San Bernardino County

Regional Greenhouse Gas Reduction plan - Appendices

FINAL

Adelanto	Colton	Montclair	San Bernardino
Apple Valley	Fontana	Needles	Twentynine Palms
Barstow	Grand Terrace	Ontario	Upland
Big Bear Lake	Hesperia	Rancho Cucamonga	Victorville
Chino	Highland	Redlands	Yucaipa
Chino Hills	Loma Linda	Rialto	Yucca Valley

Unincorporated San Bernardino County

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SAN BERNARDINO COUNTY REGIONAL GREENHOUSE GAS REDUCTION PLAN

APPENDICES

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Appendix A
San Bernardino County Regional GHG Reduction Plan: 2016 Community GHG Inventories and 2030 and 2045 Forecasts

March 2021

Adelanto	Montclair
Apple Valley	Needles
Barstow	Ontario
Big Bear Lake	Rancho Cucamonga
Chino	Redlands
Chino Hills	Rialto
Colton	San Bernardino
Fontana	San Bernardino County
Grand Terrace	Twentynine Palms
Hesperia	Upland
Highland	Victorville
Loma Linda	Yucaipa
	Yucca Valley

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Section 1: Executive Summary

1.1 GHG Inventory and Forecast Introduction

This appendix summarizes the GHG emissions inventory and forecasted GHG emissions for each of the 25 jurisdictions in the County. The emissions inventory and forecast include GHG emissions from the following sources:

- Building energy use (including the subsectors of residential and non-residential);
- Light/medium-duty vehicles;
- Heavy-duty vehicles;
- Off-road equipment;
- Agriculture;
- Solid waste management;
- Wastewater treatment;
- Water transport, distribution, and treatment; and
- Stationary fuel combustion at industrial sources (i.e., stationary sources).

The total emissions for all 25 jurisdictions combined is referred to as "Regional Community Greenhouse Gas Inventory" or "Regional Emissions" throughout this appendix.

Additionally, this appendix provides background and introductory information related to climate change and climate change policy, a description of the methods used to prepare the inventory, and inventory results for each jurisdiction. Similar to the state-level GHG planning framework, the 2016 GHG inventory provides a baseline from which to forecast future year emissions in 2030 and 2045. The emissions forecast represents a business as usual (BAU) scenario (i.e., the scenario that would occur in the absence of further action taken by local, state, and federal governments or by private parties to mitigate emissions) for each jurisdiction in 2030 and 2045. The 25 jurisdictions participating in this exercise are:

Adelanto	Apple Valley	Barstow
Big Bear Lake	Chino	Chino Hills
Colton	Fontana	Grand Terrace
Hesperia	Highland	Loma Linda
Montclair	Needles	Ontario
Rancho Cucamonga	Redlands	Rialto
San Bernardino	Twentynine Palms	Upland
Victorville	Yucaipa	Yucca Valley
Unincorporated San Bernardino County		

1.2 Regional Emissions—2016, 2030, and 2045

1.2.1 Emissions by Sector

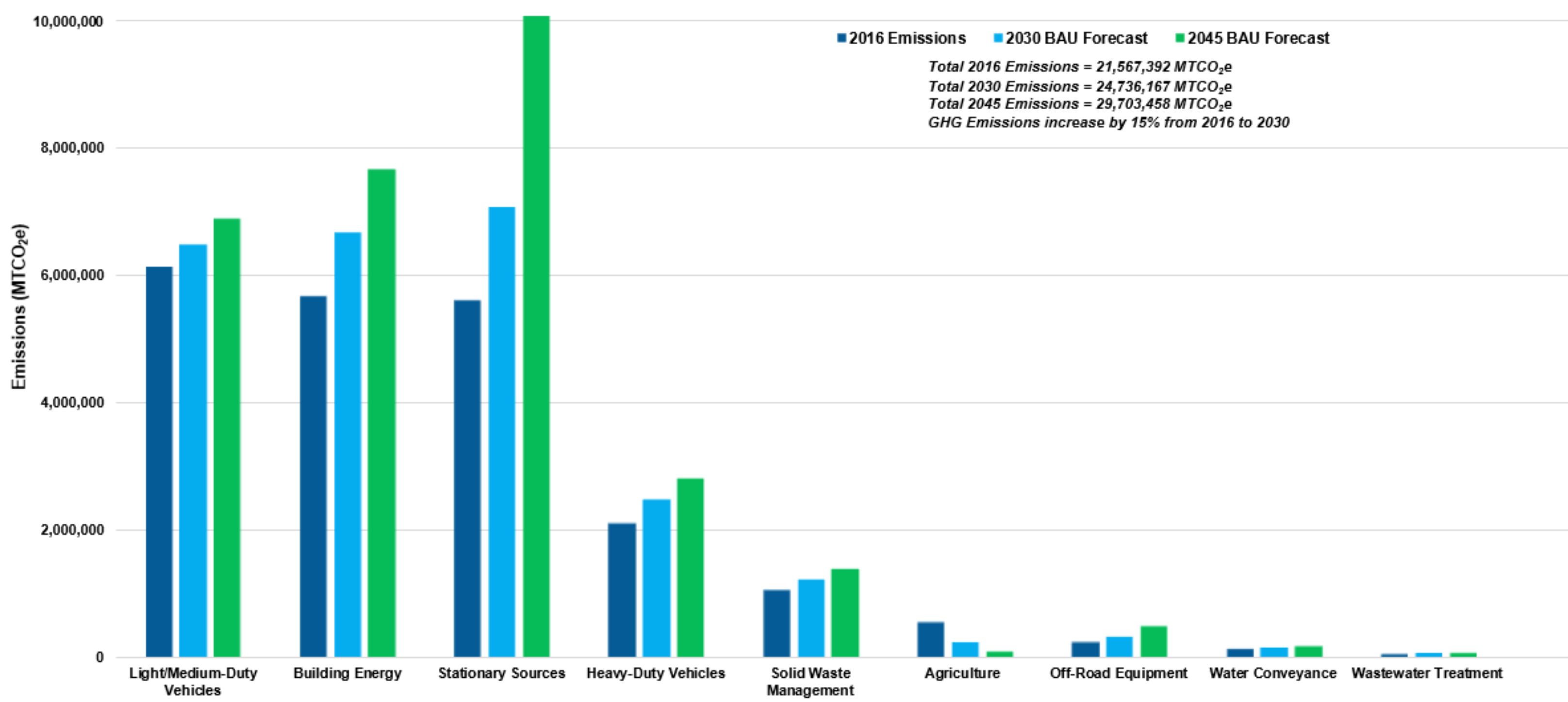
Table 1-1 shows 2016 GHG emissions by sector for the sum of all 25 municipal governments in the County. The emissions by sector are presented visually in Figure 1-1.

Table 1-1. San Bernardino Regional Community Greenhouse Gas Inventory and Forecast by Sector ($MTCO_2e$)

	2016 Inventory		2030 BAU Forecast		2045 BAU Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Building Energy	**5,649,589**	**35%**	**6,647,783**	**38%**	**7,664,821**	**39%**
Residential Natural Gas	1,246,576	8%	1,494,075	8%	1,750,408	9%
Commercial/Industrial Natural Gas	965,955	6%	1,143,111	6%	1,323,963	7%
Residential Electricity	1,230,762	8%	1,420,522	8%	1,615,033	8%
Commercial/Industrial Electricity	2,206,297	14%	2,590,075	15%	2,975,418	15%
On-Road Vehicles	**8,223,640**	**51%**	**8,955,209**	**51%**	**9,695,447**	**49%**
Light/Medium-Duty Vehicles	6,108,245	38%	6,473,242	37%	6,882,208	35%
Heavy-Duty Vehicles	2,115,395	13%	2,481,967	14%	2,813,239	14%
Off-Road Equipment	**247,911**	**2%**	**341,637**	**2%**	**503,215**	**3%**
Agriculture	**559,685**	**4%**	**254,938**	**1%**	**113,656**	**1%**
Solid Waste Management	**1,074,629**	**7%**	**1,234,462**	**7%**	**1,402,324**	**7%**
Wastewater Treatment	**70,039**	**0%**	**78,835**	**0%**	**89,874**	**0%**
Water Transport, Distribution, and Treatment	**146,750**	**1%**	**161,588**	**1%**	**183,023**	**1%**
Total GHG Emissions	**15,972,244**	100%	**17,674,452**	100%	**19,652,359**	100%
Stationary Sources[1]	5,595,148		7,061,714		10,051,098	

$MTCO_2e$ = metric tons of carbon dioxide equivalent.
[1] This sector is included as an informational line item and is not accounted for in the inventory totals. See Section 2 for more information on this sector.

Figure 1-1. San Bernardino County Regional Community Greenhouse Gas Inventory and Forecast (2016, 2030, and 2045)



Total Regional Emissions in 2016 were 21,567,392 metric tons carbon dioxide equivalent ($MTCO_2e$), approximately 5.0% of California's GHG emissions in 2016. For comparison, the County's total population was 5.4% of California's population in 2016. In 2016, the top three sources of emissions in the region were:

- Light/medium-duty vehicles,
- Building energy use,[1] and
- Stationary sources.[2]

Total GHG emissions from light/medium-duty vehicles in the region were 6,108,245 $MTCO_2e$ in 2016. On-road transportation is typically a considerable component of a community's total GHG emissions; ranging from 30% to 60%, depending upon other sources and local conditions. State-wide on-road transportation emissions are approximately 40% of total emissions.

Total GHG emissions in the building energy sector in 2016 were 5,649,589 $MTCO_2e$. Building energy is often one of the largest sources of GHG emissions in community inventories and includes the residential, commercial, and industrial components. Emissions result from the energy consumed to heat, cool, and light buildings as well as natural gas used for cooking. Total GHG emissions from stationary sources in the region were 5,595,148 $MTCO_2e$ in 2016. For some communities, stationary source fossil fuel combustion represents a small component of the GHG footprint but in others they can be substantial, depending on the specific nature and extent of industry in each jurisdiction. These emissions are largely the result of industrial and commercial activity and signify the prominent role of industry in the region.

Additional sources of GHG emissions in the region include heavy-duty vehicles; off-road equipment; agriculture; solid waste management; water transport, distribution, and treatment; and wastewater treatment.

Regional emissions in 2030 are projected to be 24,736,167 $MTCO_2e$, an increase of approximately 15% from 2016 levels. In the absence of mitigation measures, the regional allocation of emissions by sector in 2030 will remain largely unchanged from that in 2016. As such, the largest sources of GHG emissions in 2030 in this constant scenario are projected to be stationary sources, building energy, and light/medium-duty vehicles.

1.2.2 Emissions by Jurisdiction

Table 1-2 shows GHG emissions for each jurisdiction, and the relative contribution of each jurisdiction's emissions to the regional total. The emissions by jurisdiction are presented visually in Figure 1-2.

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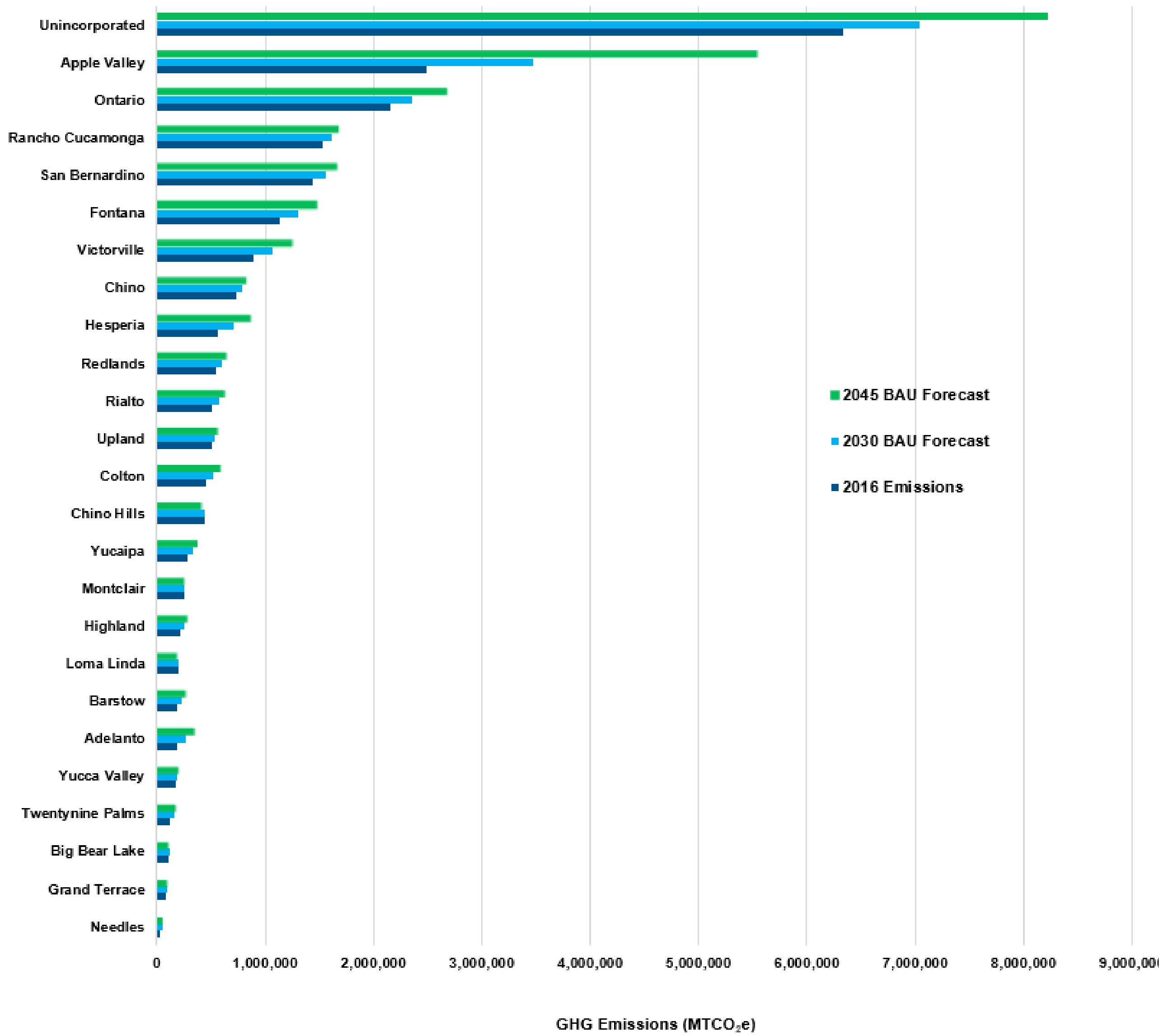
[1] Includes electricity and natural gas use in residential, commercial, and industrial buildings

[2] Stationary sources include burning of fossil fuels on site (other than natural gas). Examples include boilers and industrial equipment.

Table 1-2. San Bernardino Regional Community Greenhouse Gas Inventory and Forecast by Jurisdiction (2016, 2030, and 2045) ($MTCO_2e$)

	2016 Inventory		2030 BAU Forecast		2045 BAU Forecast	
Jurisdiction	Emissions	Percent	Emissions	Percent	Emissions	Percent
Adelanto	191,431	1%	273,216	1%	363,843	1%
Apple Valley	2,482,689	12%	3,478,872	14%	5,547,688	19%
Barstow	192,539	1%	232,535	1%	277,360	1%
Big Bear Lake	105,769	0%	115,809	0%	126,307	0%
Chino	736,215	3%	785,555	3%	843,480	3%
Chino Hills	438,898	2%	434,884	2%	430,952	1%
Colton	448,948	2%	526,453	2%	599,529	2%
Fontana	1,130,927	5%	1,301,505	5%	1,487,115	5%
Grand Terrace	78,066	0%	90,587	0%	104,193	0%
Hesperia	563,369	3%	710,136	3%	874,079	3%
Highland	218,940	1%	251,432	1%	289,831	1%
Loma Linda	203,924	1%	202,951	1%	200,884	1%
Montclair	254,852	1%	260,101	1%	265,964	1%
Needles	31,608	0%	50,014	0%	63,706	0%
Ontario	2,162,916	10%	2,358,335	10%	2,691,714	9%
Rancho Cucamonga	1,526,628	7%	1,605,250	6%	1,695,461	6%
Redlands	546,000	3%	599,876	2%	658,453	2%
Rialto	508,304	2%	575,269	2%	641,653	2%
San Bernardino	1,440,525	7%	1,553,719	6%	1,679,882	6%
Twentynine Palms	125,545	1%	156,802	1%	191,139	1%
Unincorporated County	6,334,474	29%	7,040,202	28%	8,222,303	28%
Upland	501,746	2%	536,496	2%	574,278	2%
Victorville	889,825	4%	1,066,792	4%	1,261,623	4%
Yucaipa	280,522	1%	336,285	1%	393,842	1%
Yucca Valley	172,732	1%	193,090	1%	218,180	1%
Total	**21,567,392**	**100%**	**24,736,167**	**100%**	**29,703,458**	**100%**

Figure 1-2. San Bernardino Regional Greenhouse Gas Emissions by Jurisdiction – 2016, 2030, 2045



The jurisdictions with the highest levels of GHG emissions in 2016 were as follows, in order of emissions magnitude (from largest).

- Unincorporated County
- Apple Valley
- Ontario
- Rancho Cucamonga
- San Bernardino

In general, total GHG emissions are proportional to a jurisdiction's population, housing stock, employment, or a combination of both. Four of these five jurisdictions have the highest populations of the Partnership jurisdictions and the highest number of jobs. However, in the case of Apple Valley, total emissions are heavily influenced by the presence of the CEMEX cement plant, a large stationary source within the jurisdiction's jurisdictional boundaries.

These same five jurisdictions will also have the highest projected levels of emissions in 2030. These jurisdictions are expected to remain the most populous in the region with a high level of employment. The CEMEX cement plant is expected to continue to be operational in 2030 and will continue to greatly influence emissions in Apple Valley.

1.2.3 San Bernardino Regional per Capita Emissions

On a state level, the SB 32 reduction target corresponds to a per capita emissions goal for 2030 of no more than 6 $MTCO_2e$ per capita. The San Bernardino regional 2016 per capita emissions are 9.1 $MTCO_2e$, representing the average of all jurisdictions' per capita emissions. Average per capita emissions in California in 2016 are 10.9 $MTCO_2e$ and U.S. average per capita emissions are 20.2 $MTCO_2e$ (California Air Resources Board 2020b; U.S. Environmental Protection Agency 2019f; U.S. Census Bureau 2020).

Excluding cement manufacturing emissions (all located in Apple Valley at the CEMEX plant), the 25-jurisdiction regional average would be 8.0 $MTCO_2e$.

Per capita emissions vary depending on the methods used to estimate emissions for each individual source and the types of emissions sources included in each inventory, as well as climate zones, spatial layouts of jurisdictions, industries, and major power sources (i.e., coal, nuclear, natural gas, or hydroelectric). While the methods used for this inventory is consistent for all jurisdictions included, per capita emissions for other jurisdictions and jurisdictions not included in this study could be based on different methodologies, producing some uncertainty in comparisons made.

Figure 1-3 presents average 2016 per capita emissions grouped by the jurisdictions located in the mountain, valley, desert, and unincorporated areas of the County.[3]

Figure 1-4 shows total per capita emissions by jurisdiction for all jurisdictions in the region. The jurisdictions are color-coded to indicate the region (mountain, valley, desert, or unincorporated

[3] These general geographic areas are not formal regional planning areas, but they do correspond to the unincorporated County General Plan planning areas.

county) in which each is located. Average per capita emissions (without cement emissions) are shown as the horizontal red line. In general, valley jurisdictions have the lowest per capita emissions, desert jurisdictions have higher per capita emissions, and the mountain jurisdiction, Big Bear Lake, has the highest per capita emissions, likely due to the influx of tourists to the resorts. The Unincorporated County has the second highest per capita emissions.

Figure 1-5 shows per capita emissions by jurisdiction for building energy emissions. Per capita emissions for this sector (including residential, commercial, and industrial electricity and natural gas usage) are presented because they represent the largest sector of the inventory.

Figure 1-3. Per Capita Greenhouse Gas Emissions for Partnership Jurisdictions

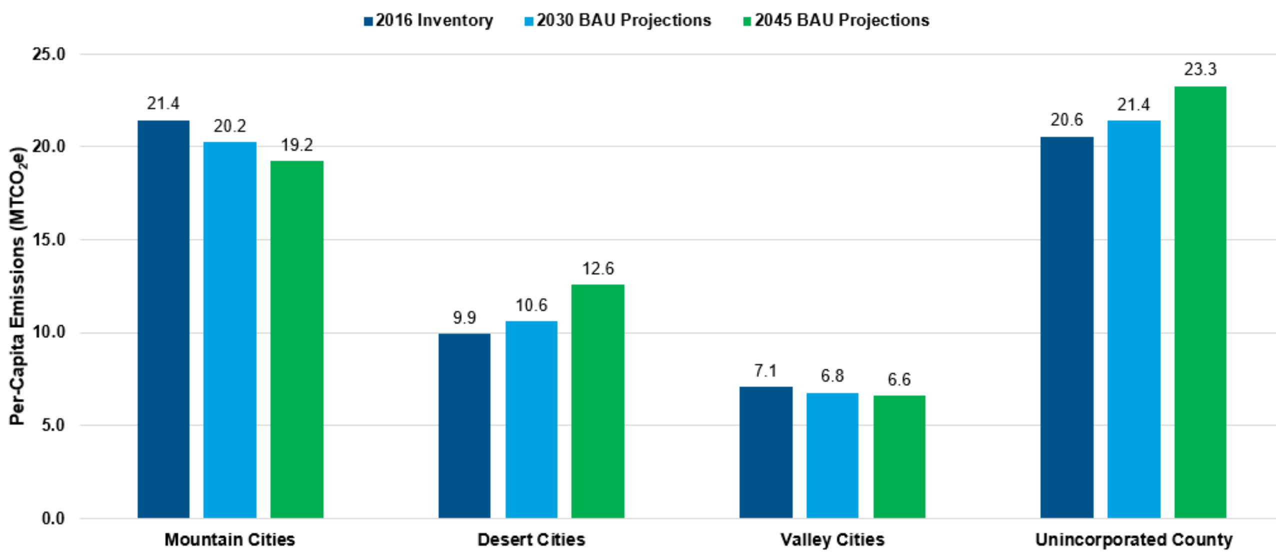


Figure 1-4. 2016 Per Capita GHG Emissions by Jurisdiction and Region

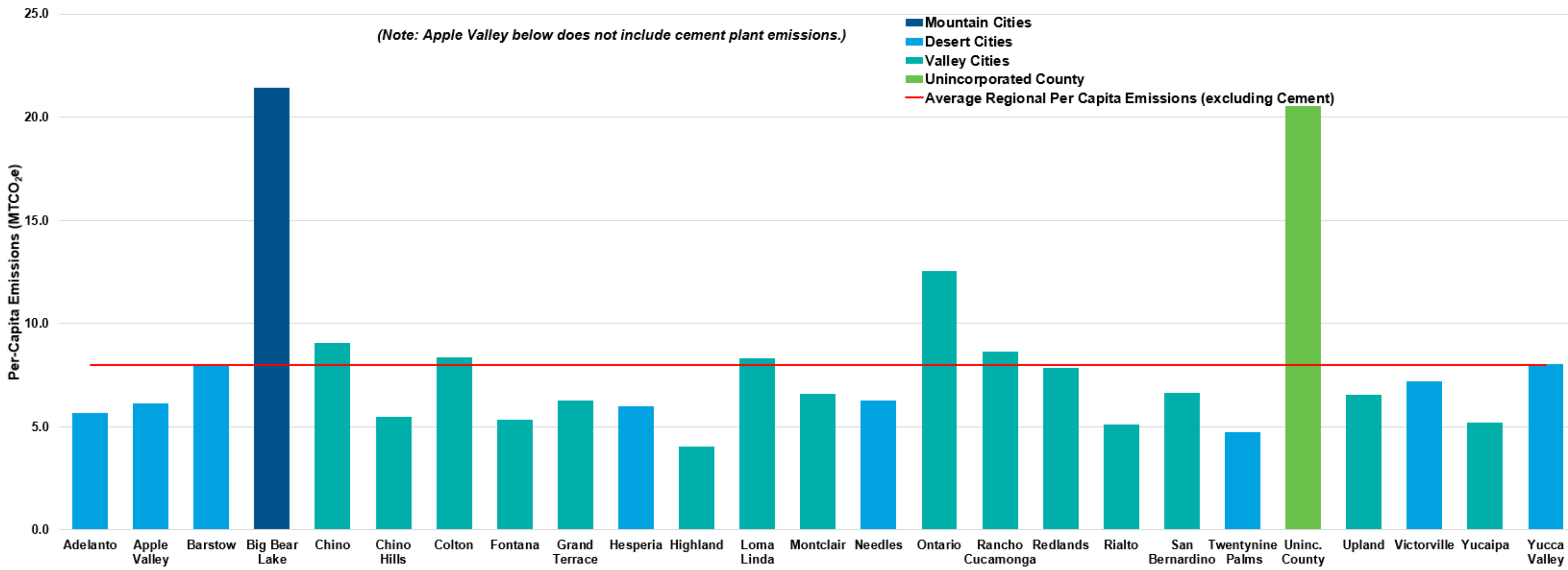
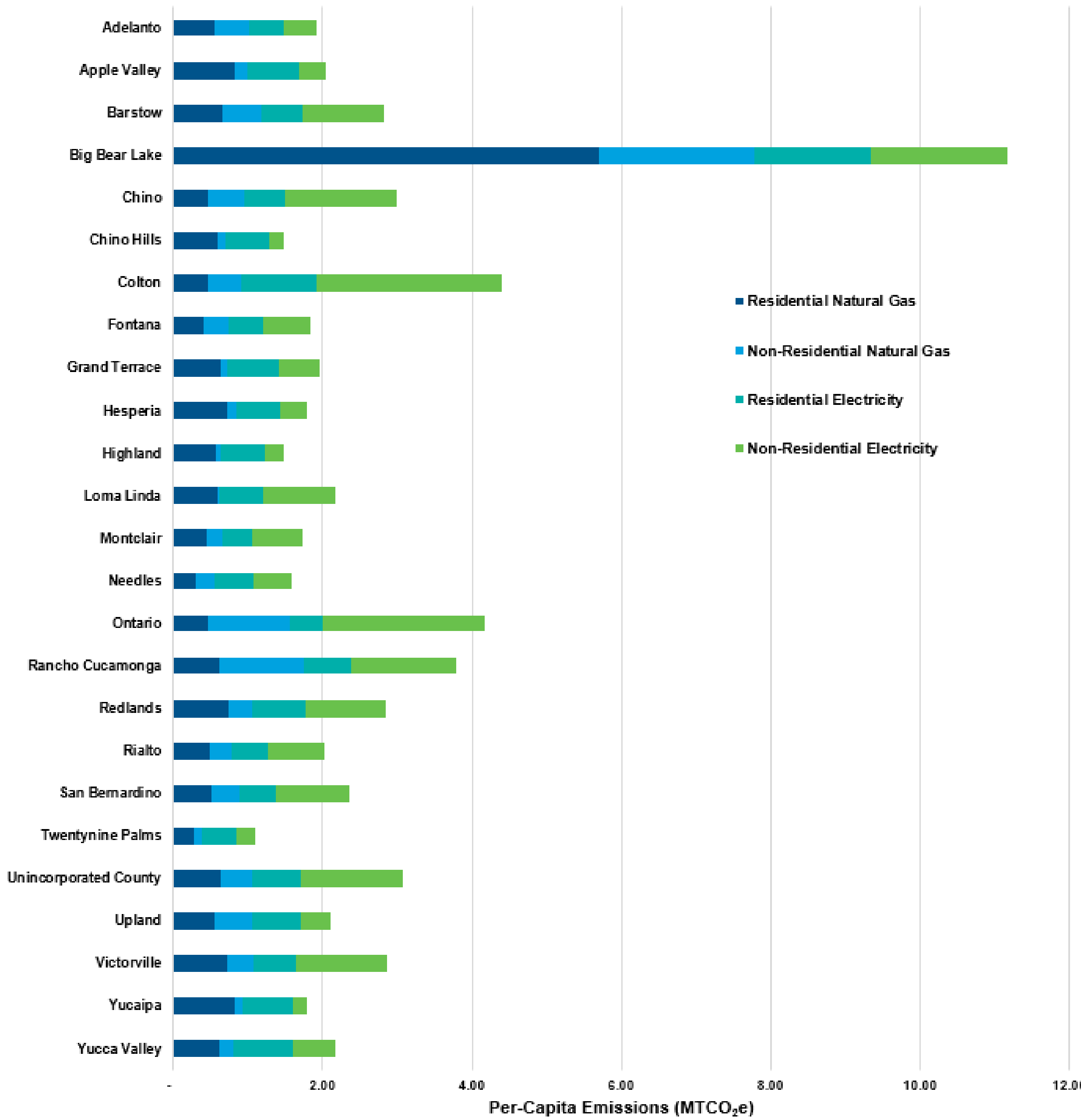


Figure 1-5. 2016 Per Capita Building Energy Emissions by Jurisdiction



As demonstrated by these graphs, there is a large variation in per capita emissions across jurisdictions and sectors. Building energy use varies greatly due to climate, population density, the mix of residential versus commercial/industrial land uses, and other factors. Higher density areas are more likely to have lower energy usage per resident, as homes are generally smaller than lower density areas and require less energy for air conditioning, lighting, appliances, etc. Some jurisdictions have more commercial and industrial activity than others and, therefore, consume different amounts of energy. Some jurisdictions, such as Big Bear lake, have a higher number of visitors than other jurisdictions. The jurisdiction's local climate also plays a role; for example, desert jurisdictions are more likely have higher air conditioning energy demands than valley jurisdictions. Also, energy providers vary by region and each provider has a different GHG energy emissions factor.

