and avoided disposal, and the recycling emissions credit calculates emissions reductions from using recycled inputs instead of virgin materials and avoided landfill disposal emissions.

Sequestration Notes:

Activity	Data Input	Data Entity	Changes to Previous Inventory Calculations
Mature Trees in Alameda	9,009 $MTCO_2$ 7.11 $MTNO_2$ Sequestered	City of Alameda Tree Canopy Study	New category
Newly Planted Trees in Alameda	200 Trees	Public Works Dept, City Tree Inventory, EPA Sequestration Data	New category

Sequestration was added as a new category in this inventory. The City of Alameda conducted a Tree Canopy Assessment in 2017 outlining the sequestration benefits of all the trees in Alameda. As the tree canopy continues to grow through City efforts, it will be an important data point to track. According the Public Works department, the City has been actively planting new trees, reporting 200 trees in 2015. Sequestration benefits from these trees were found using the City tree inventory as a proxy for what types of trees were planted and US EPA tree sequestration data to determine total greenhouse gases sequestered.