1.3 Next Steps

1.3.1 Climate Action Plans and Reduction Targets

This report serves as the foundation for the CAP component of the project in which reduction opportunities will be evaluated with the goal of achieving a reduction in projected 2030 emissions.

1.3.2 GHG Monitoring

This report identifies the major sources of emissions for all jurisdictions in the Partnership. In addition, this report describes the data used to estimate GHG emissions in 2016, 2030 and 2045. GHG emissions monitoring is recommended as a future action for all jurisdictions so that each one can track its progress in reducing emissions, identify potential issues, target funding needs, inform future updates to both the GHG Inventory and CAP, and fully integrate GHG planning into the community's general planning process. Jurisdictions are encouraged to begin monitoring and maintaining data as soon as possible for metrics related to GHG emissions such as public utility data, traffic data, water consumption, and waste generation. Numerous protocols and tools are available for these purposes, such as the ICLEI U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, the LGOP for municipal inventories, California Community-Wide Greenhouse Gas Baseline Inventory Protocol White Paper by the Association of Environmental Professionals, and the Statewide Energy Efficiency Collaborative (SEEC) Community Inventory Tool.

This inventory identifies significant GHG emissions from regional activities in the region and serves as a baseline for emissions reduction measures and as a starting point for future GHG emissions inventories. Future updates to the GHG emissions inventories presented in this report should be conducted periodically to ensure that the inventory remains accurate and that data gaps are resolved in a timely manner. This also would enable efficient tracking of the effectiveness of GHG-reduction measures put in place to address these emission sources.

Appendix A: Section 2: Background Information

2.1 GHG Inventories

Over the last several decades, private and public entities including states, nations, cities, corporations, and universities, have sought to understand their GHG emissions and to identify ways to decrease their carbon footprint. The first step in this process is the completion of a GHG inventory, which is an audit of all sources of GHG emissions related to activity associated with a specific entity and a quantitative analysis of their magnitude. Standard protocols and procedures exist for conducting a GHG inventory—these are described in Section 5, of Appendix A. Since 2006 when AB 32 was signed into law, many local governments in California have completed a community GHG inventory. Because AB 32 established 2020 as the target year by which California should reduce its emissions to 1990 levels, many communities in California previously prepared GHG forecasts for 2020 in addition to their base year inventory. With the passage of SB 32 in 2016, which codified the State's 2030 reduction goal of 40% below 1990 levels, California jurisdictions are now looking at 2030 consistent with the State's next milestone year. In 2018, Executive Order B-55-18 calls for the state to achieve carbon neutrality no later than 2045.

SBCOG and the jurisdictions, with the assistance of ICF and LSA, developed 2016 community GHG inventories and forecasted 2030 and 2045 GHG emissions for each jurisdiction. The boundaries of the inventory are defined as activities associated with specific jurisdictions. Emissions for a particular source were included in a jurisdiction's inventory if either the source of emissions occurs within the geographic boundaries of the jurisdiction, the emissions are associated with land use in the geographic boundary (such as a portion of vehicle emissions that begin or end within the jurisdiction) or if the activity indirectly associated with a source of emissions occurs within the geographic boundaries of the jurisdiction (such as electricity consumption or waste generation).

The 2016 inventories are based mostly on actual 2016 activity data, emission factors from 2016, and socioeconomic data (i.e., population, household, and employment) for the region. The inventories include all significant contributing sectors to GHG emissions, based on the guidelines of the ICLEI U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (ICLEI–Local Governments for Sustainability USA, 2012). This inventory was developed with sufficient detail to support the identification of GHG-reduction measures specific to the each jurisdiction's community emissions.

The 2030 and 2045 emissions projections represent the BAU forecast based on anticipated growth in each jurisdiction and each sector of the inventory. The BAU projections are based on 2016 activity data and anticipated growth rates provided by the jurisdictions, SBCOG, CARB, and other appropriate data sources, as listed in this report. The BAU projections do not assume the implementation of any federal, state, or local reduction measures, but are projections of the future emissions based on current energy and carbon intensity in the existing economy.

2.2 San Bernardino County

GHG emissions are correlated with the daily activities that occur due to land use within the jurisdictional boundary of a community. These activities include vehicle travel, energy and water use, and waste disposal. As such, the quantities and sources of emissions reflect the unique geography, climate, demographics, economy, and character of a community. Future projections of GHG emissions reflect how communities are projected to grow with respect to population, housing, jobs, and infrastructure.

San Bernardino County covers more than 20,000 square miles, is the largest County by area in the United States, and has diverse natural landscapes such as mountains, valleys, forests, and waterways. The County is home to 25 municipal jurisdictions, including 22 incorporated cities, 2 incorporated towns, and the unincorporated County. Currently and in the inventory year of 2016, San Bernardino County is the fifth most populous county in California (California Department of Finance, 2020). For 2016, SBCOG estimated the population of San Bernardino County to be 2,134,967. In that same year, the County also had nearly 800,000 jobs (SBCOG, 2019). Table 2-1 shows the population and employment data for each jurisdiction in the County, in addition to the household data for each jurisdiction.

The County boasts a diverse economy, with economic output and employment distributed among multiple sectors. As of 2018, the largest labor market in San Bernardino County is the combined sector of trade, transportation, and utilities (28% of the total employed labor force), government (17%), educational and health services (16%), professional and business services (10%) and leisure and hospitality (10%). All other industries, such as farm, mining/logging, construction, manufacturing, information services, financial activities, and other services, accounted for less than 20% of the total labor force.

Since 1990, the County’s fastest growing sectors have been education and health services (178% increase); trade, transportation, and utilities (136% increase); and professional and business services (129% increase) (California Employment Development Department, 2019).

The County is home to 12 universities and colleges, a number of museums, and two mountain resorts. About 90% of the County is desert, and the remainder consists of the San Bernardino Valley and the San Bernardino Mountains. The San Bernardino Valley climate is temperate with about 15 inches of rain annually and average temperatures ranging from 39 to 66°F in January and from 59°F to 96°F in July (Western Regional Climate Center, n.d.).

Figure 2-1 shows a map of the County and its jurisdictions. As noted above, Table 2-1 shows current and projected population, households, and jobs for each jurisdiction.

Figure 2-1. San Bernardino County Map

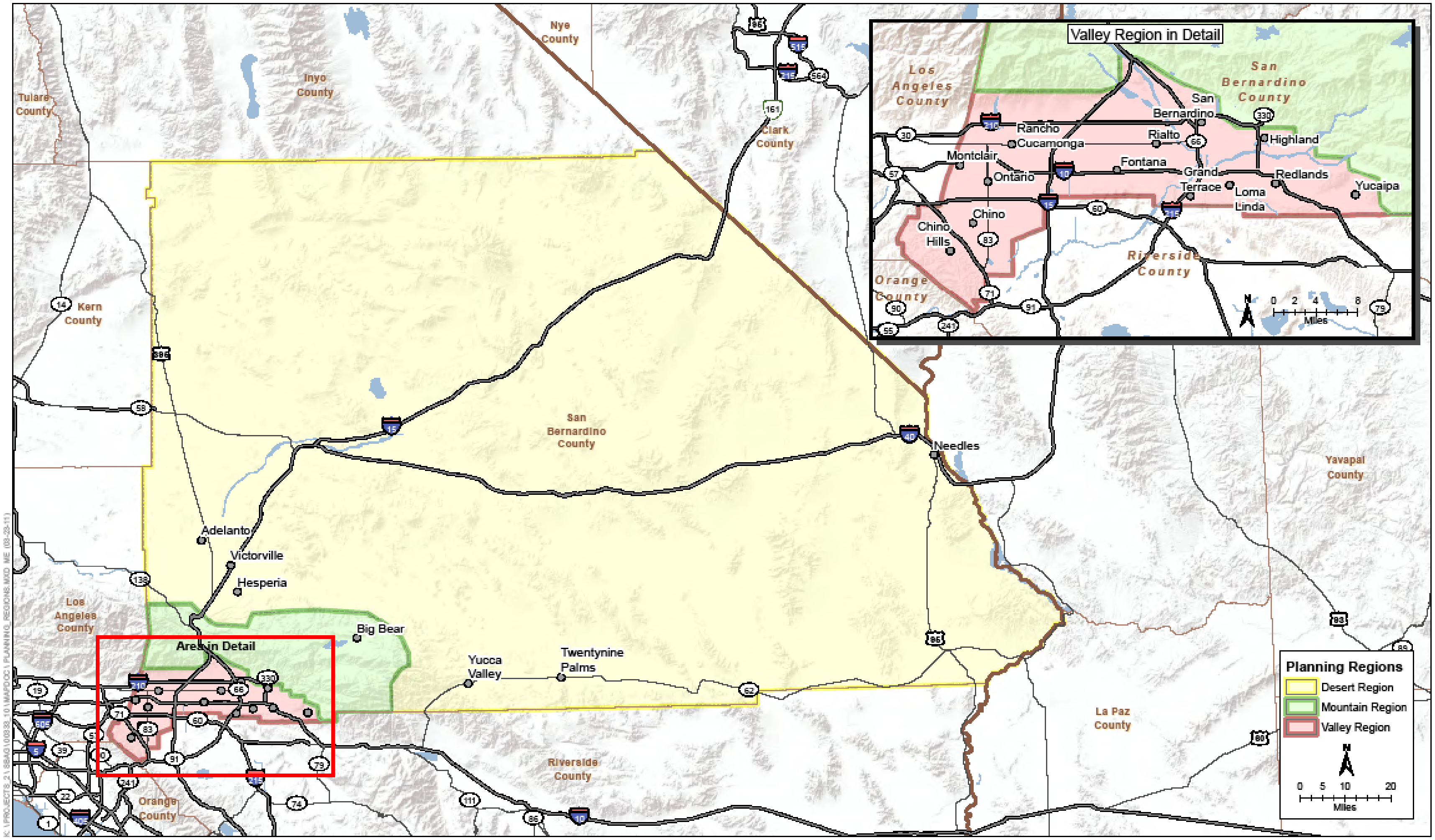


Table 2-1. Regional Population, Housing, and Employment Estimates and Forecasts by Jurisdiction

	Population			Households[a]			Employment		
Jurisdiction	2016	2030	2045	2016	2030	2045	2016	2030	2045
Adelanto	33,893	50,081	66,637	8,159	13,686	19,802	6,141	8,005	10,007
Apple Valley	74,313	89,425	101,405	24,734	31,547	37,386	18,012	23,871	30,160
Barstow	24,187	28,228	32,695	8,417	10,556	12,849	11,704	14,993	18,516
Big Bear Lake	4,932	5,722	6,569	2,095	2,442	2,813	4,683	5,207	5,768
Chino	81,294	97,940	115,773	23,227	27,983	33,078	50,408	53,796	57,425
Chino Hills	79,737	85,623	92,822	23,838	25,868	28,043	16,424	17,156	17,940
Colton	53,705	64,184	70,710	15,026	19,002	21,668	19,453	24,042	28,958
Fontana	210,983	247,196	286,666	51,518	64,192	77,772	56,724	65,619	75,149
Grand Terrace	12,400	13,359	14,501	4,421	4,975	5,569	3,481	4,738	6,085
Hesperia	93,687	129,410	168,067	26,764	39,503	53,153	22,460	33,861	46,077
Highland	54,201	60,631	68,942	15,391	17,956	21,410	6,938	8,952	11,116
Loma Linda	24,474	27,093	30,112	9,033	10,458	11,985	24,184	26,152	28,260
Montclair	38,701	42,971	49,150	9,866	10,492	11,162	19,309	20,259	20,892
Needles	5,031	7,636	10,281	1,941	3,070	4,280	1,731	1,928	2,140
Ontario	172,249	221,806	269,050	46,001	60,602	74,521	113,859	143,699	169,331
Rancho Cucamonga	176,503	186,120	201,255	56,764	61,426	66,421	88,314	96,434	105,135
Redlands	69,531	74,690	80,832	24,421	27,516	30,832	42,569	49,220	56,347
Rialto	99,318	119,193	139,068	26,485	31,785	37,085	25,472	30,837	35,524
San Bernardino	216,326	220,565	230,532	59,709	64,084	68,771	101,330	113,030	125,566
Twentynine Palms	26,487	29,768	33,266	8,367	10,031	11,814	4,427	6,440	8,596
Unincorporated County	76,403	84,208	92,963	26,088	29,336	32,817	35,893	38,960	42,247
Upland	123,309	158,601	194,522	33,932	47,392	61,813	41,180	50,848	61,207
Victorville	53,779	66,706	75,209	19,987	23,716	27,349	10,824	13,500	17,624
Yucaipa	21,445	23,447	25,810	8,358	9,566	10,861	6,937	8,857	10,914
Yucca Valley	308,079	328,897	353,053	97,066	105,700	114,950	58,795	65,587	72,864
Total	**2,134,967**	**2,463,500**	**2,809,889**	**631,608**	**752,884**	**878,202**	**791,252**	**925,991**	**1,063,848**

Source: San Bernardino Council of Governments, 2019.

Appendix A
Section 3: Inventory Results by Jurisdiction

The following section presents emissions summaries for each jurisdiction. Each jurisdiction summary includes:

- A brief description of the major emissions sources and the projected growth in emissions from 2016 to 2030 and 2045,
- A table showing 2016 emissions and 2030 and 2045 BAU forecast emissions by scope and sector,
- A pie chart showing the 2016 inventory by scope and sector, and
- A bar chart with 2016 emissions and 2030 and 2045 BAU forecast emissions by sector from highest to lowest emissions.

Additional information for each inventory sector is discussed in Section 4, Inventory Results by Sector.

Percentages for each major sector of emissions presented for each jurisdiction are based on the current jurisdiction inventories. "Average" per capita emissions are defined as the total Regional Emissions in each sector per resident within the region (i.e., total emissions/total population for all 25 jurisdictions) excluding emissions from the CEMEX plant in Apple Valley, as shown in Figure 1-4. For comparison purposes, CEMEX emissions were excluded from the per-capita numbers but were included in the total emissions inventory for Apple Valley and the Region.

3.1 Adelanto

Primary sources of GHG emissions in Adelanto are on-road transportation (55%), building energy (34%), and waste (6%). Emissions are projected to increase by 43% from 2016 to 2030 and by 90% from 2016 to 2045 due to economic and population growth. In 2016, Adelanto had per capita emissions of 5.6 MT CO2e, which are lower than the region's average per capita emissions of 7.5 MT CO2e.

Table 3-1. Adelanto 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts (MTCO$_2$e)

	2016 Inventory		2030 Forecast		2045 Emissions	
Sector	**Emissions**	**Percent**	**Emissions**	**Percent**	**Emissions**	**Percent**
Residential Natural Gas	18,728	10%	31,415	11%	45,453	12%
Non-Residential Natural Gas	15,334	8%	22,039	8%	29,362	8%
Light-Medium Duty Vehicles	67,323	35%	96,003	35%	126,582	35%
Heavy-Duty Vehicles	37,252	19%	52,544	19%	69,453	19%
Off-Road Equipment	3,622	2%	6,356	2%	10,785	3%
Agriculture	5,501	3%	3,097	1%	1,674	<1%
Residential Electricity	16,102	8%	23,793	9%	31,659	9%
Non-Residential Electricity	14,669	8%	18,947	7%	23,568	6%
Solid Waste Management	11,187	6%	16,531	6%	21,995	6%
Wastewater Treatment	1,062	1%	1,569	1%	2,088	1%
Water Transport, Distribution, and Treatment	650	<1%	921	<1%	1,226	<1%
Total Emissions	**191,431**	**100%**	**273,216**	**100%**	**363,843**	**100%**

Figure 3-1a. Adelanto GHG Emissions by Sector for 2016

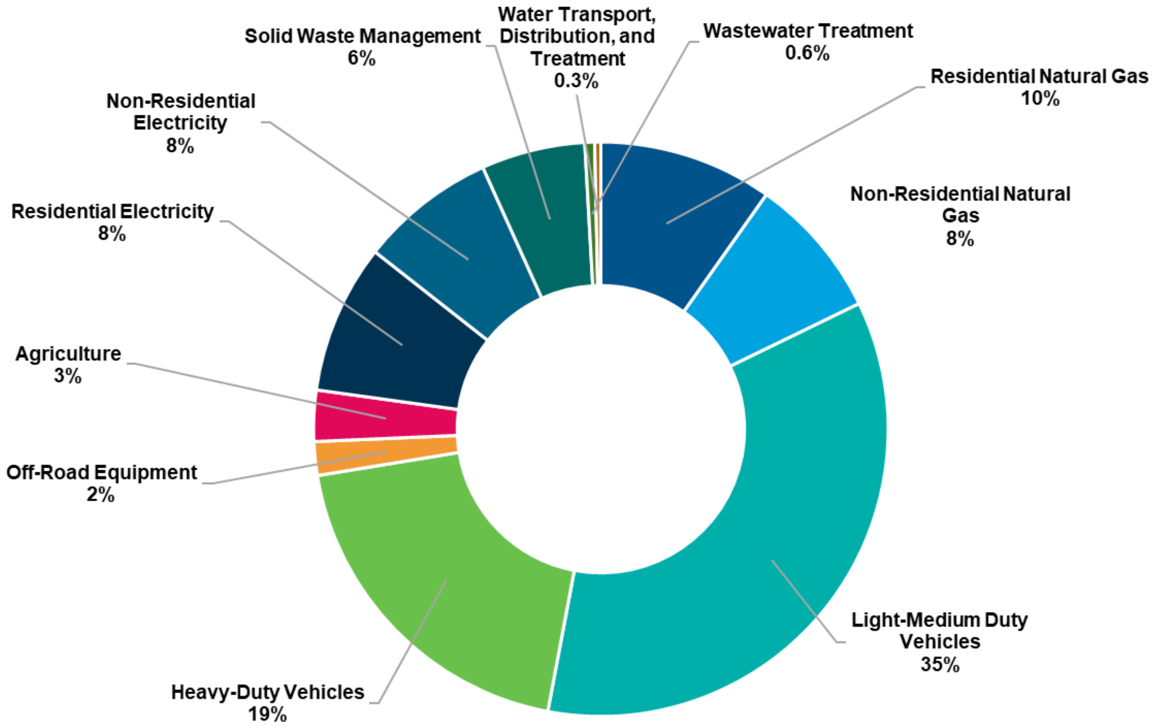
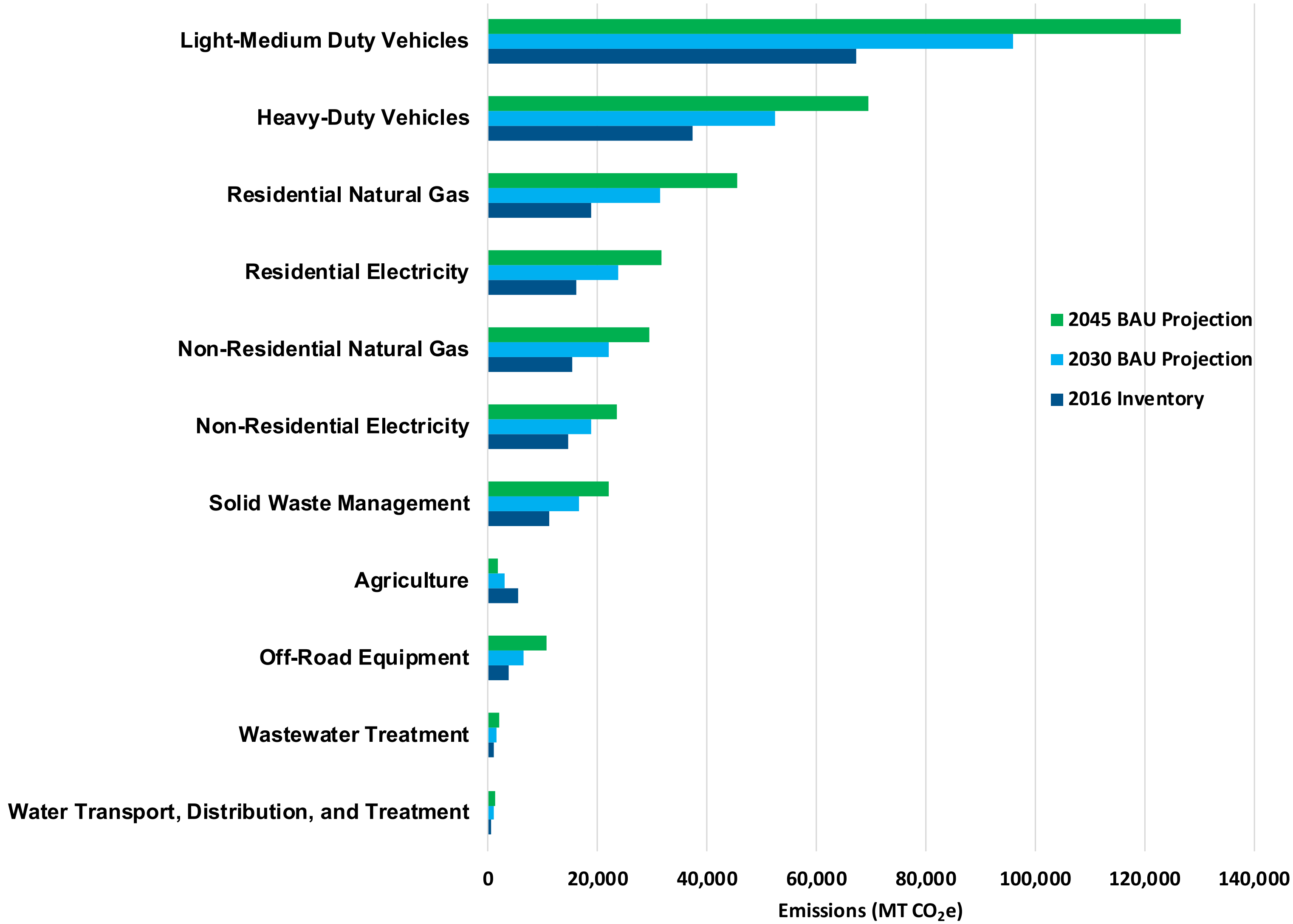


Figure 3-1b. Adelanto GHG Emissions by Sector for 2016, 2030, and 2045



3.2 Apple Valley

Primary sources of GHG emissions in Apple Valley are stationary sources (82%) due to the CEMEX cement plant, on-road transportation (10%), and building energy (6%). Emissions are projected to increase by 40% from 2016 to 2030 and by 123% from 2016 to 2045 due to economic and population growth. Including emissions from the CEMEX plant, in 2026, Apple Valley had the highest per capita emissions among the jurisdictions in this study, 33.4 $MTCO_2e$, because the cement plant is the single largest emissions source in the entire inventory area (compared to the regional average of 10.1 $MTCO_2e$ with cement). Excluding emissions from the CEMEX plant, Apple Valley would have an average per capita emissions of 6.1 MT CO_2e per person, which is lower than the region's average per capita emissions without cement of 7.5 MT CO_2e.

Table 3-2. Apple Valley 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	60,544	2%	77,221	2%	91,514	2%
Non-Residential Natural Gas	13,175	1%	16,806	<1	19,920	<1%
Stationary Sources	2,026,887	82%	2,934,656	84%	4,913,904	89%
Light-Medium Duty Vehicles	164,345	7%	190,567	5%	218,326	4%
Heavy-Duty Vehicles	90,936	4%	104,300	3%	119,791	2%
Off-Road Equipment	8,092	<1%	11,792	<1%	17,500	<1%
Agriculture	4,793	<1%	2,698	<1%	1,458	<1%
Residential Electricity	51,684	2%	62,195	2%	70,527	1%
Non-Residential Electricity	26,892	1%	36,353	1%	46,800	1%
Solid Waste Management	28,032	1%	33,732	1%	38,251	1%
Wastewater Treatment	2,328	<1%	2,801	<1%	3,177	<1%
Water Transport, Distribution, and Treatment	4,981	<1%	5,751	<1%	6,521	<1%
Total Emissions	**2,482,689**	**100%**	**3,478,872**	**100%**	**5,547,688**	**100%**

Figure 3-2a. Apple Valley GHG Emissions by Sector for 2016 with Cement Plant Emissions

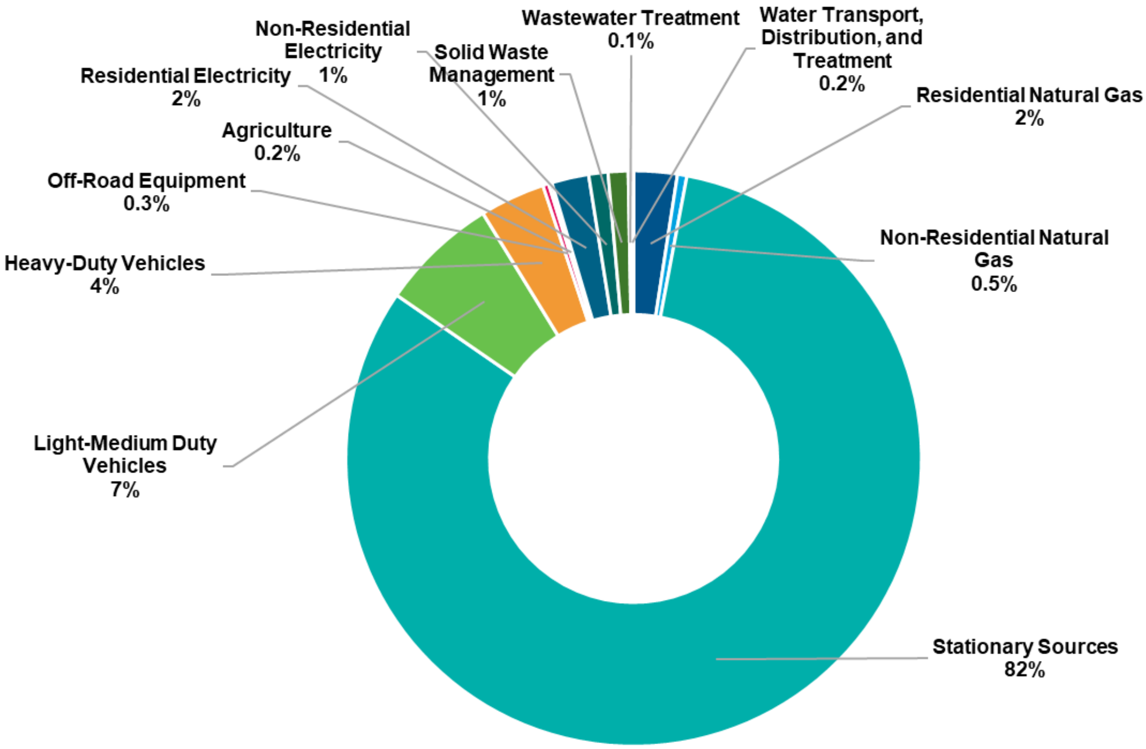


Figure 3-2b. Apple Valley GHG Emissions by Sector for 2016, 2030, and 2045 with Cement Plant Emissions

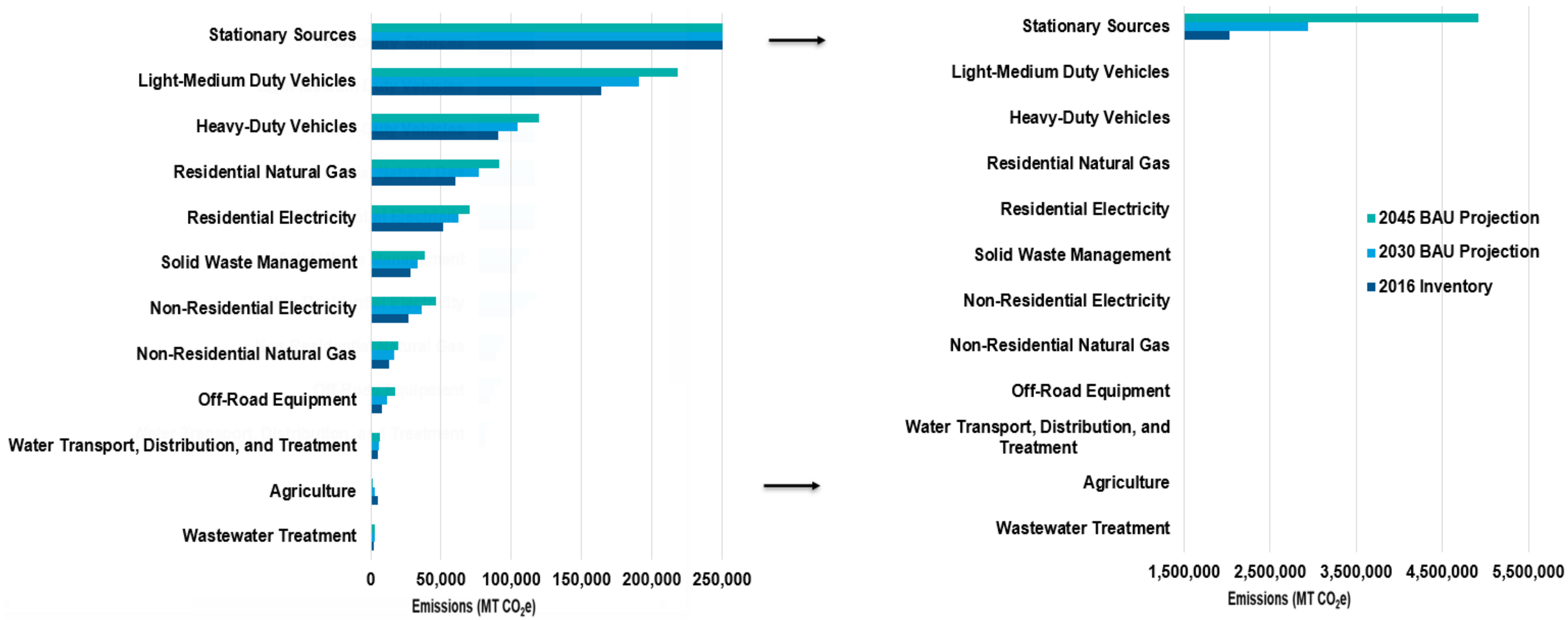


Figure 3-2c. Apple Valley GHG Emissions by Sector for 2016 without Cement Plant Emissions

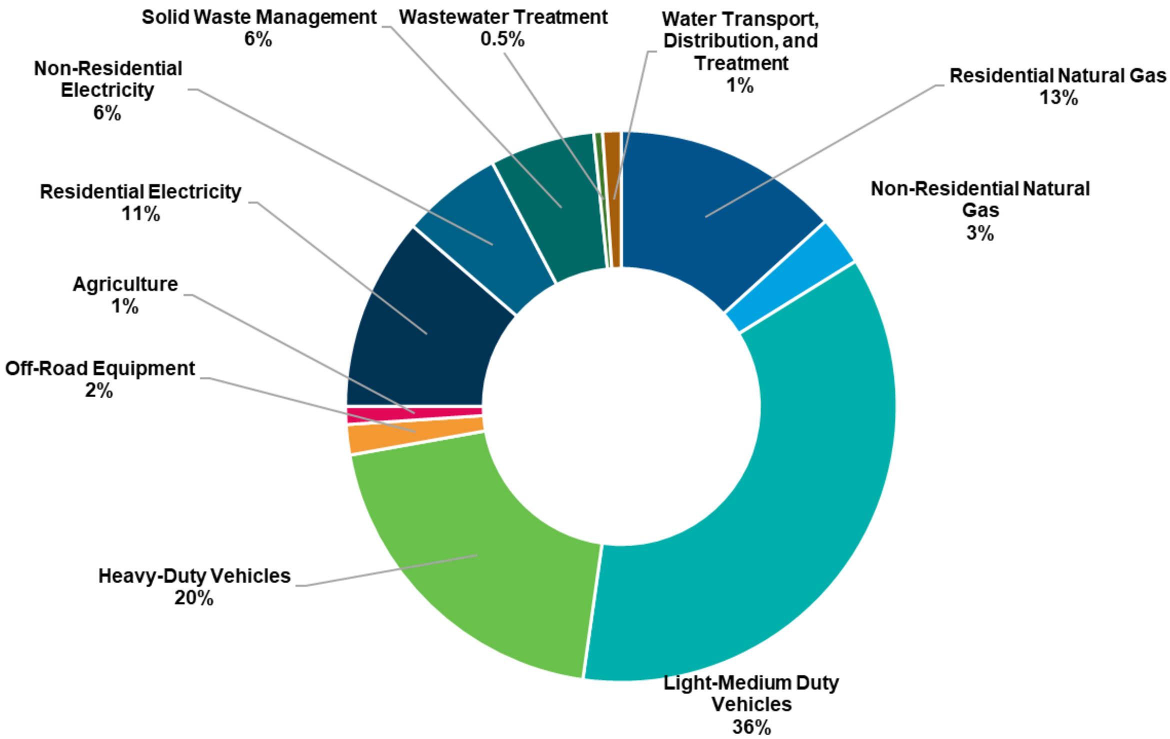
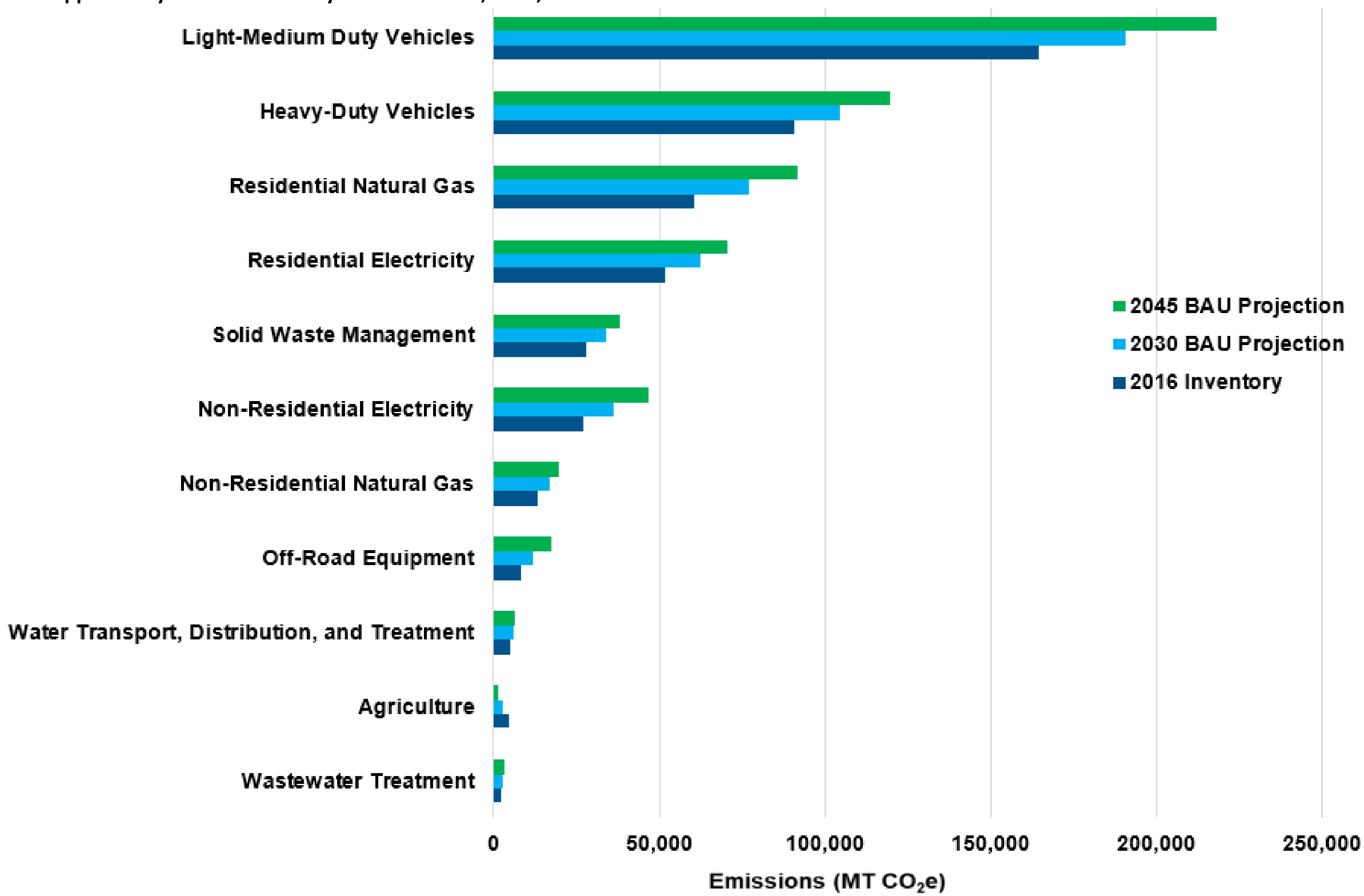


Figure 3-2d. Apple Valley GHG Emissions by Sector for 2016, 2030, and 2045 without Cement Plant Emissions



3.3 Barstow

Primary sources of GHG emissions in Barstow are on-road transportation (54%), building energy (35%), and waste (7%). Emissions are projected to increase by 21% from 2016 to 2030 and by 44% from 2016 to 2045 due to economic and population growth. In 2016, Barstow had per capita emissions of 8.0 $MTCO_2e$, which is higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-3. Barstow 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	15,897	8%	19,938	9%	24,267	9%
Non-Residential Natural Gas	12,745	7%	15,985	7%	19,456	7%
Light-Medium Duty Vehicles	67,545	35%	81,231	35%	95,754	35%
Heavy-Duty Vehicles	37,374	19%	44,459	19%	52,538	19%
Off-Road Equipment	2,814	1%	4,034	2%	6,222	2%
Agriculture	2,826	1%	1,591	1%	860	1%
Residential Electricity	13,336	7%	15,564	7%	18,027	7%
Non-Residential Electricity	26,330	14%	33,809	15%	41,819	15%
Solid Waste Management	12,567	7%	14,667	6%	16,961	6%
Wastewater Treatment	465	<1%	543	<1%	629	<1%
Water Transport, Distribution, and Treatment	638	<1%	715	<1%	828	<1%
Total Emissions	**192,539**	**100%**	**232,535**	**100%**	**277,360**	**100%**

Figure 3-3a. Barstow GHG Emissions by Sector for 2016

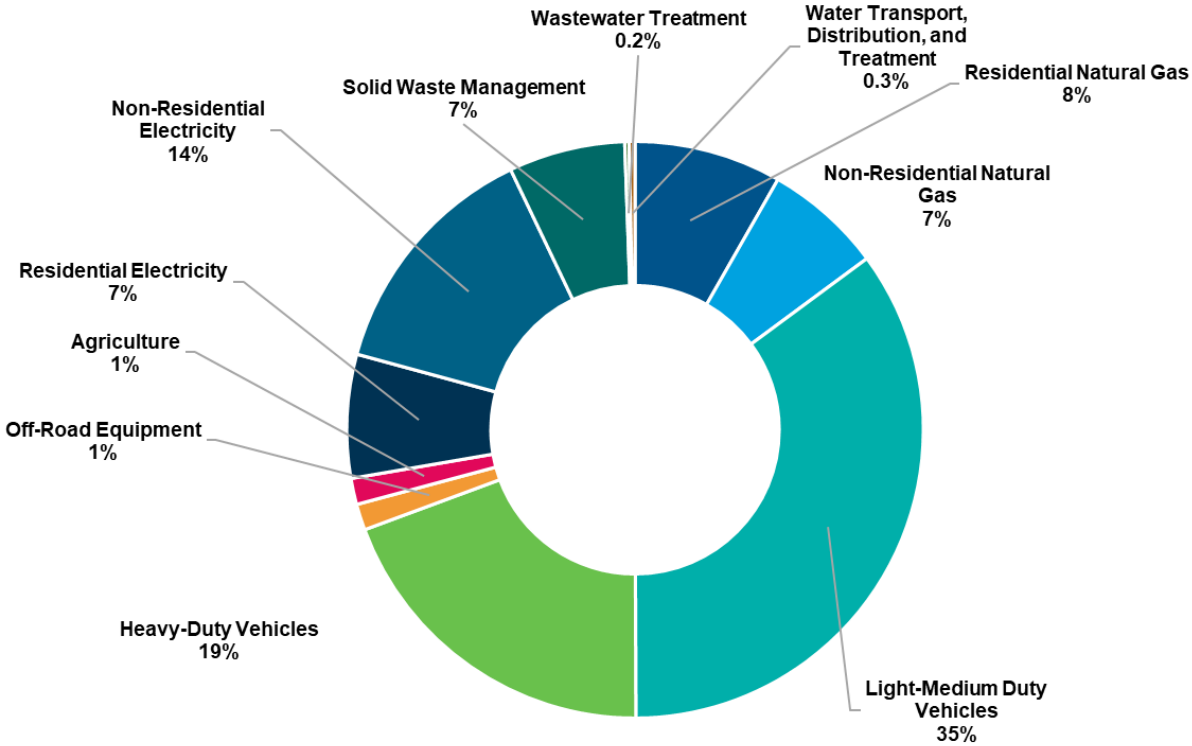
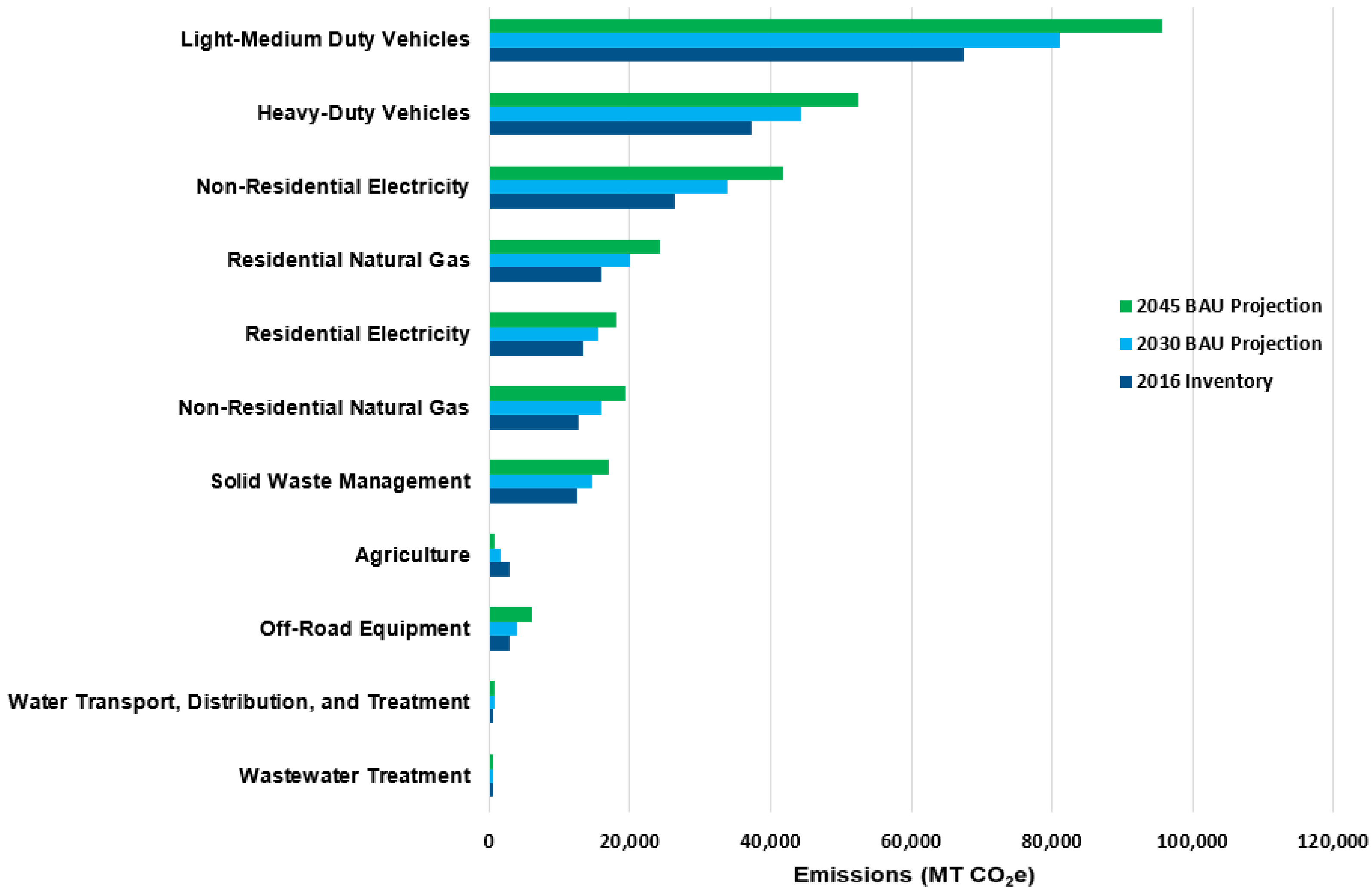


Figure 3-3b. Barstow GHG Emissions by Sector for 2016, 2030, and 2045



3.4 Big Bear Lake

Primary sources of GHG emissions in Big Bear Lake are building energy (52%), on-road transportation (39%), and waste (8%). Emissions are projected to increase by 9% from 2016 to 2030 and by 19% from 2016 to 2045 due to economic and population growth. In 2016, Big Bear Lake had per capita emissions of 21.4 $MTCO_2e$, which is higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-4. Big Bear Lake 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	28,151	27%	32,814	28%	37,800	30%
Non-Residential Natural Gas	10,263	10%	11,956	10%	13,765	11%
Light-Medium Duty Vehicles	31,974	30%	30,687	26%	29,490	23%
Heavy-Duty Vehicles	9,068	9%	10,099	9%	10,579	8%
Off-Road Equipment	631	1%	897	1%	1,375	1%
Agriculture	-	0%	-	0%	-	<1%
Residential Electricity	7,672	7%	8,901	8%	10,219	8%
Non-Residential Electricity	8,976	8%	9,978	9%	11,051	9%
Solid Waste Management	8,889	8%	10,313	9%	11,840	9%
Wastewater Treatment	79	<1%	92	<1%	106	<1%
Water Transport, Distribution, and Treatment	64	<1%	71	<1%	82	<1%
Total Emissions	**105,769**	**100%**	**115,809**	**100%**	**126,307**	**100%**

Figure 3-4a. Big Bear Lake GHG Emissions by Sector for 2016

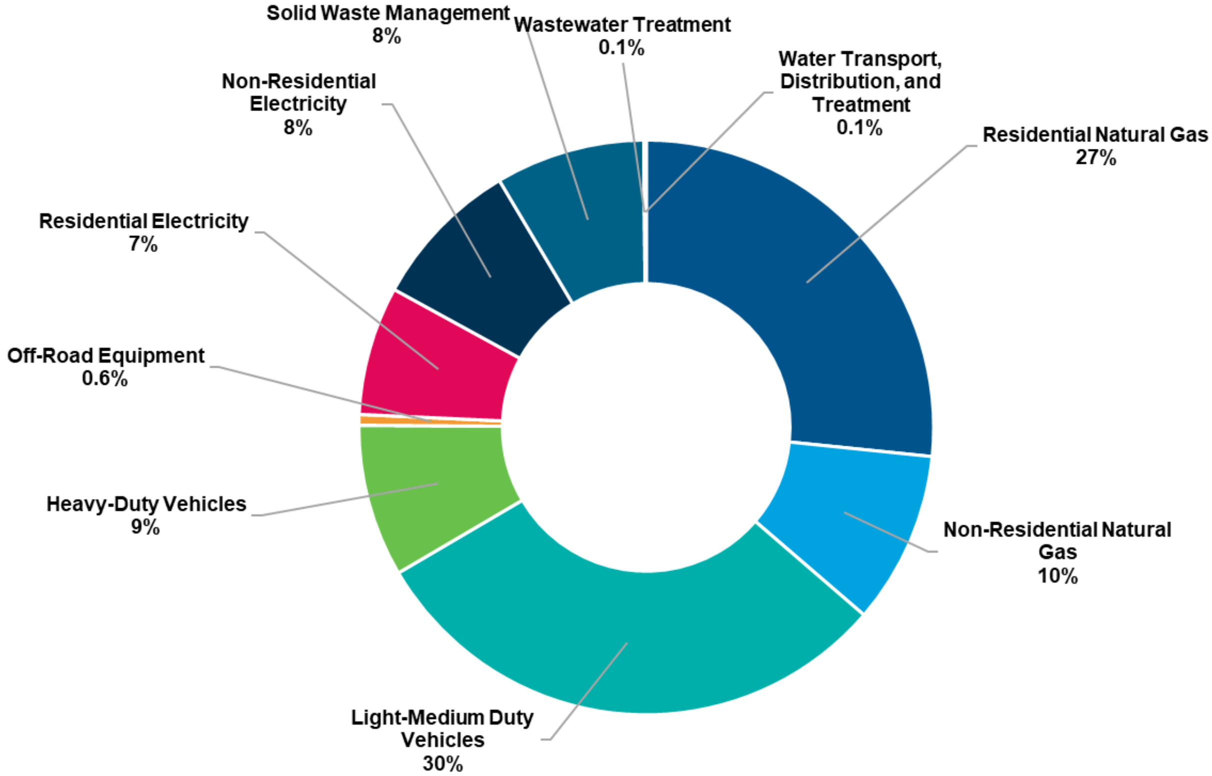
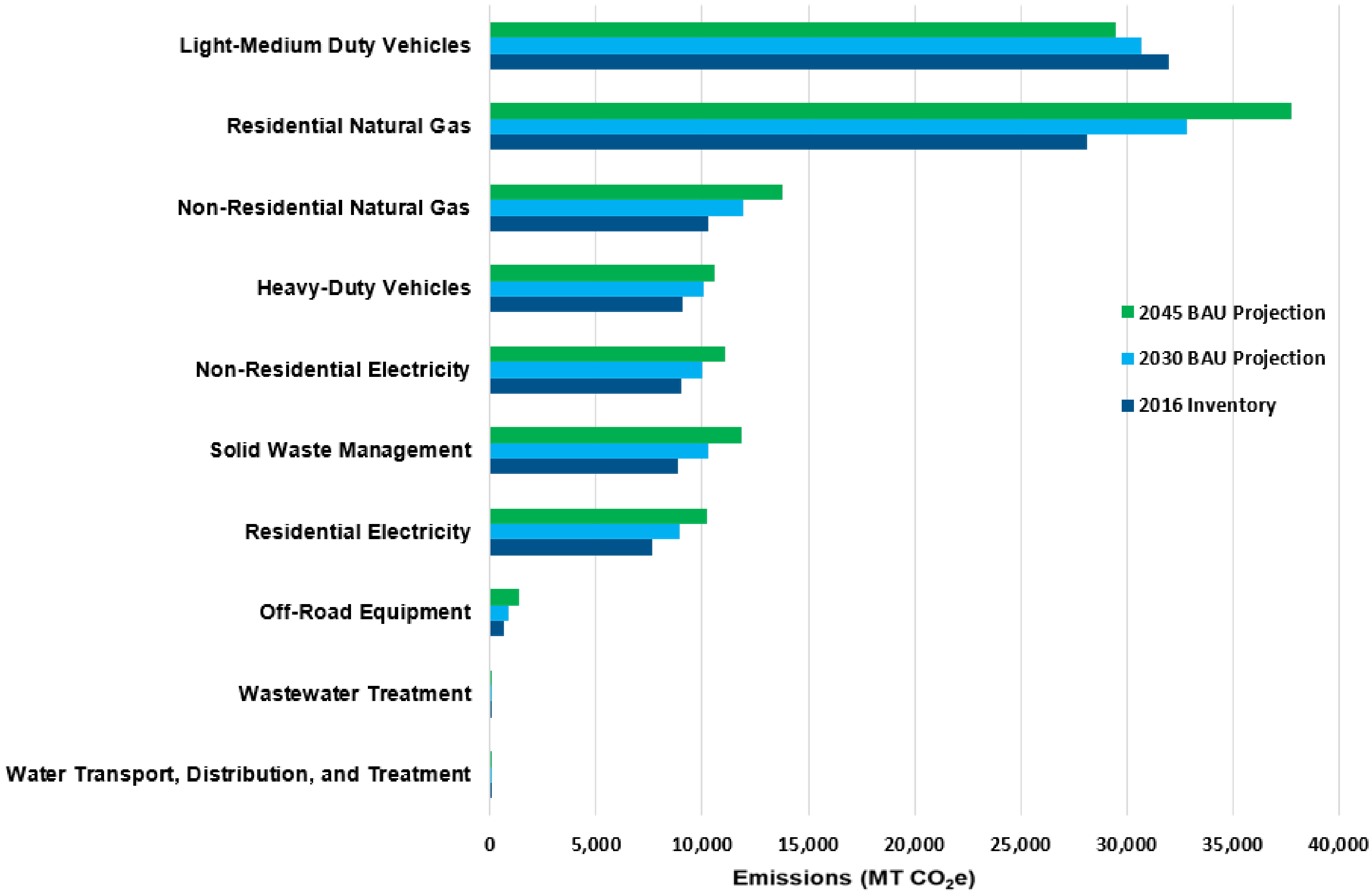


Figure 3-4b. Big Bear Lake GHG Emissions by Sector for 2016, 2030, and 2045



3.5 Chino

Primary sources of GHG emissions in Chino are on-road transportation (53%), building energy (33%), and waste (7%). Emissions are projected to increase by 7% from 2016 to 2030 and by 15% from 2016 to 2045 due to economic and population growth. In 2016, Chino had per capita emissions of 9.1 $MTCO_2e$, which are higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-5. Chino 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	38,623	5%	46,532	6%	55,004	7%
Non-Residential Natural Gas	39,143	5%	41,774	5%	44,592	5%
Light-Medium Duty Vehicles	303,999	41%	306,781	39%	311,248	37%
Heavy-Duty Vehicles	86,213	12%	100,960	13%	111,652	13%
Off-Road Equipment	10,210	1%	14,314	2%	21,474	3%
Agriculture	26,295	4%	14,804	2%	8,000	1%
Residential Electricity	44,159	6%	53,201	7%	62,888	7%
Non-Residential Electricity	121,468	16%	128,089	16%	135,179	16%
Solid Waste Management	52,509	7%	63,261	8%	74,721	9%
Wastewater Treatment	2,547	<1%	3,068	<1%	3,627	<1%
Water Transport, Distribution, and Treatment	11,049	2%	12,770	2%	15,095	2%
Total Emissions	**736,215**	**100%**	**785,555**	**100%**	843,480	**100%**

Figure 3-5a. Chino GHG Emissions by Sector for 2016

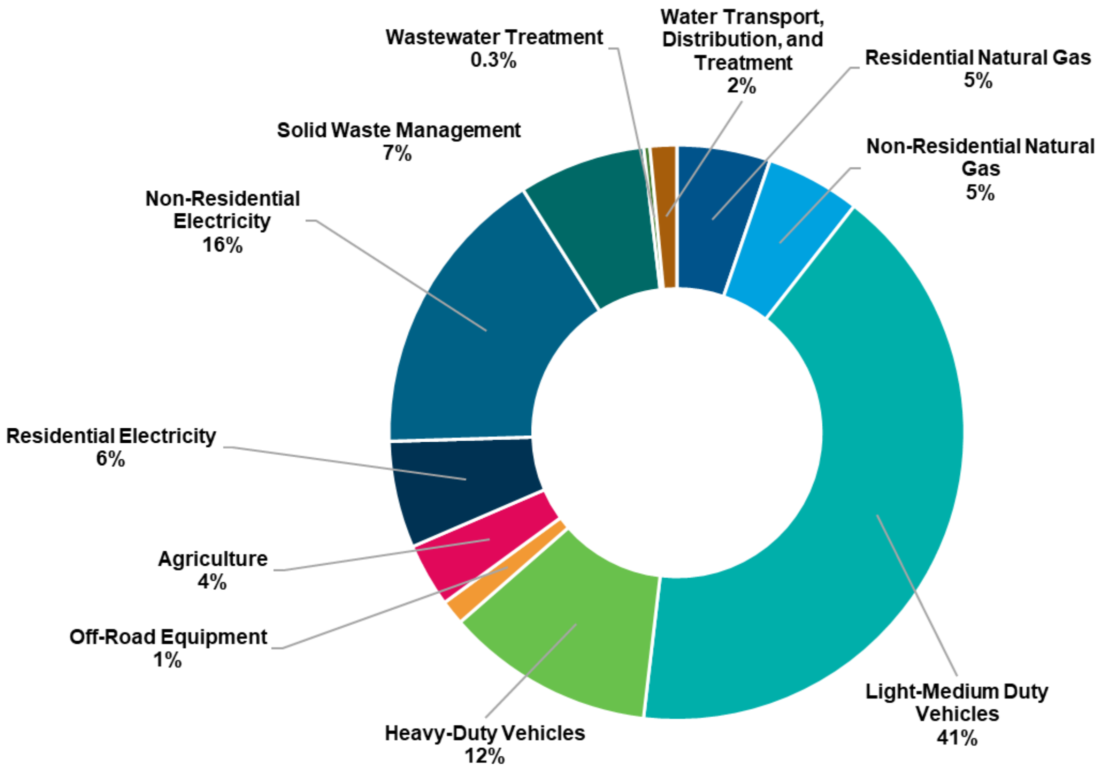
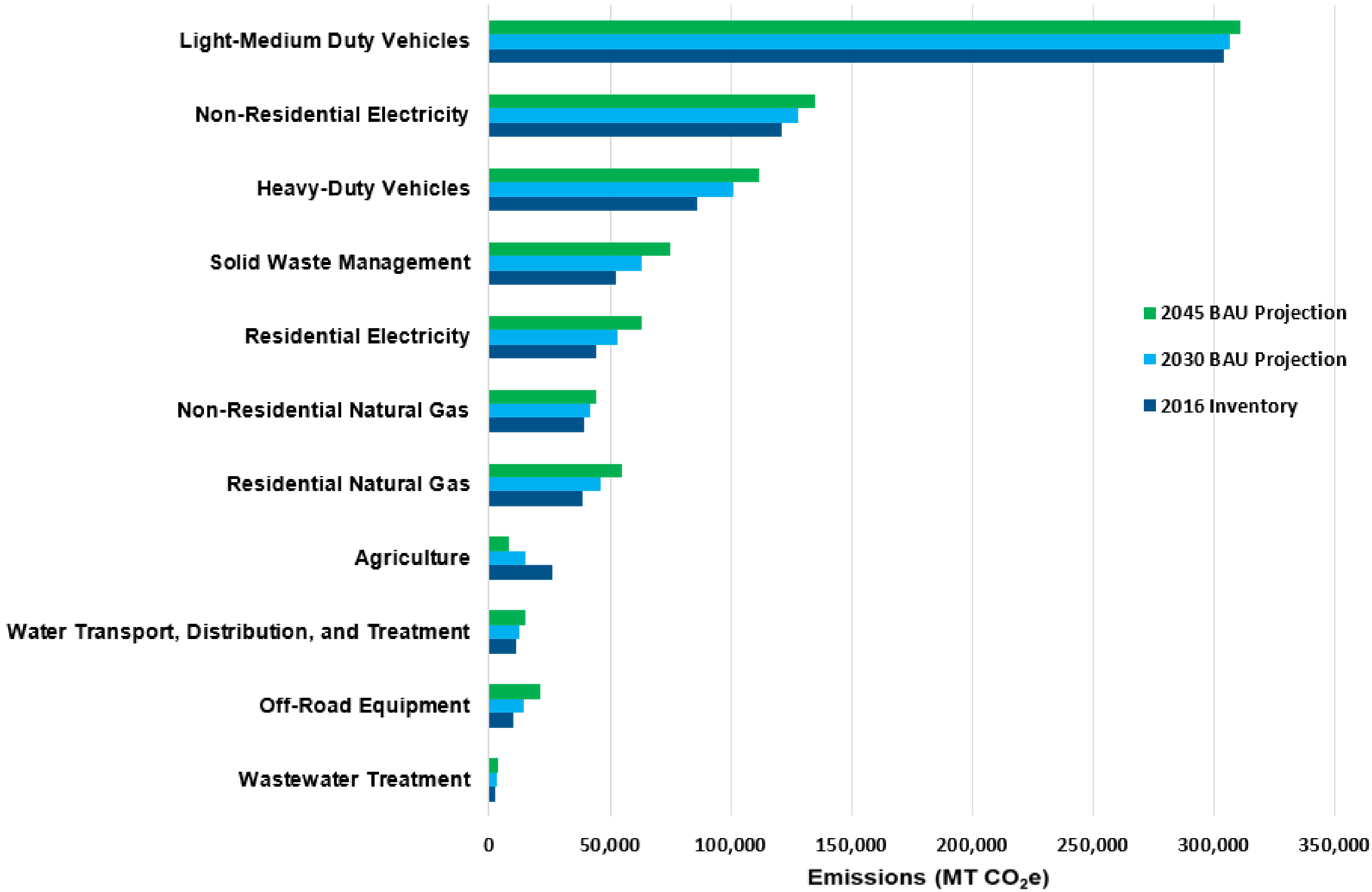


Figure 3-5b. Chino GHG Emissions by Sector for 2016, 2030, and 2045



3.6 Chino Hills

Primary sources of GHG emissions in Chino Hills are on-road transportation (62%), building energy (27%), and waste (5%). Emissions are projected to increase by -1% from 2016 to 2030 and by -2% from 2016 to 2045 due to economic and population growth. In 2016, Chino Hills had per capita emissions of 5.5 $MTCO_2e$, which is lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-6. Chino Hills 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	47,130	11%	51,144	12%	55,444	13%
Non-Residential Natural Gas	8,921	2%	9,319	2%	9,745	2%
Light-Medium Duty Vehicles	211,216	48%	192,401	44%	173,610	40%
Heavy-Duty Vehicles	59,900	14%	63,318	15%	62,278	14%
Off-Road Equipment	8,651	2%	11,098	3%	15,419	4%
Agriculture	3,222	1%	1,814	<1%	980	0%
Residential Electricity	45,729	10%	49,105	11%	53,234	12%
Non-Residential Electricity	16,529	4%	16,880	4%	17,093	4%
Solid Waste Management	22,057	5%	23,686	5%	25,675	6%
Wastewater Treatment	2,498	1%	2,682	1%	2,908	1%
Water Transport, Distribution, and Treatment	13,043	3%	13,437	3%	14,566	3%
Total Emissions	**438,898**	**100%**	**434,884**	**100%**	**430,952**	**100%**

Figure 3-6a. Chino Hills GHG Emissions by Sector for 2016

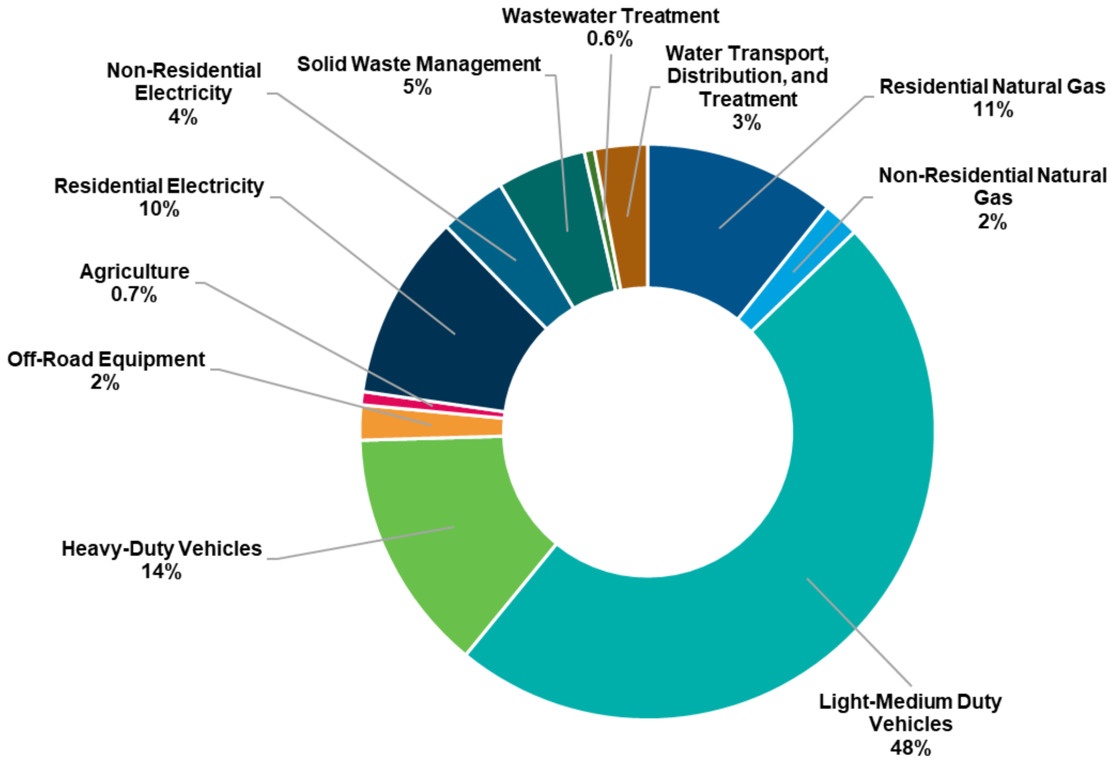
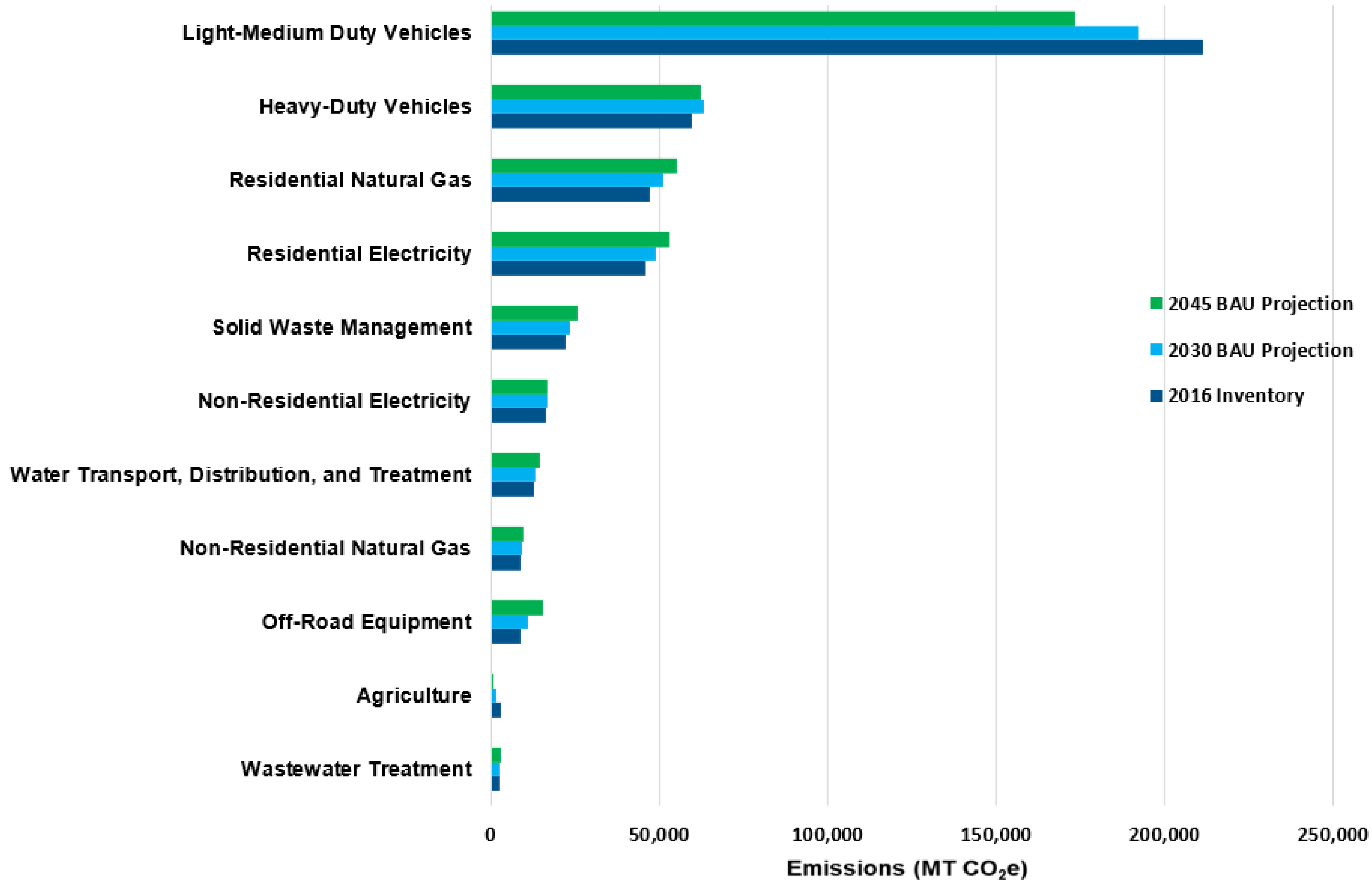


Figure 3-6b. Chino Hills GHG Emissions by Sector for 2016, 2030, and 20452045



3.7 Colton

Primary sources of GHG emissions in Colton are building energy (53%), on-road transportation (39%), and waste (5%). Emissions are projected to increase by 17% from 2016 to 2030 and by 34% from 2016 to 2045 due to economic and population growth. In 2016, Colton had per capita emissions of 8.4 $MTCO_2e$, which is higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-7. Colton 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	24,799	6%	31,361	6%	35,761	6%
Non-Residential Natural Gas	23,847	5%	29,472	6%	35,499	6%
Light-Medium Duty Vehicles	137,762	31%	144,238	27%	151,766	25%
Heavy-Duty Vehicles	39,069	9%	47,468	9%	54,442	9%
Off-Road Equipment	5,997	1%	8,687	2%	12,626	2%
Agriculture	426	<1%	240	<1%	130	<1%
Residential Electricity	53,996	12%	64,532	12%	71,093	12%
Non-Residential Electricity	133,926	30%	165,729	31%	199,964	33%
Solid Waste Management	23,755	5%	28,390	5%	31,271	5%
Wastewater Treatment	1,682	0%	2,011	<1%	2,215	<1%
Water Transport, Distribution, and Treatment	3,689	1%	4,324	1%	4,764	1%
Total Emissions	**448,948**	**100%**	**526,453**	**100%**	**599,529**	**100%**

Figure 3-7a. Colton GHG Emissions by Sector for 2016

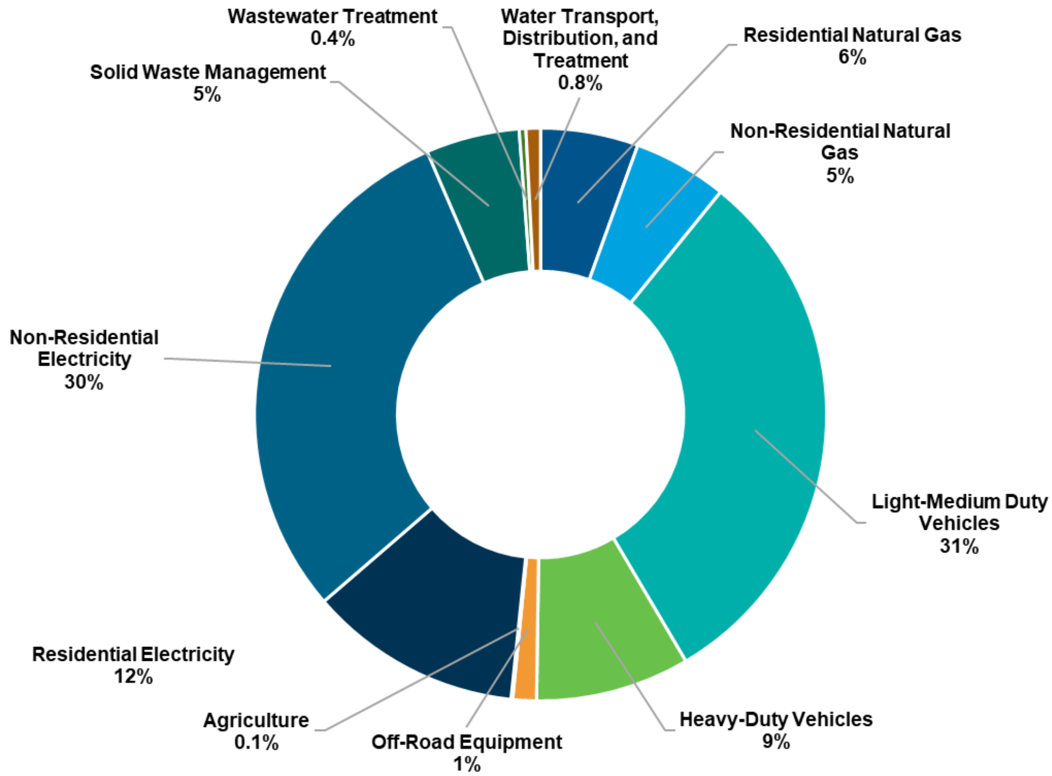
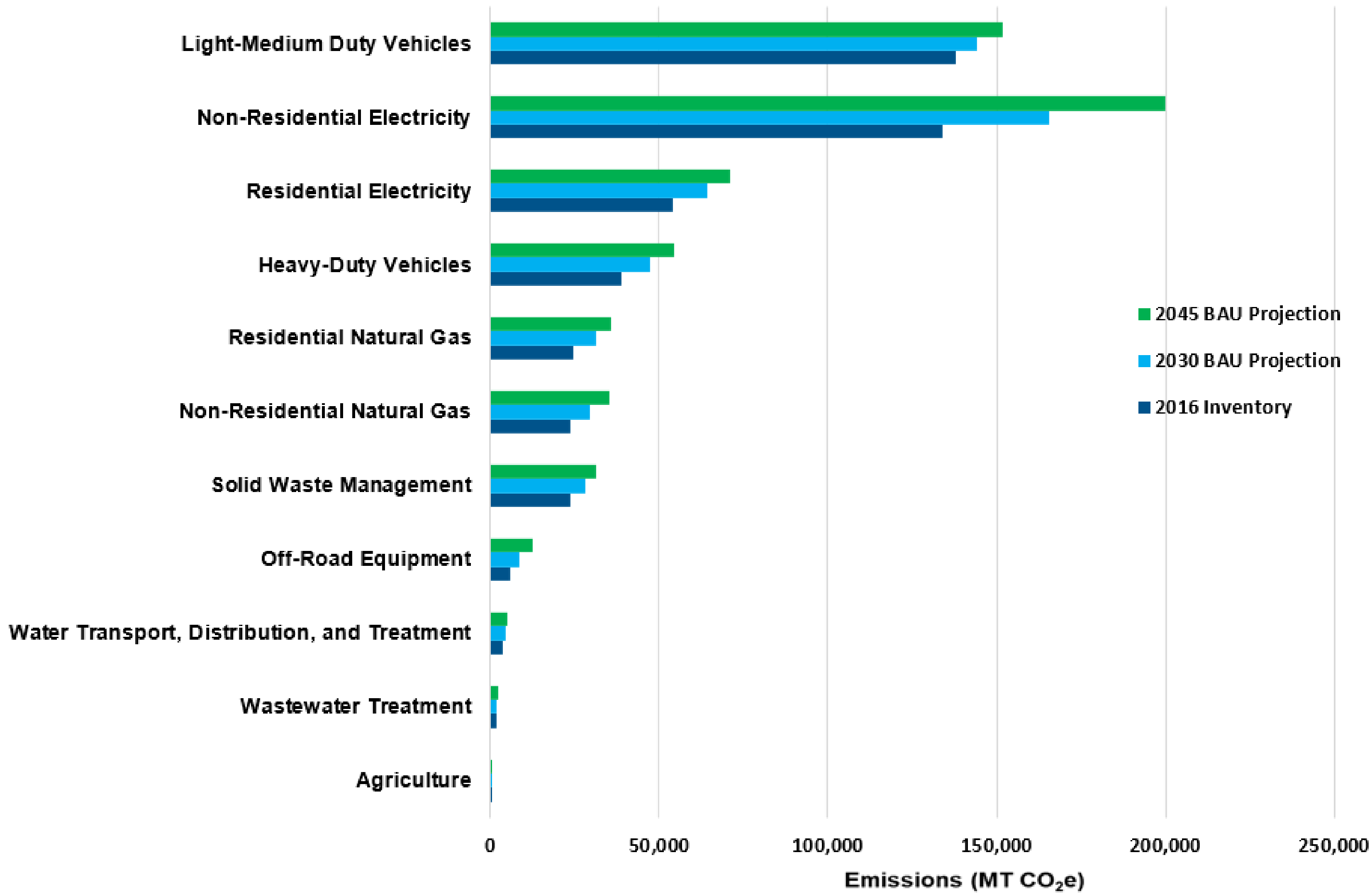


Figure 3-7b. Colton GHG Emissions by Sector for 2016, 2030, and 2045



3.8 Fontana

Primary sources of GHG emissions in Fontana are on-road transportation (55%), building energy (34%), and waste (8%). Emissions are projected to increase by 15% from 2016 to 2030 and by 31% from 2016 to 2045 due to economic and population growth. In 2016, Fontana had per capita emissions of 5.4 $MTCO_2e$, which is lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-8. Fontana 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	86,355	8%	107,599	8%	130,362	9%
Non-Residential Natural Gas	68,268	6%	81,745	6%	96,186	6%
Light-Medium Duty Vehicles	480,465	42%	518,076	40%	560,186	38%
Heavy-Duty Vehicles	136,258	12%	170,497	13%	200,951	14%
Off-Road Equipment	23,220	2%	32,595	3%	48,700	3%
Agriculture	1,016	<1%	572	<1%	309	<1%
Residential Electricity	96,888	9%	113,518	9%	131,643	9%
Non-Residential Electricity	134,422	12%	155,516	12%	178,072	12%
Solid Waste Management	86,844	8%	101,750	8%	117,932	8%
Wastewater Treatment	6,610	1%	7,744	1%	8,981	1%
Water Transport, Distribution, and Treatment	10,581	1%	11,893	1%	13,792	1%
Total Emissions	**1,130,927**	**100%**	**1,301,505**	**100%**	**1,487,115**	**100%**

Figure 3-8a. Fontana GHG Emissions by Sector for 2016

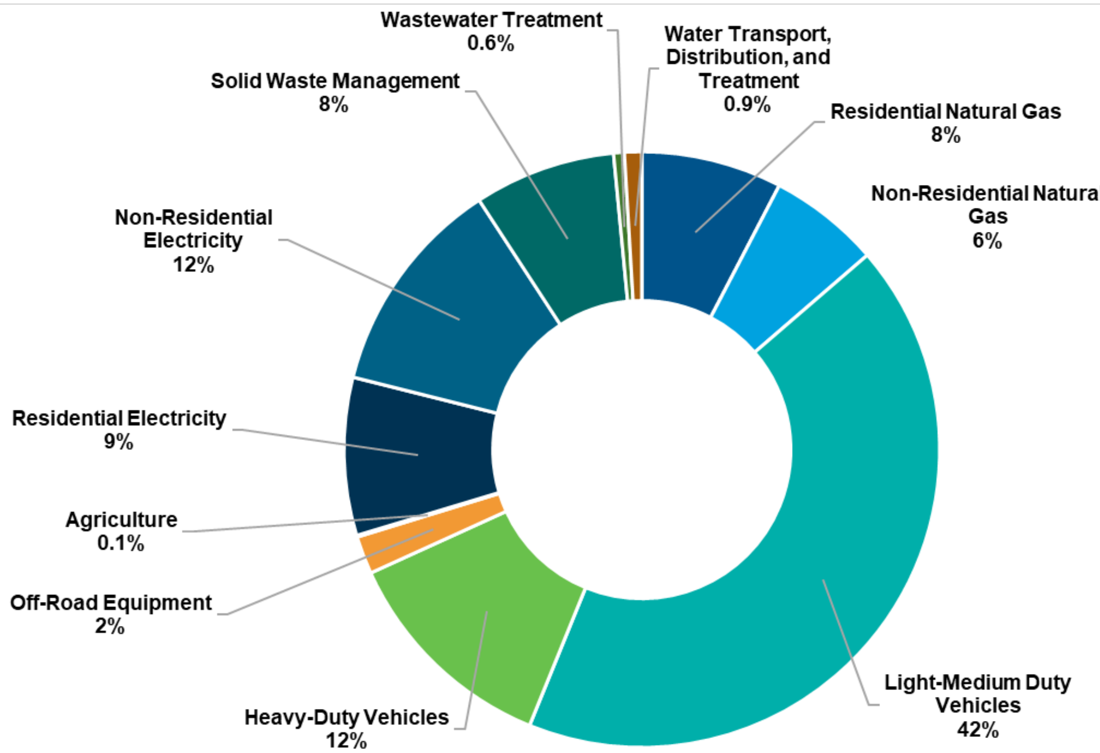
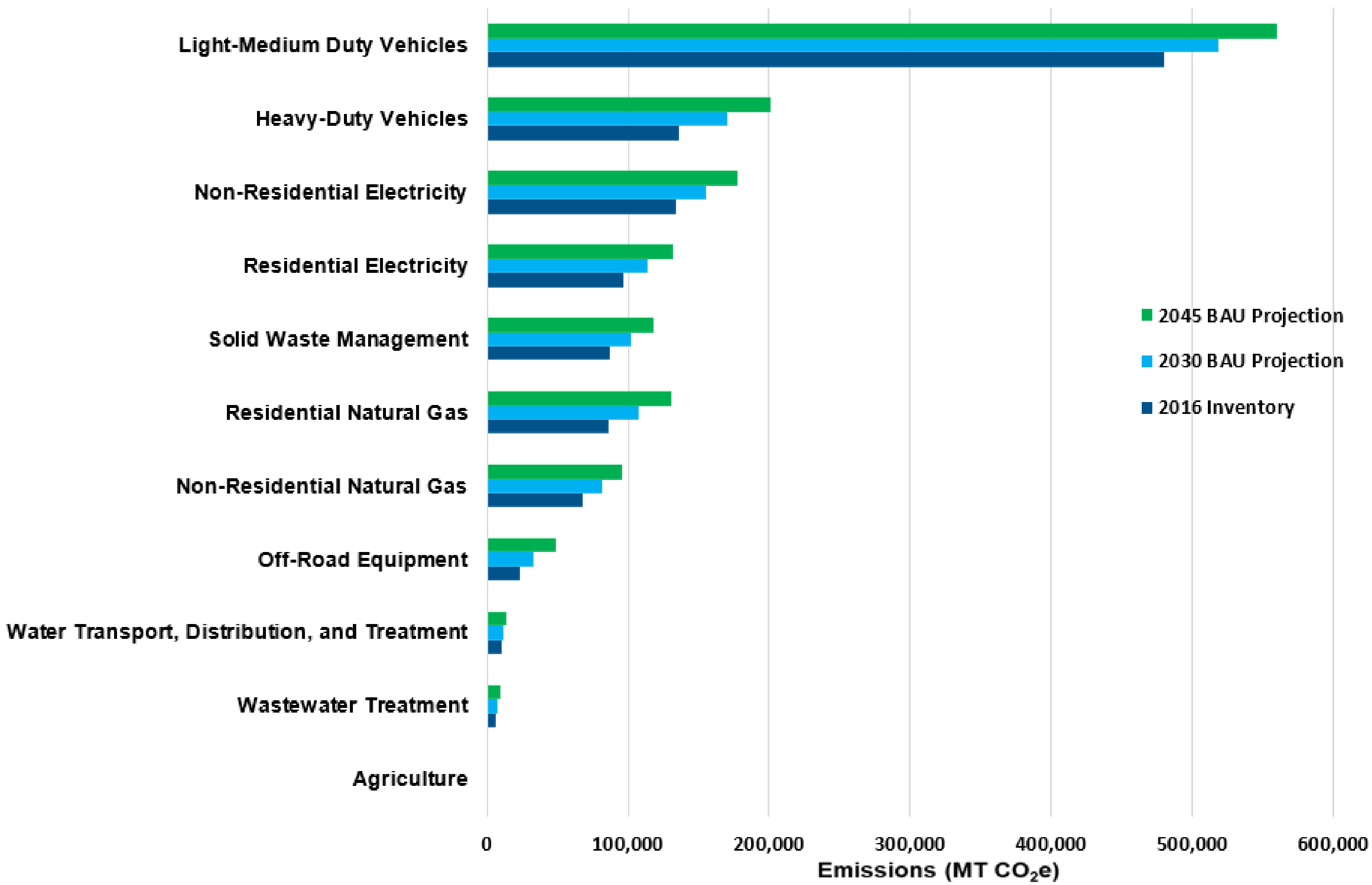


Figure 3-8b. Fontana GHG Emissions by Sector for 2016, 2030, and 2045



3.9 Grand Terrace

Primary sources of GHG emissions in Grand Terrace are on-road transportation (60%), building energy (31%), and waste (6%). Emissions are projected to increase by 16% from 2016 to 2030 and by 33% from 2016 to 2045 due to economic and population growth. In 2016, Grand Terrace had per capita emissions of 6.3 MT CO_2e, which are lower than the region's average per capita emissions of 7.5 MT CO_2e.

Table 3-9. Grand Terrace 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	**Emissions**	**Percent**	**Emissions**	**Percent**	**Emissions**	**Percent**
Residential Natural Gas	7,983	10%	8,984	10%	10,056	10%
Non-Residential Natural Gas	986	1%	1,342	1%	1,723	2%
Light-Medium Duty Vehicles	36,699	47%	40,849	45%	45,413	44%
Heavy-Duty Vehicles	10,408	13%	13,443	15%	16,291	16%
Off-Road Equipment	1,362	2%	1,803	2%	2,598	2%
Agriculture	73	<1%	41	<1%	22	<1%
Residential Electricity	8,642	11%	9,310	10%	10,106	10%
Non-Residential Electricity	6,576	8%	9,080	10%	11,759	11%
Solid Waste Management	4,581	6%	4,935	5%	5,357	5%
Wastewater Treatment	388	<1%	418	<1%	454	0%
Water Transport, Distribution, and Treatment	369	<1%	381	<1%	414	<1%
Total Emissions	**78,066**	**100%**	**90,587**	**100%**	**104,193**	**100%**

Figure 3-9a. Grand Terrace GHG Emissions by Sector for 2016

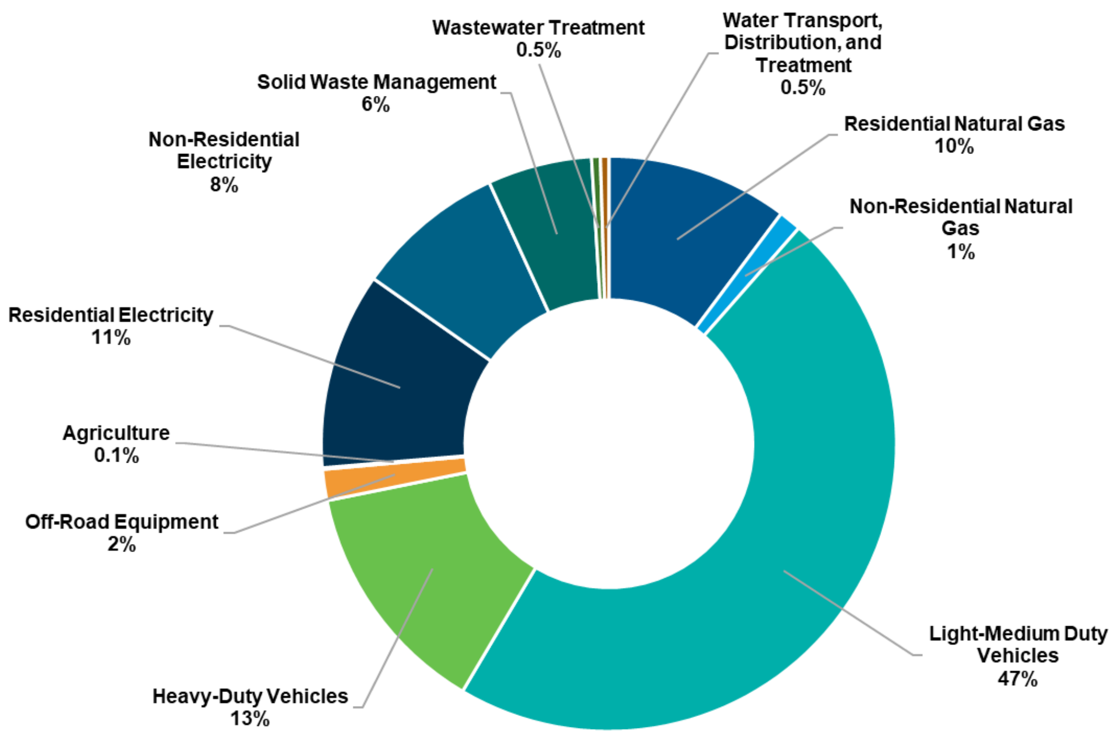
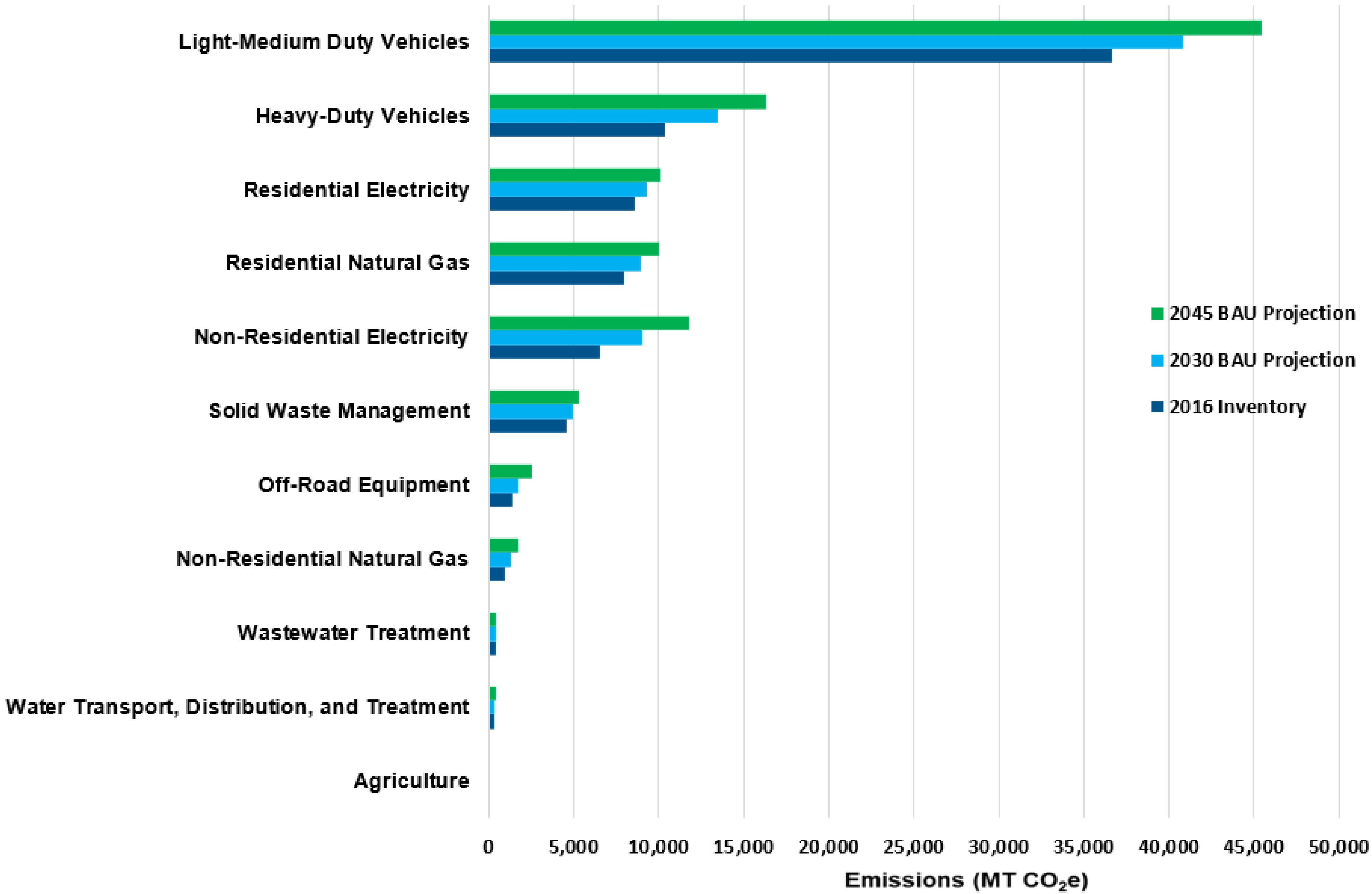


Figure 3-9b. Grand Terrace GHG Emissions by Sector for 2016, 2030, and 2045



3.10 Hesperia

Primary sources of GHG emissions in Hesperia are on-road transportation (61%), building energy (30%), and waste (5%). Emissions are projected to increase by 26% from 2016 to 2030 and by 55% from 2016 to 2045 due to economic and population growth. In 2016, Hesperia had per capita emissions of 6.0 $MTCO_2e$, which is lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-10. Hesperia 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	66,422	12%	98,038	14%	131,913	15%
Non-Residential Natural Gas	12,308	2%	18,189	3%	24,489	3%
Light-Medium Duty Vehicles	222,946	40%	257,392	36%	293,845	34%
Heavy-Duty Vehicles	123,361	22%	140,875	20%	161,227	18%
Off-Road Equipment	10,296	2%	17,152	2%	28,848	3%
Agriculture	3,642	1%	2,051	<1%	1,108	<1%
Residential Electricity	54,657	10%	75,498	11%	98,050	11%
Non-Residential Electricity	33,929	6%	51,595	7%	70,511	8%
Solid Waste Management	30,825	5%	42,579	6%	55,297	6%
Wastewater Treatment	2,935	1%	4,054	1%	5,265	1%
Water Transport, Distribution, and Treatment	2,048	<1%	2,714	<1%	3,525	<1%
Total Emissions	**563,369**	**100%**	**710,136**	**100%**	**874,079**	**100%**

Figure 3-10a. Hesperia GHG Emissions by Sector for 2016

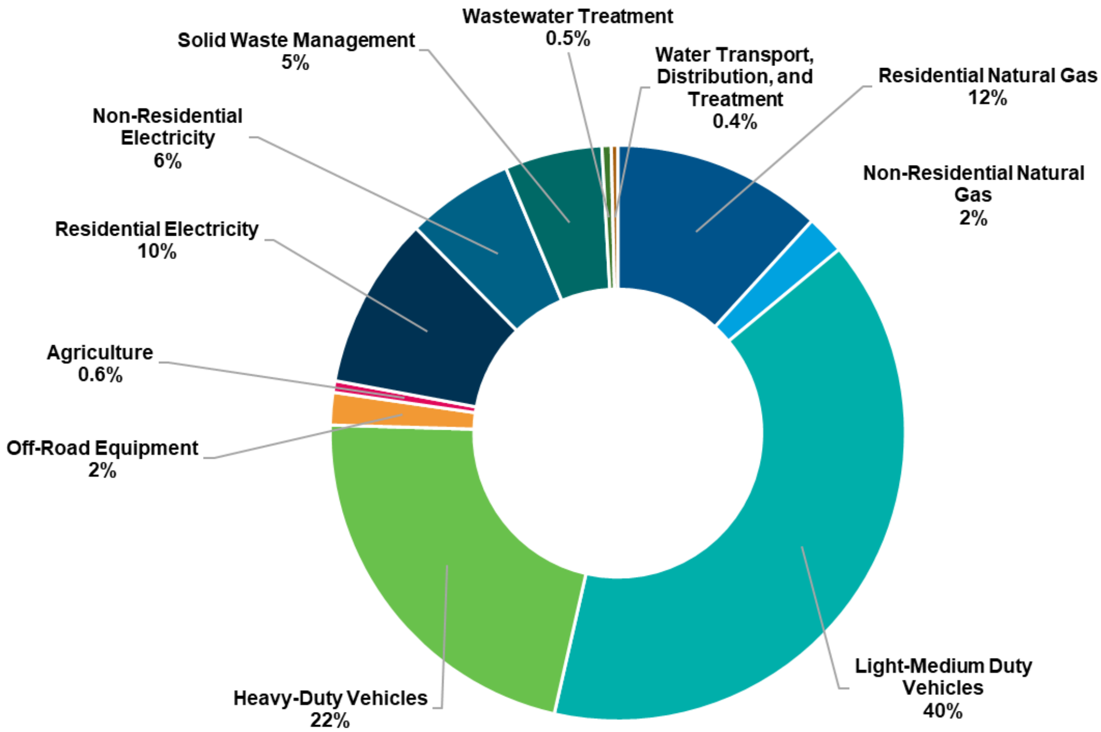
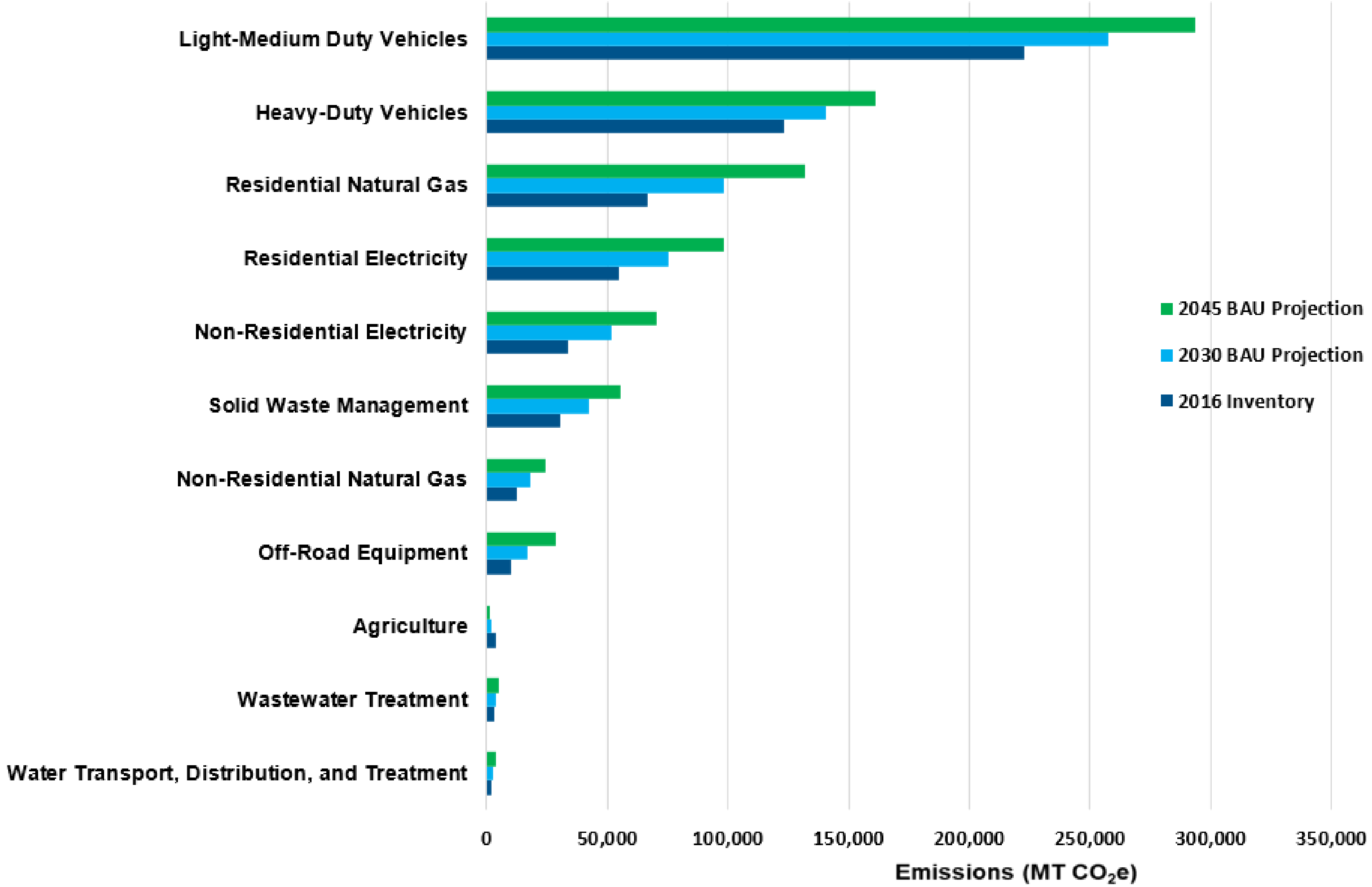


Figure 3-10b. Hesperia GHG Emissions by Sector for 2016, 2030, and 2045



3.11 Highland

Primary sources of GHG emissions in Highland are on-road transportation (52%), building energy (36%), and waste (7%). Emissions are projected to increase by 15% from 2016 to 2030 and by 32% from 2016 to 2045 due to economic and population growth. In 2016, Highland had per capita emissions of 4.0 MT CO_2e, which are lower than the region's average per capita emissions of 7.5 MT CO_2e.

Table 3-11. Highland 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	**Emissions**	**Percent**	**Emissions**	**Percent**	**Emissions**	**Percent**
Residential Natural Gas	30,477	14%	35,556	14%	42,395	15%
Non-Residential Natural Gas	4,440	2%	5,729	2%	7,114	2%
Light-Medium Duty Vehicles	88,795	41%	96,410	38%	104,893	36%
Heavy-Duty Vehicles	25,182	12%	31,728	13%	37,628	13%
Off-Road Equipment	5,671	3%	7,654	3%	11,242	4%
Agriculture	788	0%	444	<1%	240	<1%
Residential Electricity	31,329	14%	35,046	14%	39,849	14%
Non-Residential Electricity	13,626	6%	18,134	7%	22,896	8%
Solid Waste Management	14,511	7%	16,232	6%	18,457	6%
Wastewater Treatment	1,698	1%	1,899	1%	2,160	1%
Water Transport, Distribution, and Treatment	2,423	1%	2,600	1%	2,957	1%
Total Emissions	**218,940**	**100%**	**251,432**	**100%**	**289,831**	**100%**

Figure 3-11a. Highland GHG Emissions by Sector for 2016

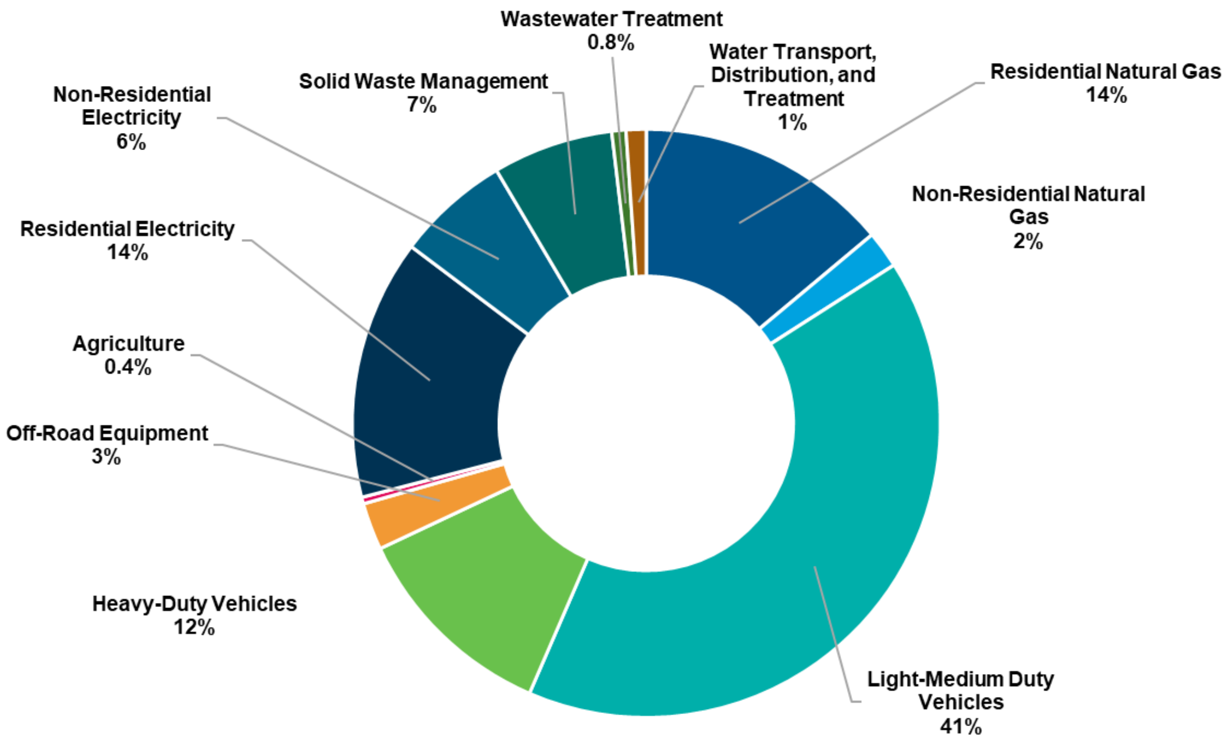
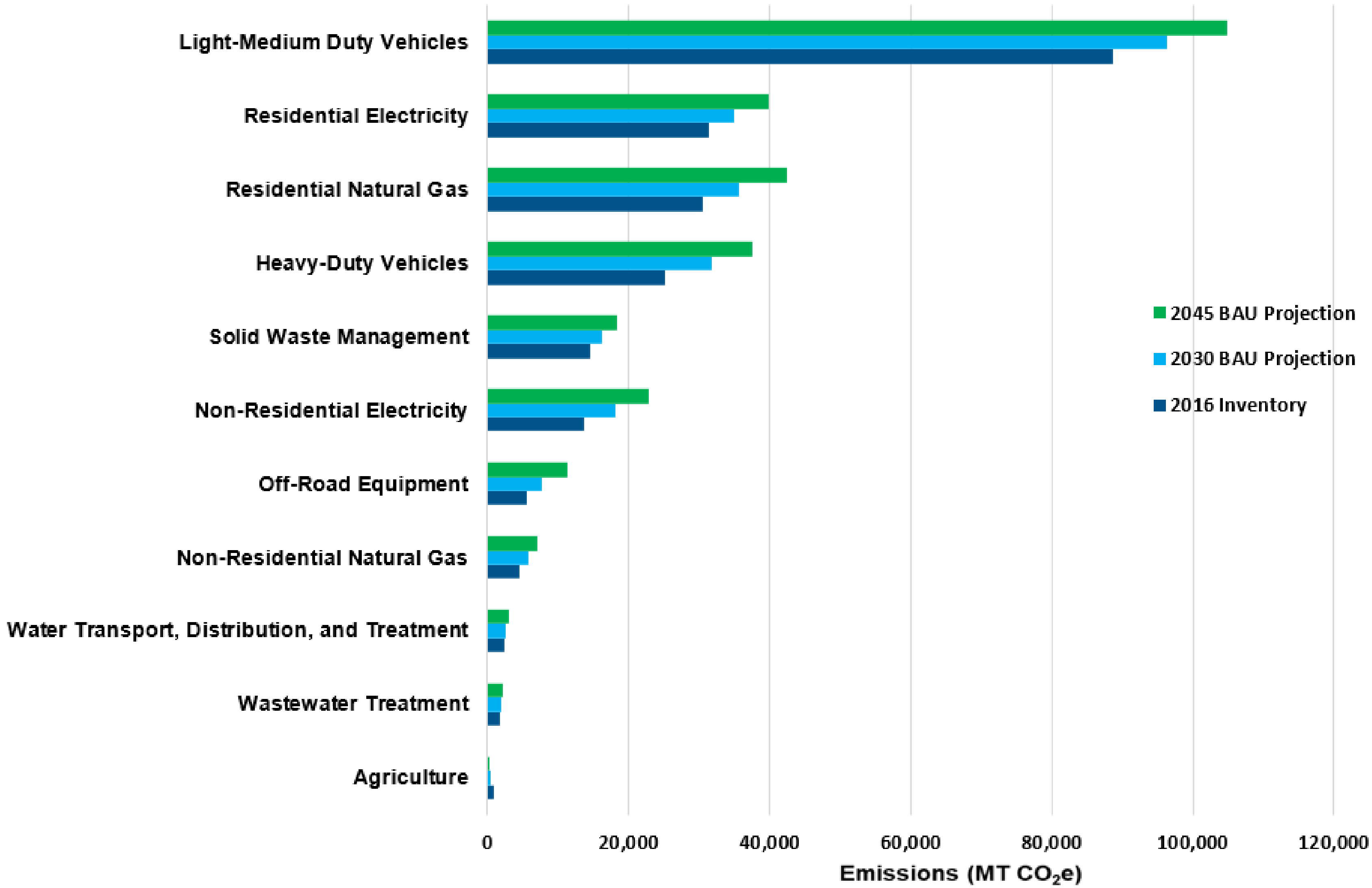


Figure 3-11b. Highland GHG Emissions by Sector for 2016, 2030, and 2045



3.12 Loma Linda

Primary sources of GHG emissions in Loma Linda are on-road transportation (70%), building energy (26%), and waste (2%). Emissions are projected to decrease by 0.5% from 2016 to 2030 and by 1% from 2016 to 2045 due to economic and population changes. In 2016, Loma Linda had per capita emissions of 8.3 $MTCO_2e$, which are higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-12. Loma Linda 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	14,424	7%	16,700	8%	19,138	10%
Non-Residential Natural Gas	468	<1%	506	<1%	547	<1%
Light-Medium Duty Vehicles	110,767	54%	100,780	50%	90,800	45%
Heavy-Duty Vehicles	31,413	15%	33,166	16%	32,572	16%
Off-Road Equipment	3,180	2%	4,320	2%	6,429	3%
Agriculture	400	<1%	225	<1%	122	<1%
Residential Electricity	14,701	7%	16,274	8%	18,088	9%
Non-Residential Electricity	23,366	11%	25,257	12%	27,272	14%
Solid Waste Management	3,574	2%	3,957	2%	3,954	2%
Wastewater Treatment	767	<1%	849	<1%	943	<1%
Water Transport, Distribution, and Treatment	863	<1%	917	<1%	1,019	1%
Total Emissions	**203,924**	**100%**	**202,951**	**100%**	**200,884**	**100%**

Figure 3-12a. Loma Linda GHG Emissions by Sector for 2016

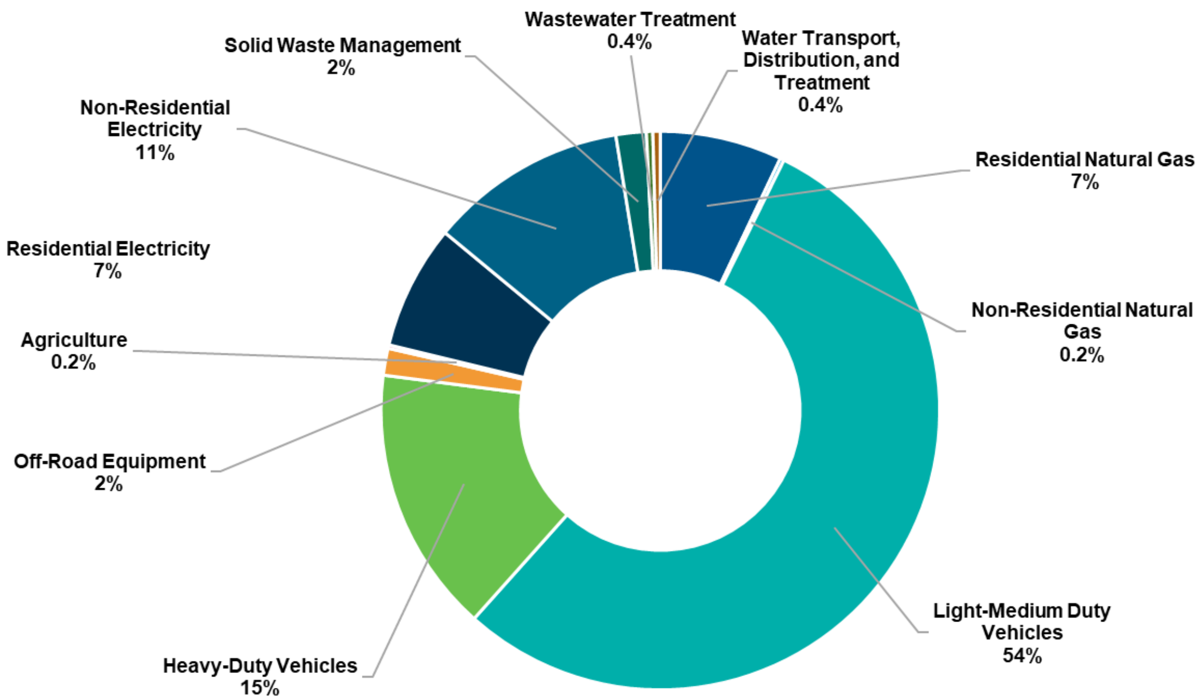
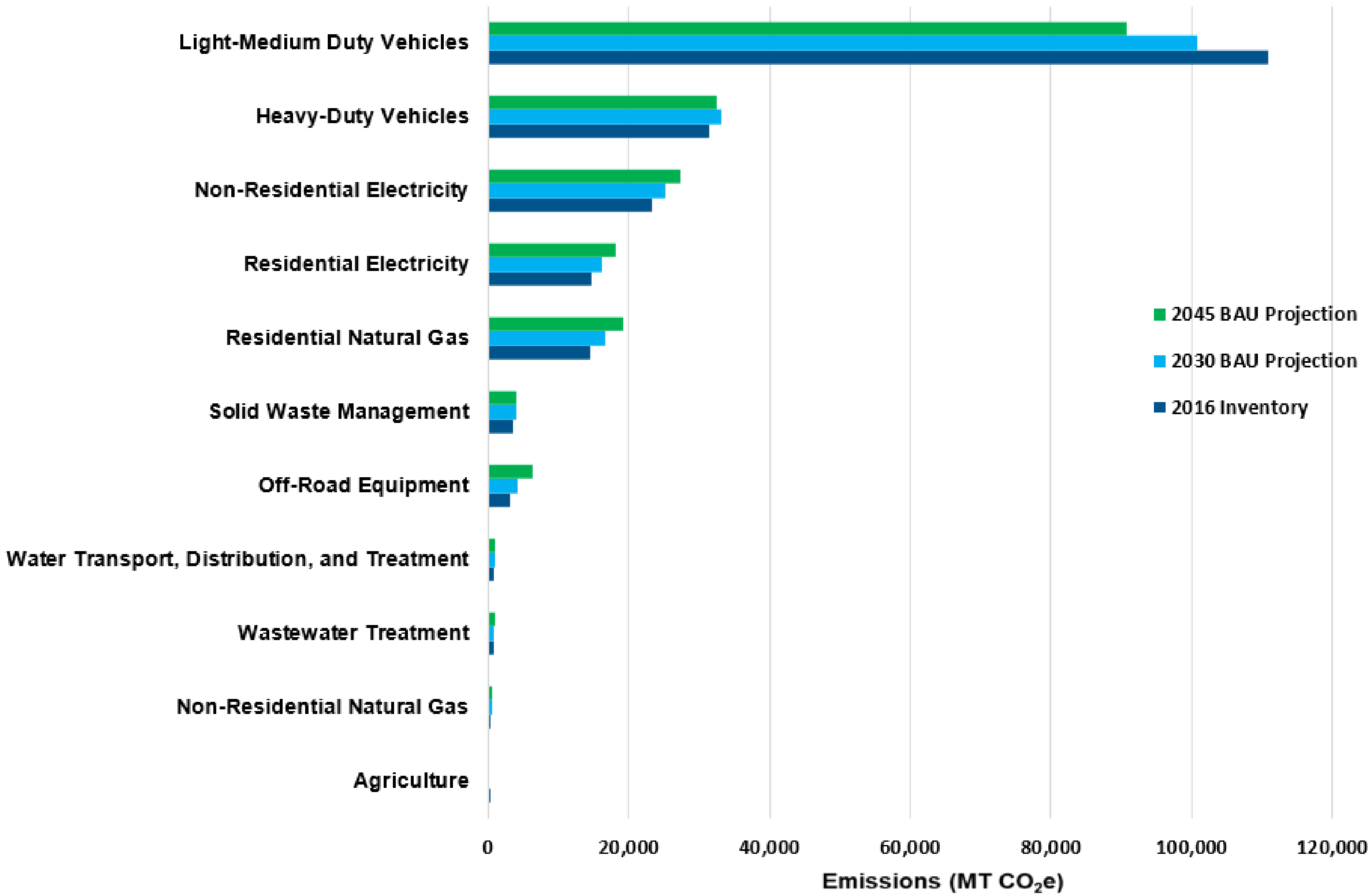


Figure 3-12b. Loma Linda GHG Emissions by Sector for 2016, 2030, and 2045



3.13 Montclair

Primary sources of GHG emissions in Montclair are on-road transportation (63%), building energy (26%), and waste (7%). Emissions are projected to increase by 2% from 2016 to 2030 and by 4% from 2016 to 2045 due to economic and population growth. In 2016, Montclair had per capita emissions of 6.6 MT CO_2e, which is lower than the region's average per capita emissions of 7.5 MT CO_2e.

Table 3-13. Montclair 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	17,177	7%	18,266	7%	19,433	7%
Non-Residential Natural Gas	7,873	3%	8,260	3%	8,518	3%
Light-Medium Duty Vehicles	126,039	49%	119,571	46%	113,381	43%
Heavy-Duty Vehicles	35,744	14%	39,350	15%	40,672	15%
Off-Road Equipment	4,531	2%	6,023	2%	8,850	3%
Agriculture	-	0%	-	0%	-	0%
Residential Electricity	15,971	6%	17,733	7%	20,283	8%
Non-Residential Electricity	25,899	10%	27,002	10%	27,496	10%
Solid Waste Management	17,991	7%	19,976	8%	22,848	9%
Wastewater Treatment	1,212	0%	1,346	1%	1,540	1%
Water Transport, Distribution, and Treatment	2,415	1%	2,572	1%	2,942	1%
Total Emissions	**254,852**	**100%**	**260,101**	**100%**	**265,964**	**100%**

Figure 3-13a. Montclair GHG Emissions by Sector for 2016

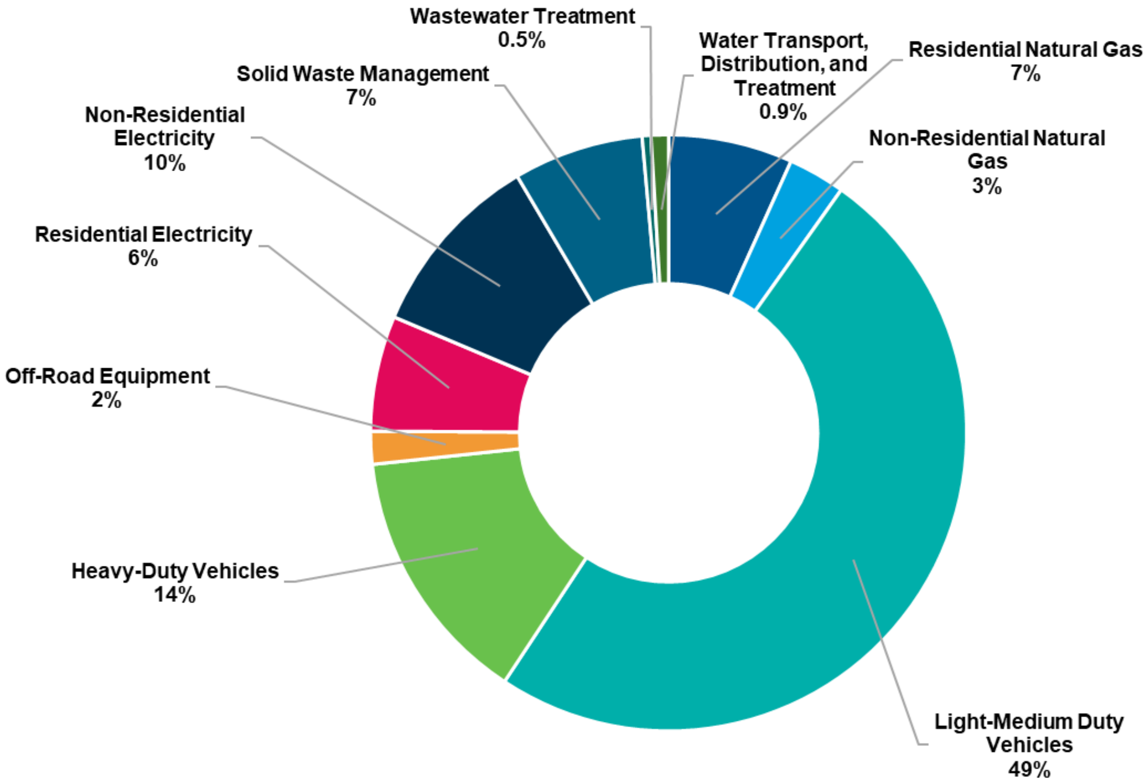
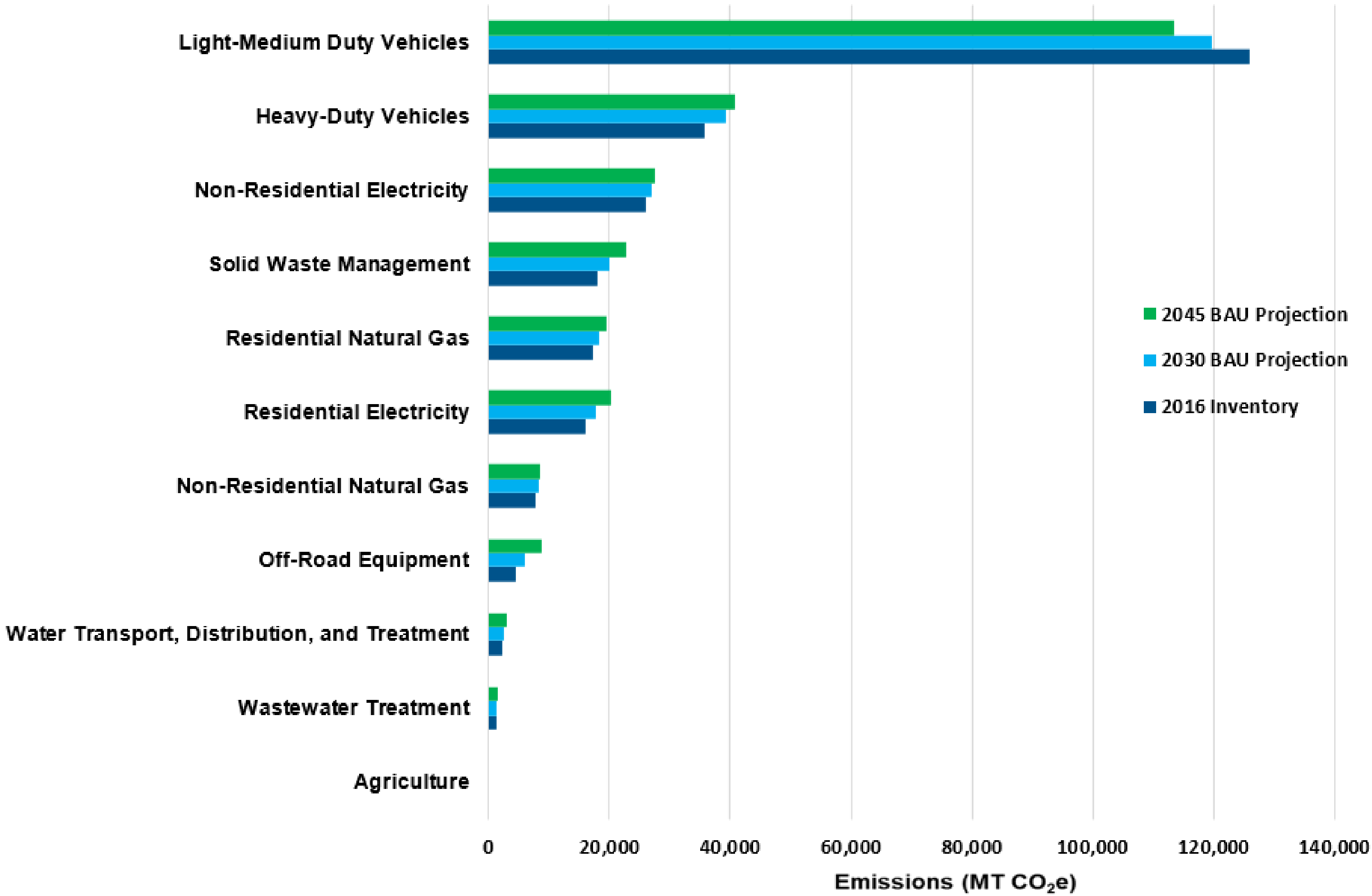


Figure 3-13b. Montclair GHG Emissions by Sector for 2016, 2030, and 2045



3.14 Needles

Primary sources of GHG emissions in Needles are waste (37%), building energy (30%), and on-road transportation (28%). Emissions are projected to increase by 67% from 2016 to 2030 and by 114% from 2016 to 2045 due to economic and population growth. In 2016, Needles had per capita emissions of 5.2 $MTCO_2e$, which is lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-14. Needles 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	1,509	6%	2,387	5%	3,327	6%
Non-Residential Natural Gas	1,261	5%	1,994	5%	2,780	5%
Light-Medium Duty Vehicles	4,754	18%	5,259	12%	5,791	10%
Heavy-Duty Vehicles	2,630	10%	2,878	7%	3,177	6%
Off-Road Equipment	573	2%	1,010	2%	1,722	3%
Agriculture	-	0%	-	0%	-	0%
Residential Electricity	2,650	10%	8,523	19%	11,475	20%
Non-Residential Electricity	2,579	10%	6,195	14%	6,807	12%
Solid Waste Management	9,827	37%	14,916	34%	20,081	36%
Wastewater Treatment	158	1%	239	1%	322	1%
Water Transport, Distribution, and Treatment	307	1%	445	1%	600	1%
Total Emissions	**26,247**	**100%**	**43,847**	**100%**	**56,081**	**100%**

Figure 3-14a. Needles GHG Emissions by Sector for 2016

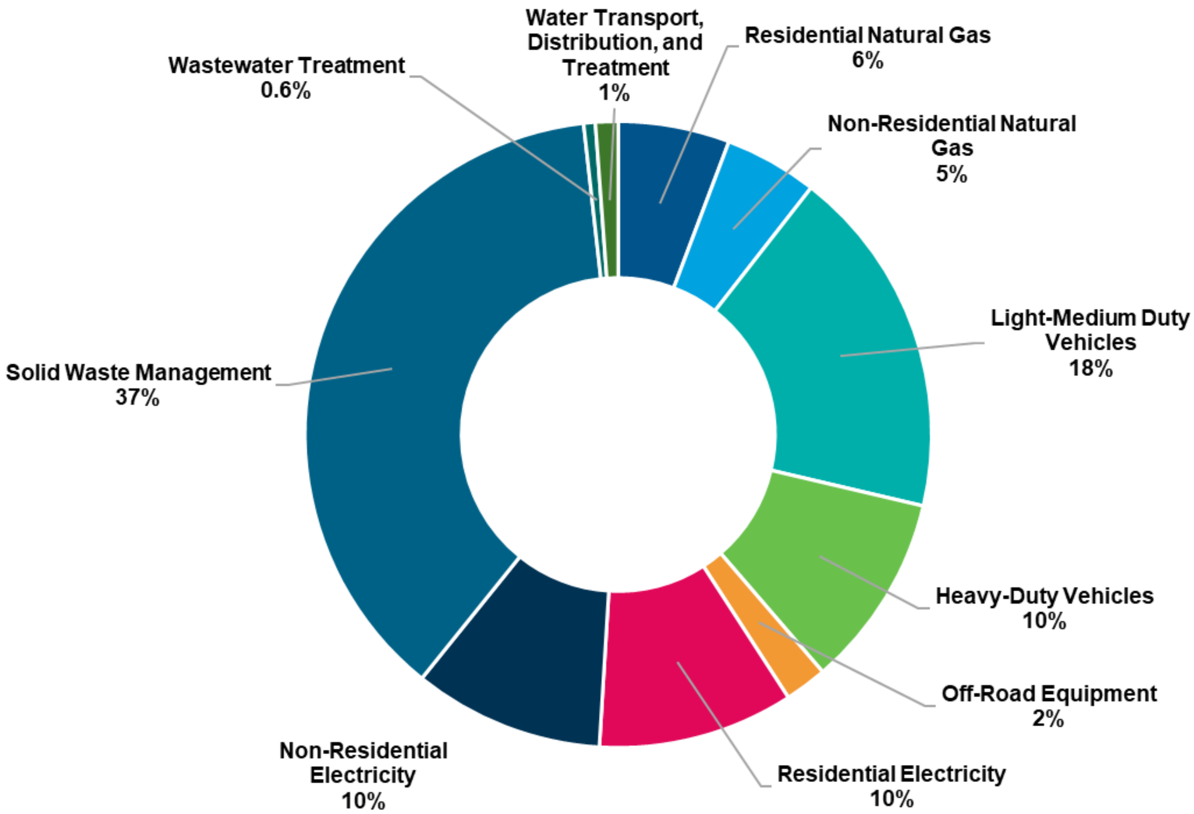
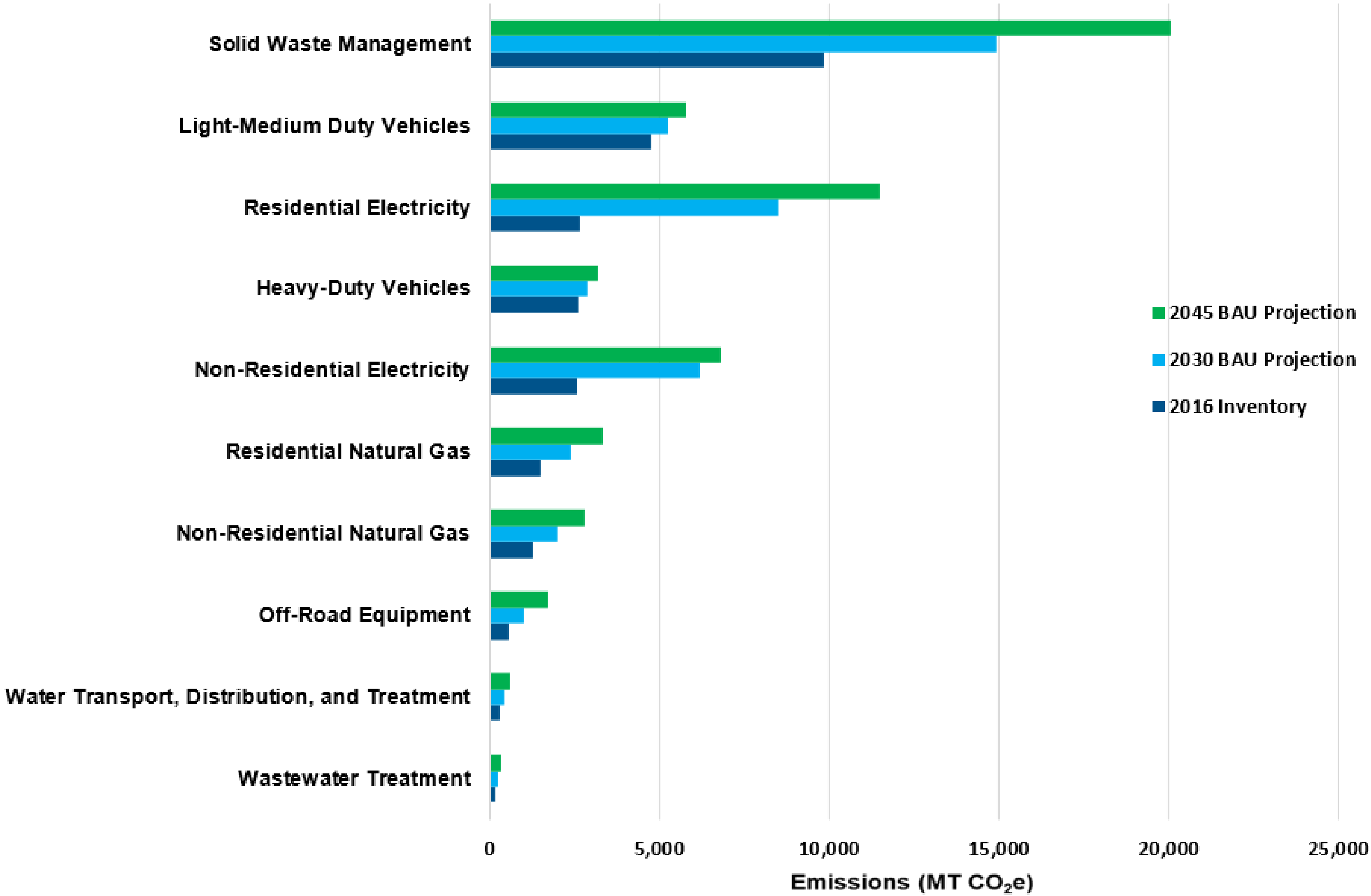


Figure 3-14b. Needles GHG Emissions by Sector for 2016, 2030, and 2045



3.15 Ontario

Primary sources of GHG emissions in Ontario are on-road transportation (41%), building energy (34%), and agriculture (17%). Emissions are projected to increase by 8% from 2016 to 2030 and by 22% from 2016 to 2045 due to economic and population growth. In 2016, Ontario had per capita emissions of 12.1 $MTCO_2e$, which is higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-15. Ontario 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	79,225	4%	104,371	5%	128,343	5%
Non-Residential Natural Gas	188,412	9%	245,509	11%	298,730	12%
Light-Medium Duty Vehicles	668,869	32%	745,361	33%	829,449	33%
Heavy-Duty Vehicles	189,689	9%	245,295	11%	297,542	12%
Off-Road Equipment	21,904	1%	33,452	1%	52,319	2%
Agriculture	356,588	17%	140,594	6%	51,868	2%
Residential Electricity	78,302	4%	100,829	4%	122,306	5%
Non-Residential Electricity	370,754	18%	467,687	21%	550,584	22%
Solid Waste Management	118,949	6%	153,171	7%	185,646	7%
Wastewater Treatment	5,396	<1%	6,949	<1%	8,429	<1%
Water Transport, Distribution, and Treatment	13,878	1%	17,145	1%	20,796	1%
Total Emissions	**2,091,964**	**100%**	**2,260,363**	**100%**	**2,546,011**	**100%**

Note: Inventory totals do not include emissions from Stationary Sources.

Figure 3-15a. Ontario GHG Emissions by Sector for 2016

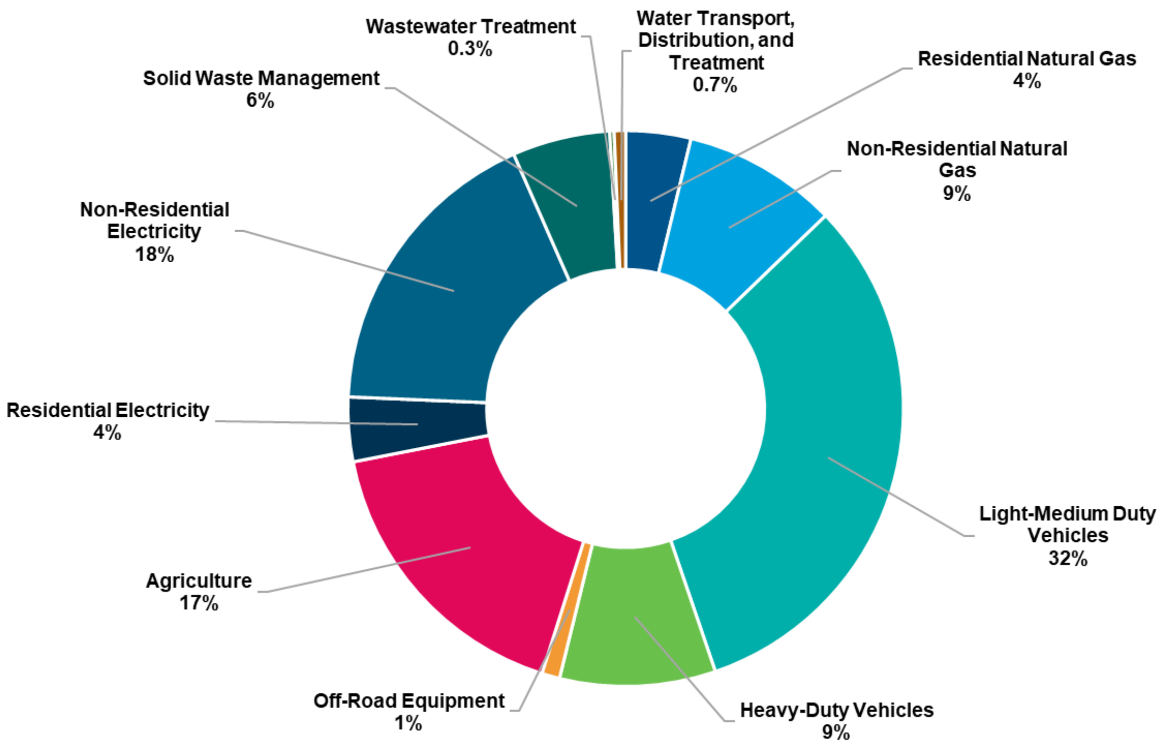
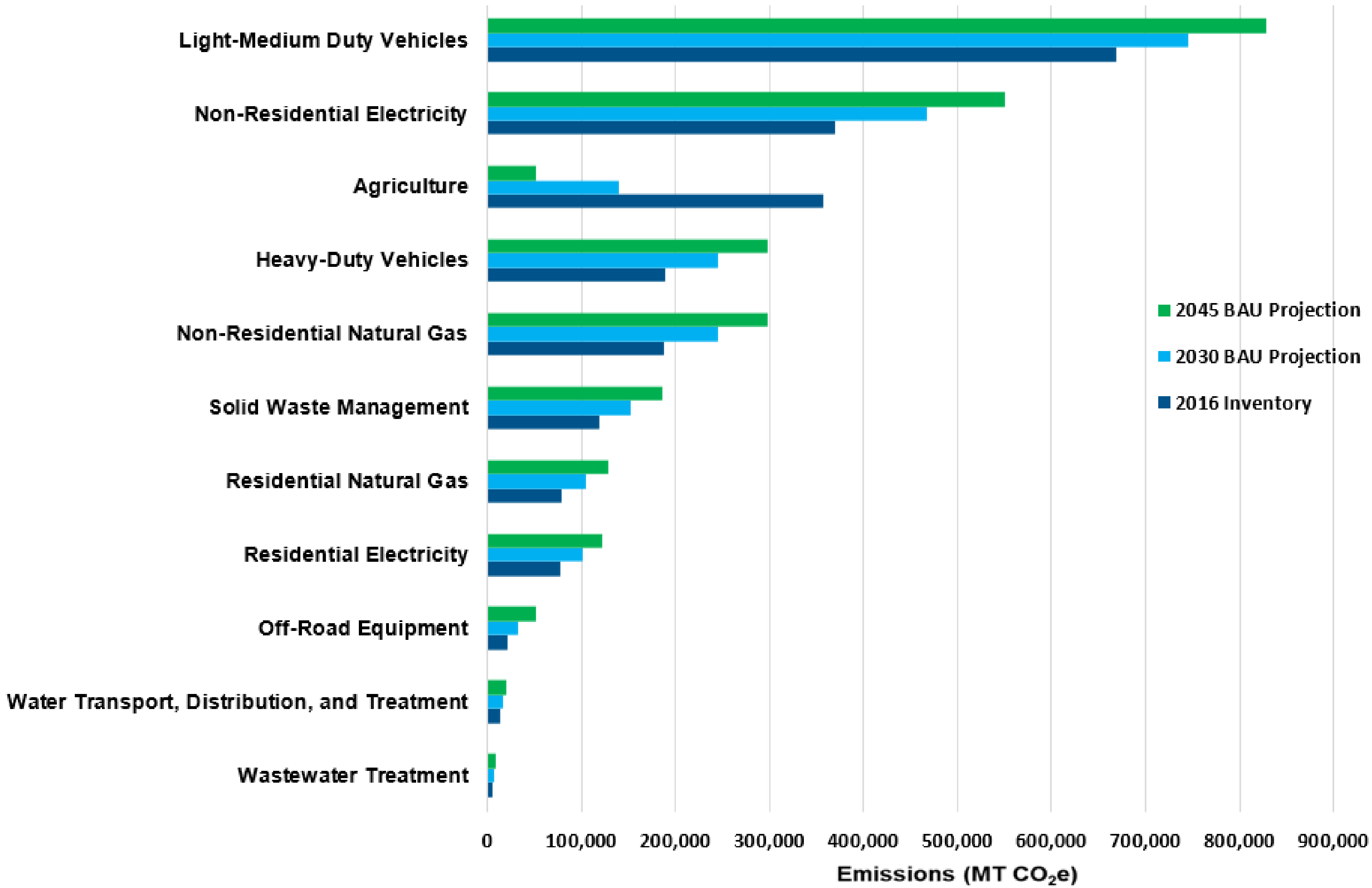


Figure 3-15b. Ontario GHG Emissions by Sector for 2016, 2030, and 2045



3.16 Rancho Cucamonga

Primary sources of GHG emissions in Rancho Cucamonga are on-road transportation (47%), building energy (45%), and waste (5%). Emissions are projected to increase by 5% from 2016 to 2030 and by 11% from 2016 to 2045 due to economic and population growth. In 2016, Rancho Cucamonga had per capita emissions of 8.5 $MTCO_2e$, which are higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-16. Rancho Cucamonga 2016 Community Greenhouse Gas Inventory and 2030 Forecast ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	108,984	7%	117,935	8%	127,525	8%
Non-Residential Natural Gas	198,337	13%	216,221	14%	235,385	14%
Light-Medium Duty Vehicles	551,383	37%	538,702	34%	528,096	32%
Heavy-Duty Vehicles	156,370	10%	177,285	11%	189,440	11%
Off-Road Equipment	20,897	1%	26,598	2%	37,495	2%
Agriculture	330	<1%	186	<1%	101	<1%
Residential Electricity	111,554	7%	117,632	7%	127,198	8%
Non-Residential Electricity	249,180	17%	272,612	17%	297,334	18%
Solid Waste Management	79,716	5%	84,059	5%	90,690	5%
Wastewater Treatment	5,529	<1%	5,831	<1%	6,305	<1%
Water Transport, Distribution, and Treatment	13,406	1%	13,515	1%	14,614	1%
Total Emissions	**1,495,685**	**100%**	**1,570,575**	**100%**	**1,654,181**	**100%**

Figure 3-16a. Rancho Cucamonga GHG Emissions by Sector for 2016

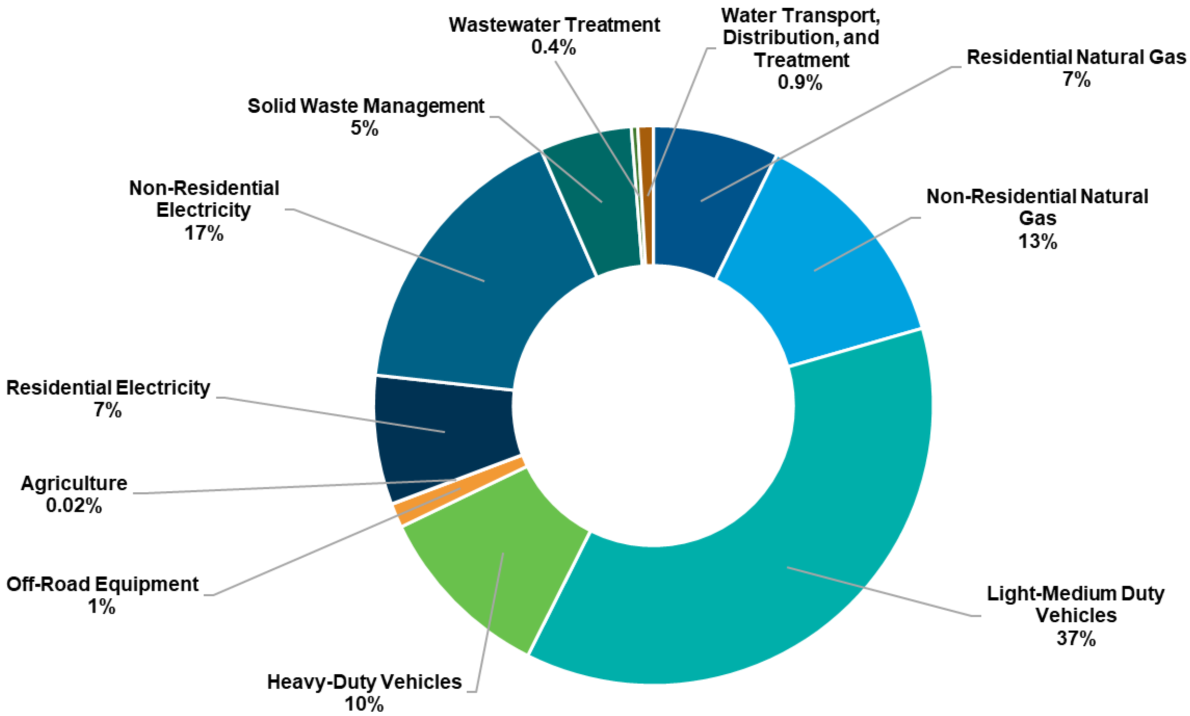
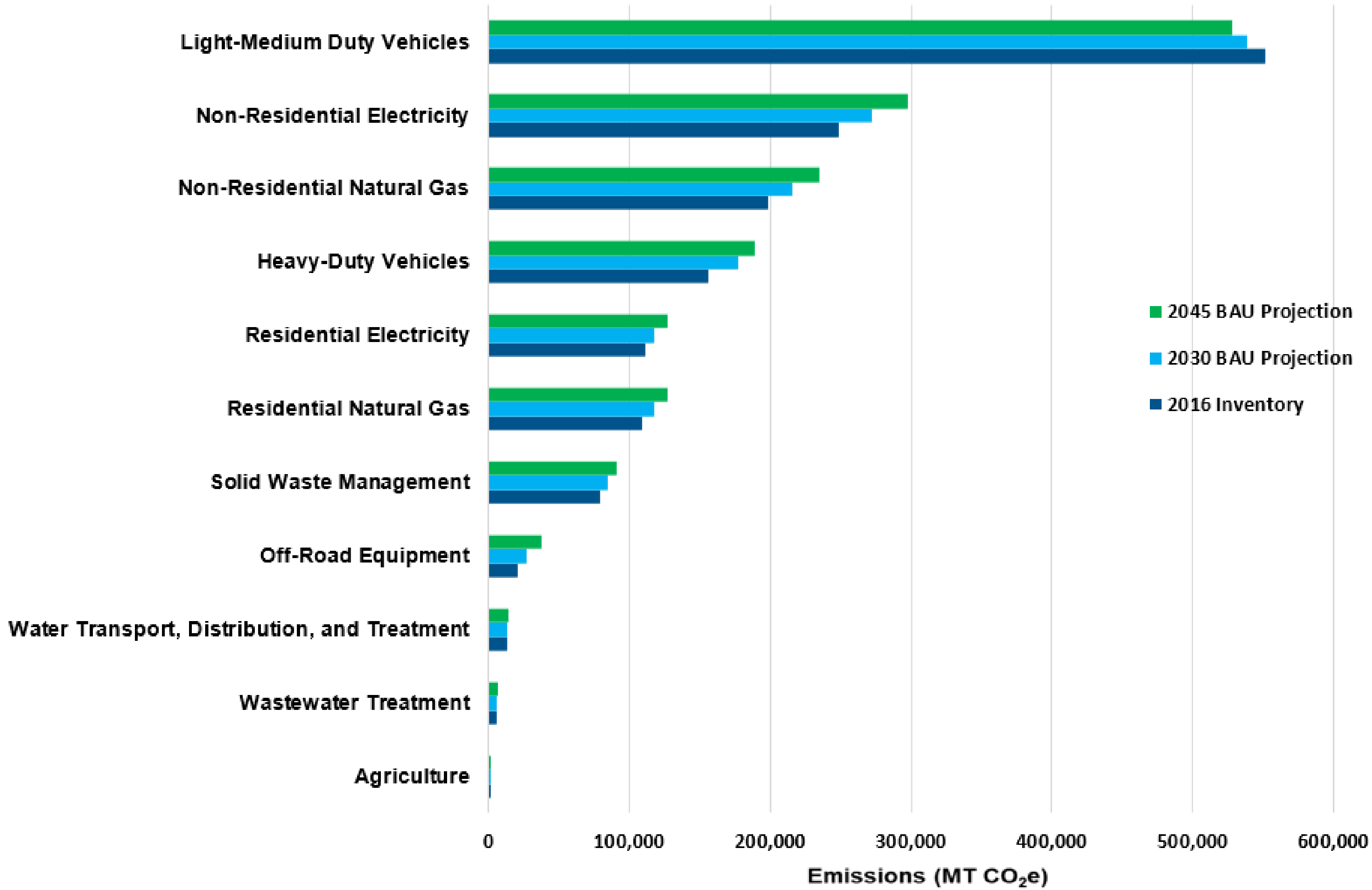


Figure 3-16b. Rancho Cucamonga GHG Emissions by Sector for 2016, 2030, and 2045



3.17 Redlands

Primary sources of GHG emissions in Redlands are on-road transportation (55%), building energy (36%), and waste (6%). Emissions are projected to increase by 10% from 2016 to 2030 and by 21% from 2016 to 2045 due to economic and population growth. In 2016, Redlands had per capita emissions of 7.9 MT CO_2e, which is higher than the region's average per capita emissions of 7.5 MT CO_2e.

Table 3-17. Redlands 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecast (MTCO₂e)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	52,105	10%	58,708	10%	65,783	10%
Non-Residential Natural Gas	20,800	4%	24,055	4%	27,543	4%
Light-Medium Duty Vehicles	232,737	43%	242,557	40%	254,090	39%
Heavy-Duty Vehicles	66,003	12%	79,824	13%	91,148	14%
Off-Road Equipment	8,424	2%	11,114	2%	16,085	2%
Agriculture	1,964	<1%	1,106	<1%	598	<1%
Residential Electricity	50,607	9%	54,361	9%	58,832	9%
Non-Residential Electricity	74,495	14%	86,522	14%	99,367	15%
Solid Waste Management	34,147	6%	36,680	6%	39,652	6%
Wastewater Treatment	1,958	<1%	2,103	<1%	2,276	<1%
Water Transport, Distribution, and Treatment	2,761	1%	2,845	<1%	3,079	<1%
Total Emissions	**546,000**	**100%**	**599,876**	**100%**	**658,453**	**100%**

[a] Redlands owns and operates the California Street Landfill, so site-based emissions from this landfill were included in Redland’s inventory. These emissions do not double-count the Scope 2 solid waste management emissions.

Figure 3-17a. Redlands GHG Emissions by Sector for 2016

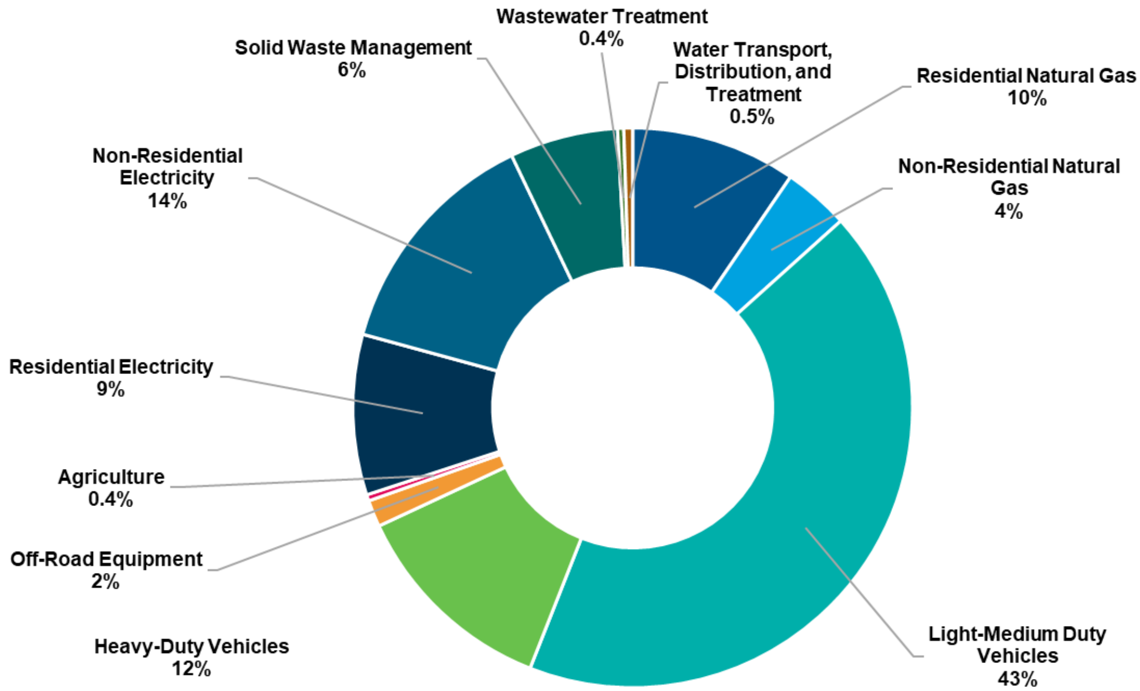
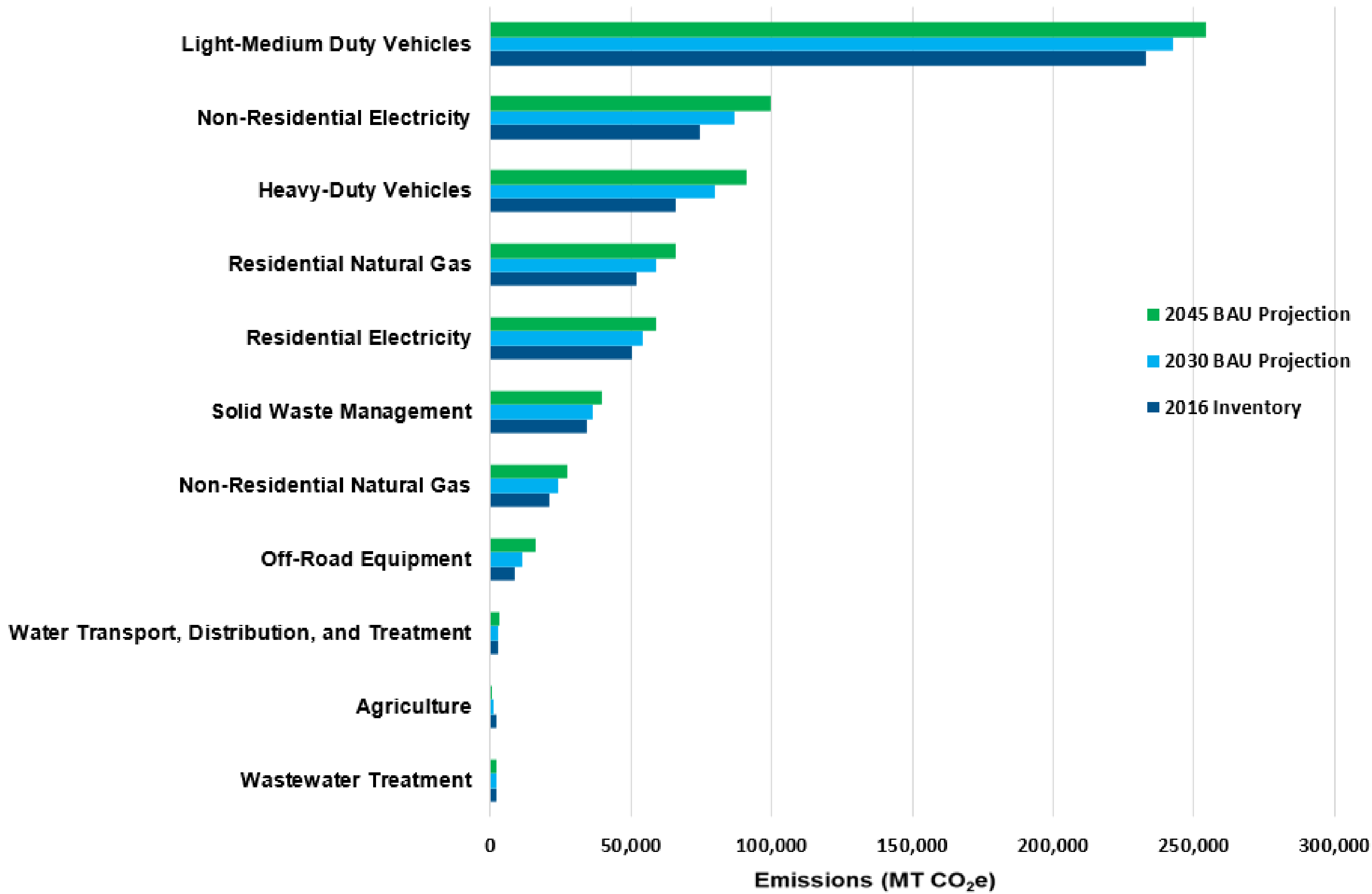


Figure 3-17b. Redlands GHG Emissions by Sector for 2016, 2030, and 2045



3.18 Rialto

Primary sources of GHG emissions in Rialto are on-road transportation (52%), building energy (39%), and waste (5%). Emissions are projected to increase by 13% from 2016 to 2030 and by 26% from 2016 to 2045 due to economic and population growth. In 2016, Rialto had per capita emissions of 5.1 $MTCO_2e$, which is lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-18. Rialto 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	**Emissions**	**Percent**	**Emissions**	**Percent**	**Emissions**	**Percent**
Residential Natural Gas	48,290	10%	57,954	10%	67,617	11%
Non-Residential Natural Gas	29,231	6%	35,256	6%	40,837	6%
Light-Medium Duty Vehicles	203,994	40%	207,833	36%	212,911	33%
Heavy-Duty Vehicles	57,852	11%	68,397	12%	76,376	12%
Off-Road Equipment	10,796	2%	15,597	3%	23,496	4%
Agriculture	212	<1%	119	<1%	64	<1%
Residential Electricity	47,894	9%	57,478	10%	67,062	10%
Non-Residential Electricity	75,299	15%	91,248	16%	105,013	16%
Solid Waste Management	25,459	5%	30,554	5%	35,637	6%
Wastewater Treatment	3,111	1%	3,734	1%	4,357	1%
Water Transport, Distribution, and Treatment	6,166	1%	7,099	1%	8,283	1%
Total Emissions	**508,304**	**100%**	**575,269**	**100%**	**641,653**	**100%**

Figure 3-18a. Rialto GHG Emissions by Sector for 2016

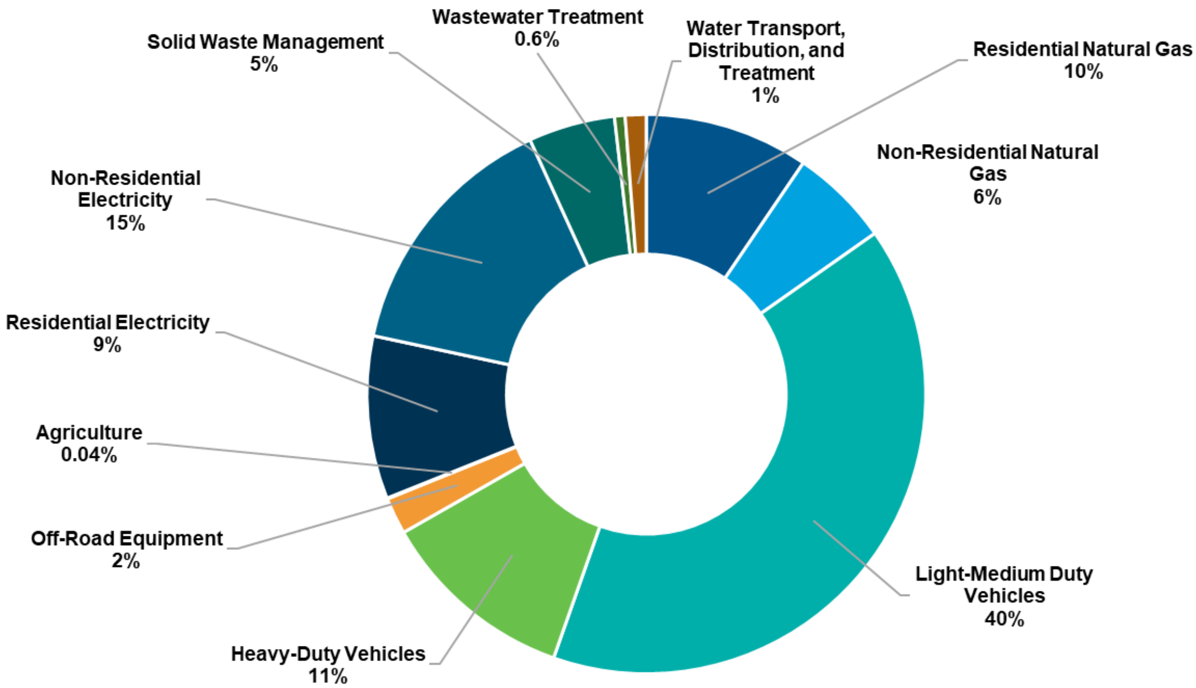
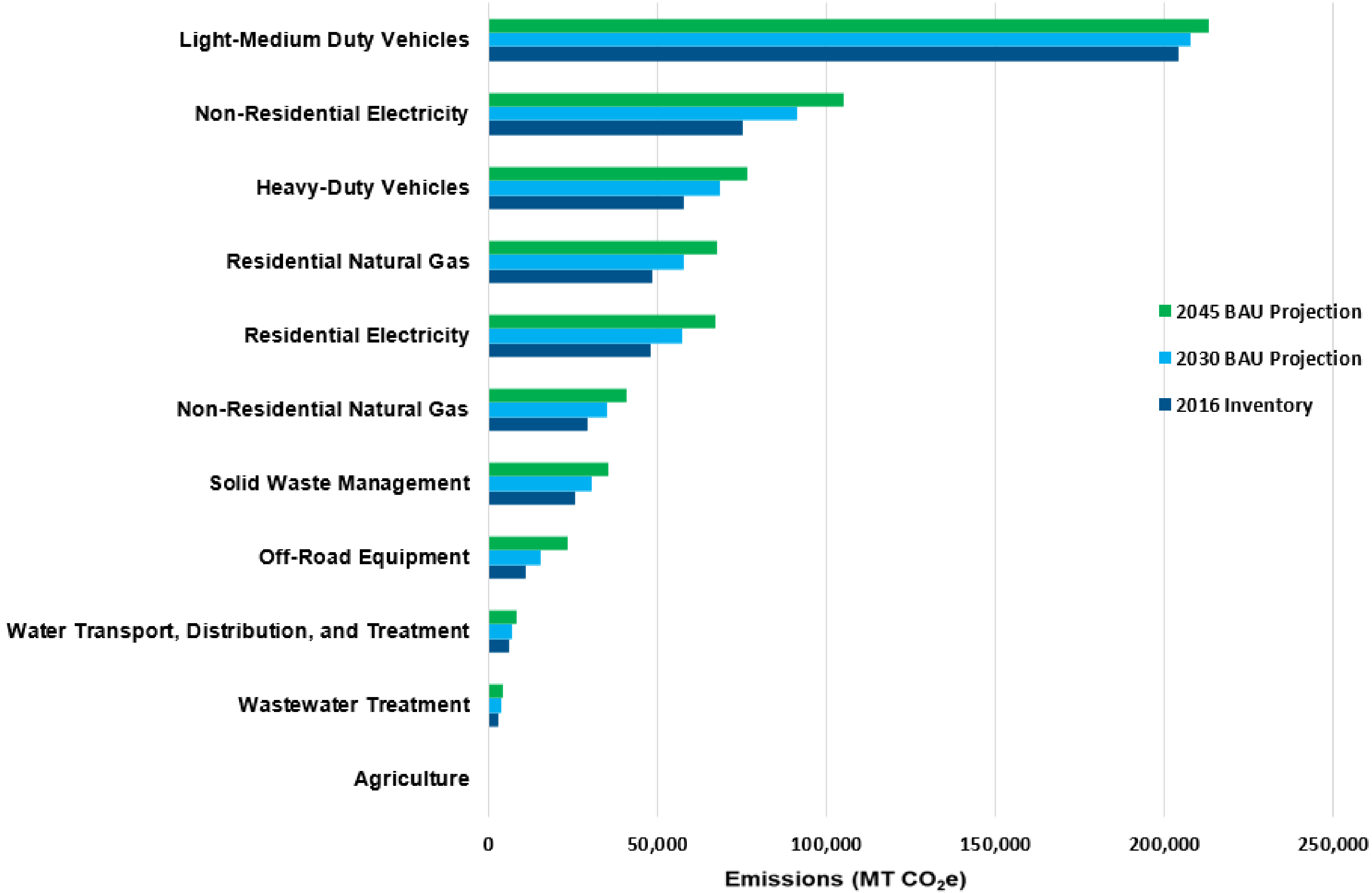


Figure 3-18b. Rialto GHG Emissions by Sector for 2016, 2030, and 2045



3.19 San Bernardino

Primary sources of GHG emissions in San Bernardino are on-road transportation (54%), building energy (35%), and waste (8%). Emissions are projected to increase by 8% from 2016 to 2030 and by 17% from 2016 to 2045 due to economic and population growth. In 2016, San Bernardino had per capita emissions of 6.7 $MTCO_2e$, which are lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-9 San Bernardino 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	108,920	8%	116,900	8%	125,450	7%
Non-Residential Natural Gas	82,966	6%	92,545	6%	102,809	6%
Light-Medium Duty Vehicles	607,035	42%	631,826	41%	661,044	39%
Heavy-Duty Vehicles	172,153	12%	207,931	13%	237,131	14%
Off-Road Equipment	27,788	2%	33,744	2%	45,595	3%
Agriculture	1,096	<1%	617	<1%	334	<1%
Residential Electricity	104,756	7%	106,809	7%	111,635	7%
Non-Residential Electricity	211,906	15%	237,285	15%	264,244	16%
Solid Waste Management	110,556	8%	112,723	7%	117,697	7%
Wastewater Treatment	6,777	<1%	6,910	<1%	7,222	<1%
Water Transport, Distribution, and Treatment	6,573	<1%	6,430	<1%	6,720	<1%
Total Emissions	**1,440,525**	**100%**	**1,553,719**	**100%**	**1,679,882**	**100%**

Figure 3-19a. San Bernardino GHG Emissions by Sector for 2016

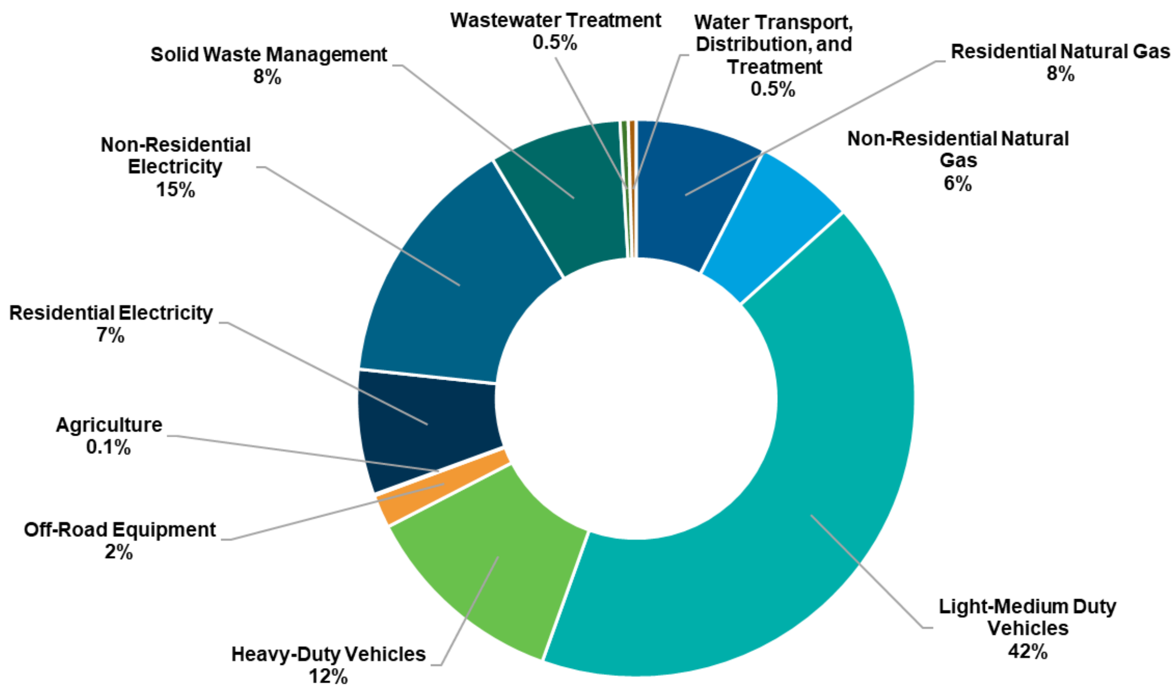
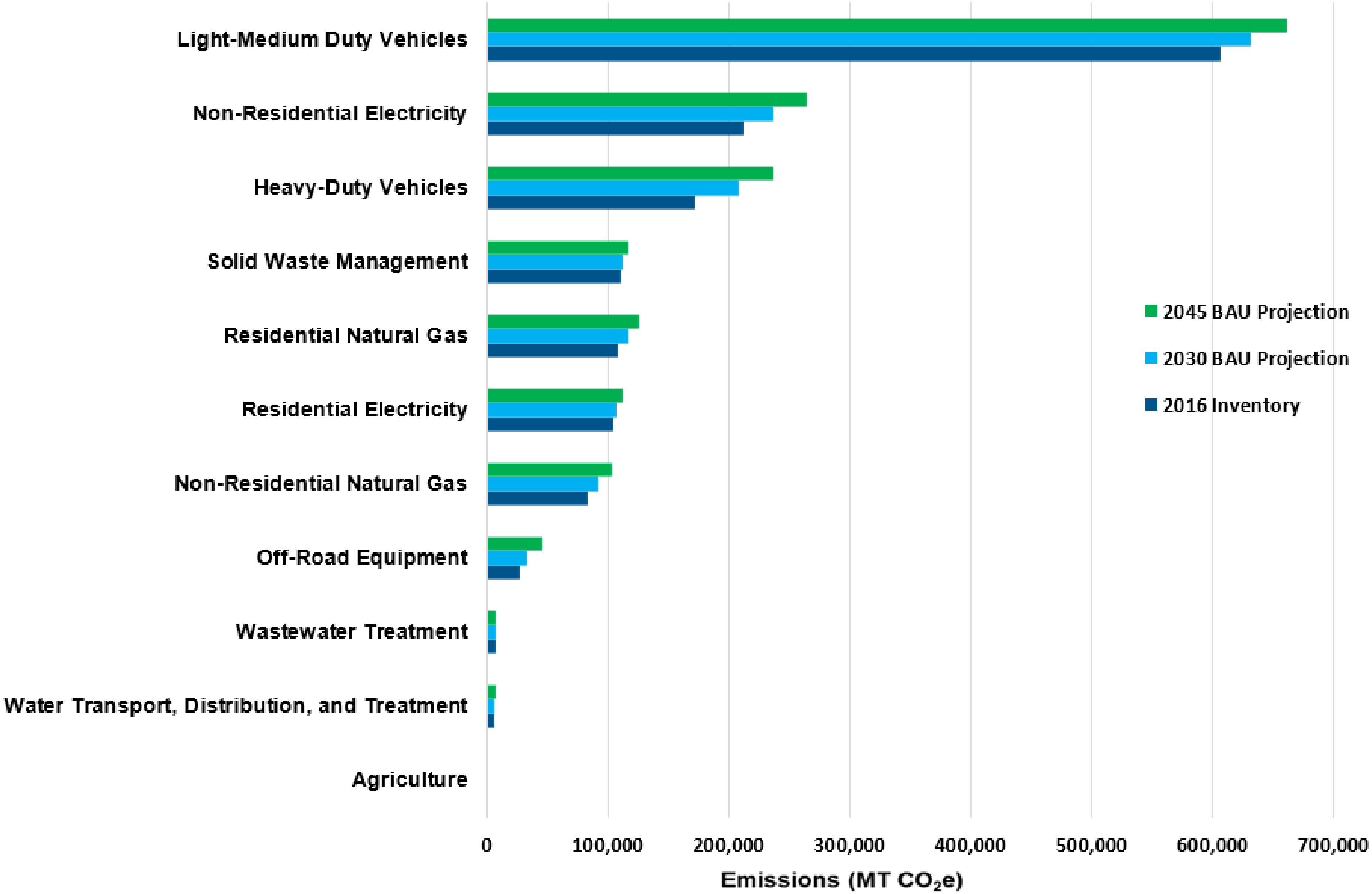


Figure 3-19b. San Bernardino GHG Emissions by Sector for 2016, 2030, and 2045



3.20 Twentynine Palms

Primary sources of GHG emissions in Twentynine Palms are on-road transportation (38%), waste (33%), and building energy (23%). Emissions are projected to increase by 25% from 2016 to 2030 and by 52% from 2016 to 2045 due to economic and population growth. In 2016, Twentynine Palms had per capita emissions of 4.7 $MTCO_2e$, which is lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-20. Twentynine Palms 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	7,532	6%	9,030	6%	10,635	6%
Non-Residential Natural Gas	2,323	2%	2,785	2%	3,280	2%
Light-Medium Duty Vehicles	30,920	25%	42,527	27%	54,896	29%
Heavy-Duty Vehicles	17,109	14%	23,276	15%	30,120	16%
Off-Road Equipment	2,802	2%	3,843	2%	5,642	3%
Agriculture	-	0%	-	0%	-	0%
Residential Electricity	12,454	10%	13,997	9%	15,642	8%
Non-Residential Electricity	6,858	5%	10,187	6%	13,753	7%
Solid Waste Management	41,972	33%	47,171	30%	52,715	28%
Wastewater Treatment	2,898	2%	3,257	2%	3,640	2%
Water Transport, Distribution, and Treatment	676	1%	729	<1%	814	<1%
Total Emissions	**125,545**	**100%**	**156,802**	**100%**	**191,139**	**100%**

Figure 3-20a. Twentynine Palms GHG Emissions by Sector for 2016

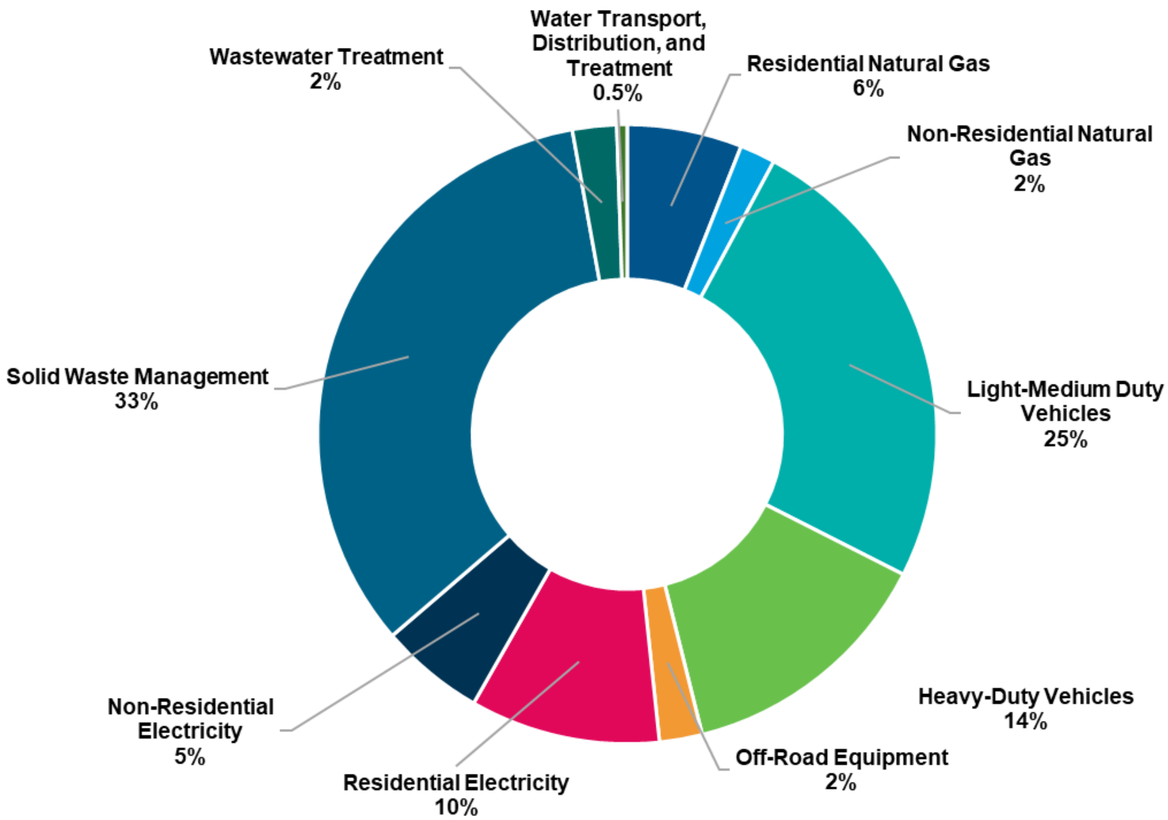
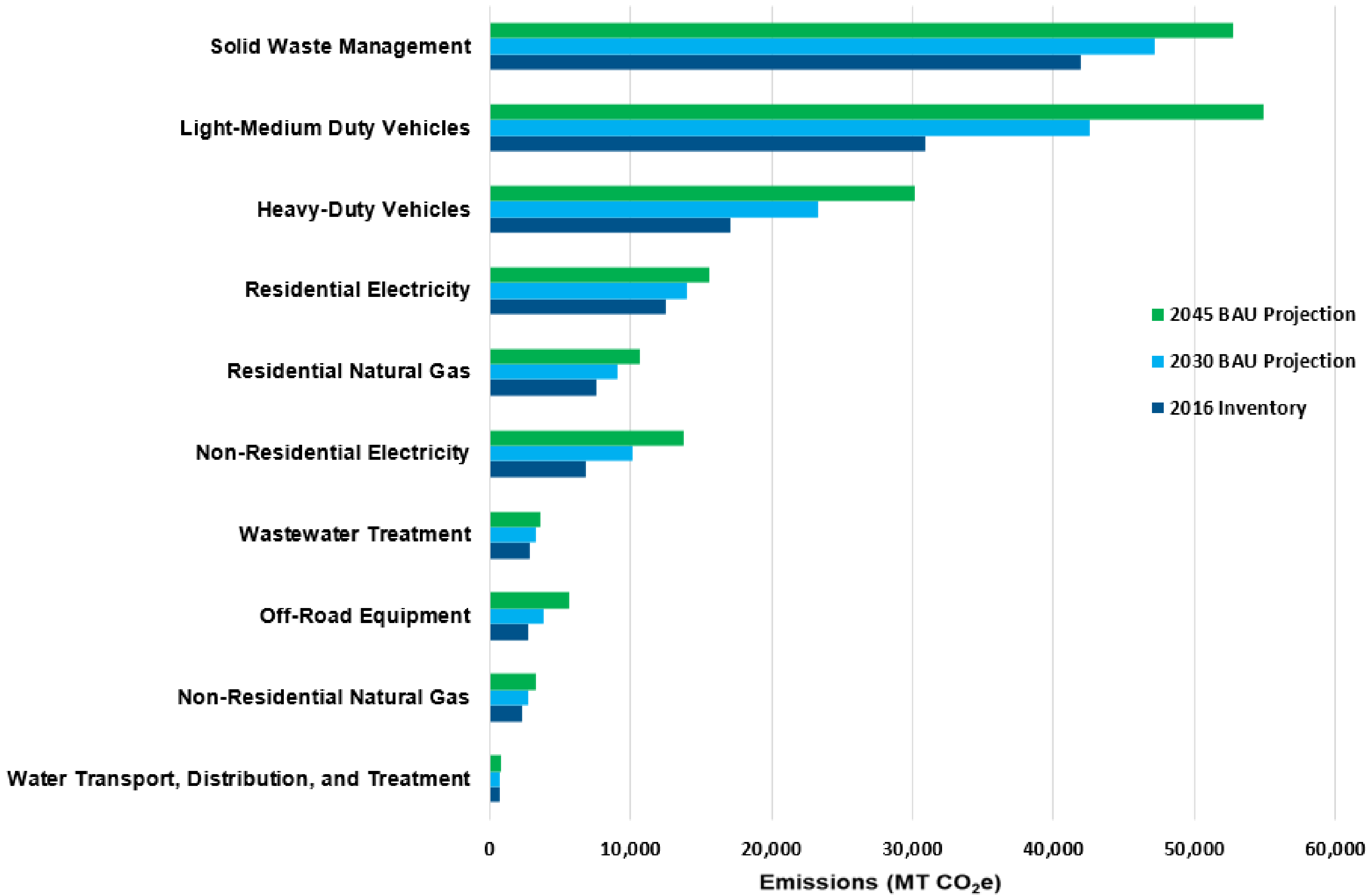


Figure 3-20b. Twentynine Palms GHG Emissions by Sector for 2016, 2030, and 2045



3.21 Upland

Primary sources of GHG emissions in Upland are on-road transportation (56%), building energy (32%), and waste (6%). Emissions are projected to increase by 7% from 2016 to 2030 and by 14% from 2016 to 2045 due to economic and population growth. In 2016, Upland had per capita emissions of 6.6 $MTCO_2e$, which are lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-21. Upland 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	41,422	8%	46,579	9%	52,105	9%
Non-Residential Natural Gas	39,522	8%	42,899	8%	46,518	8%
Light-Medium Duty Vehicles	219,226	44%	220,377	41%	222,696	39%
Heavy-Duty Vehicles	62,172	12%	72,525	14%	79,886	14%
Off-Road Equipment	8,909	2%	11,824	2%	17,002	3%
Agriculture	32	<1%	18	<1%	10	<1%
Residential Electricity	49,443	10%	54,494	10%	60,159	10%
Non-Residential Electricity	30,854	6%	33,229	6%	35,680	6%
Solid Waste Management	31,210	6%	34,399	6%	37,975	7%
Wastewater Treatment	2,394	<1%	2,638	<1%	2,912	1%
Water Transport, Distribution, and Treatment	16,563	3%	17,514	3%	19,335	3%
Total Emissions	**501,746**	**100%**	**536,496**	**100%**	574,278	**100%**

Figure 3-21a. Upland GHG Emissions by Sector for 2016

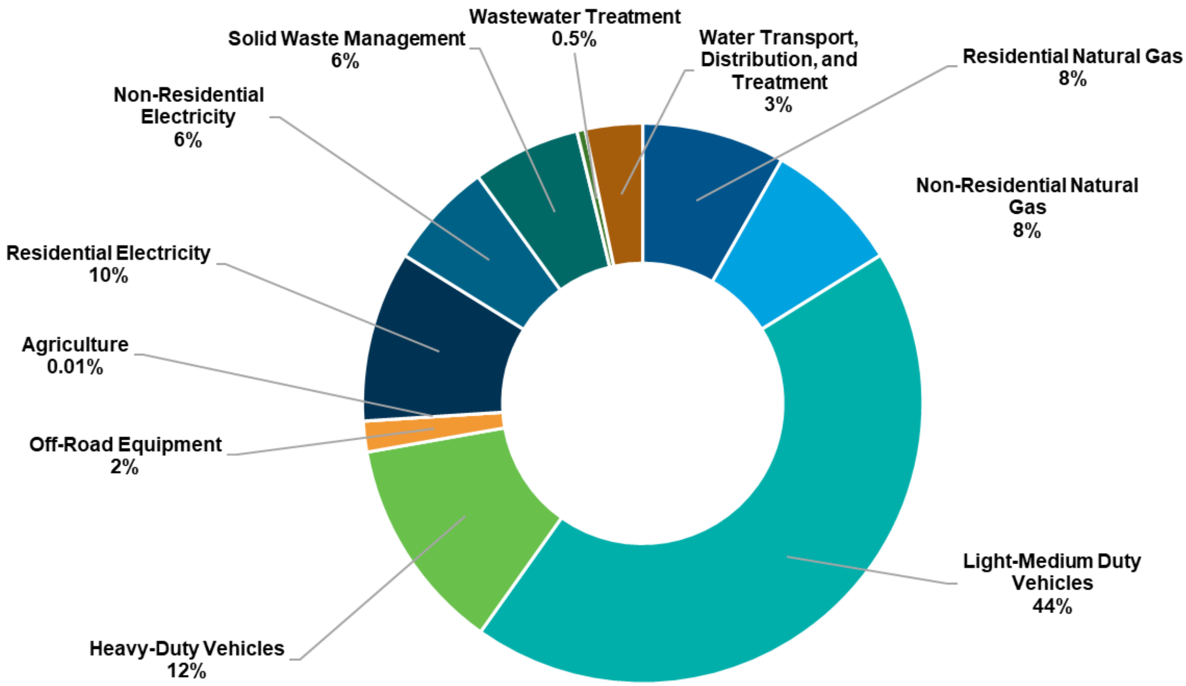
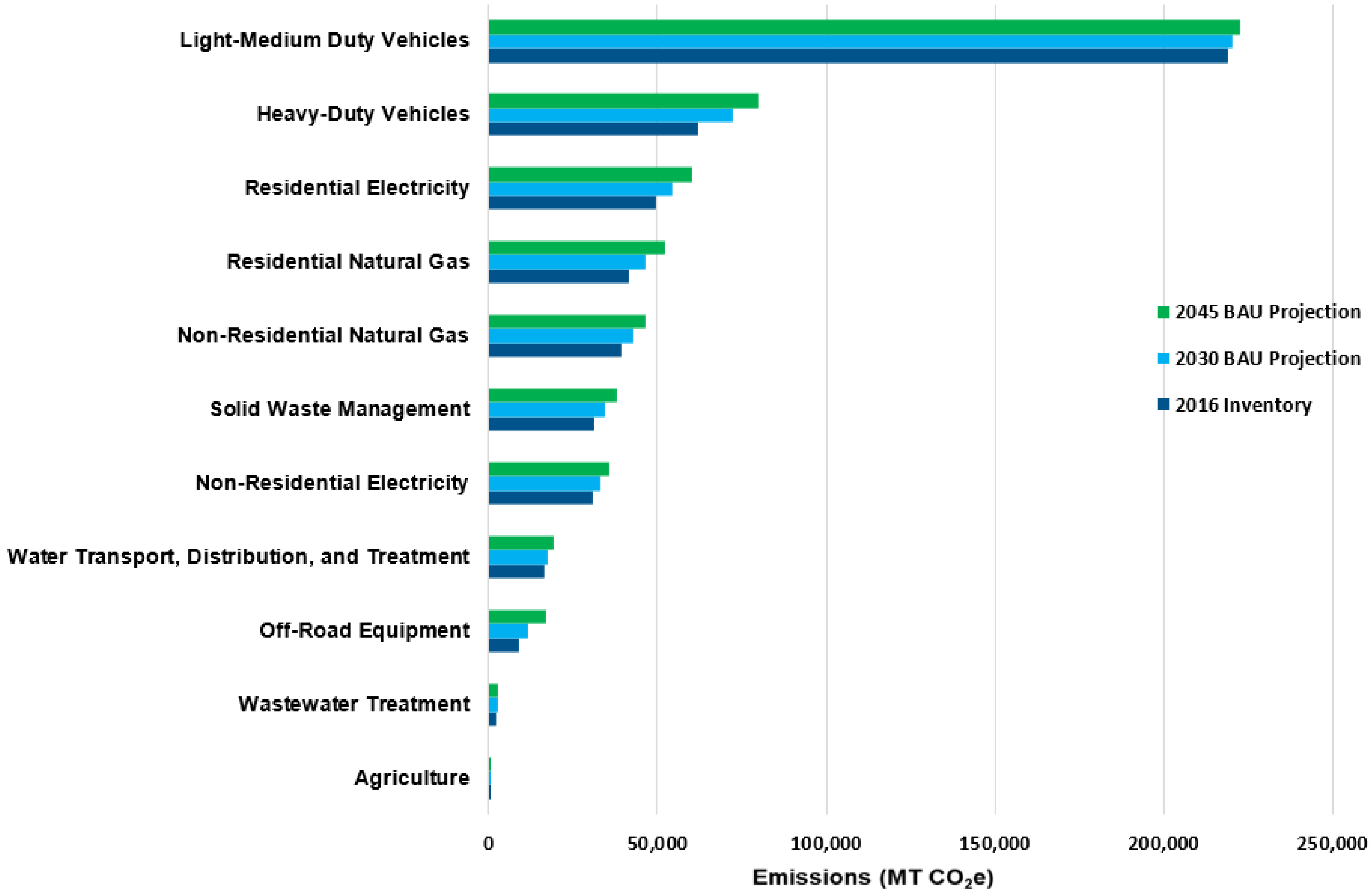


Figure 3-21b. Uplands GHG Emissions by Sector for 2016, 2030, and 2045



3.22 Victorville

Primary sources of GHG emissions in Victorville are on-road transportation (52%), building energy (40%), and waste (6%). Emissions are projected to increase by 20% from 2016 to 2030 and by 42% from 2016 to 2045 due to economic and population growth. In 2016, Victorville had per capita emissions of 7.2 $MTCO_2e$, which is lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-22. Victorville 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	**Emissions**	**Percent**	**Emissions**	**Percent**	**Emissions**	**Percent**
Residential Natural Gas	88,564	10%	123,695	12%	161,335	13%
Non-Residential Natural Gas	43,307	5%	59,717	6%	77,299	6%
Light-Medium Duty Vehicles	296,547	33%	329,008	31%	363,193	29%
Heavy-Duty Vehicles	164,086	18%	180,071	17%	199,276	16%
Off-Road Equipment	13,609	2%	21,094	2%	33,610	3%
Agriculture	5,020	1%	2,826	<1%	1,527	<1%
Residential Electricity	70,435	8%	90,594	8%	111,112	9%
Non-Residential Electricity	149,553	17%	184,582	17%	222,207	18%
Solid Waste Management	49,081	6%	63,129	6%	77,254	6%
Wastewater Treatment	3,863	<1%	4,969	<1%	6,094	<1%
Water Transport, Distribution, and Treatment	5,759	1%	7,107	1%	8,717	1%
Total Emissions	**889,825**	**100%**	**1,066,792**	**100%**	**1,261,623**	**100%**

Figure 3-22a. Victorville GHG Emissions by Sector for 2016

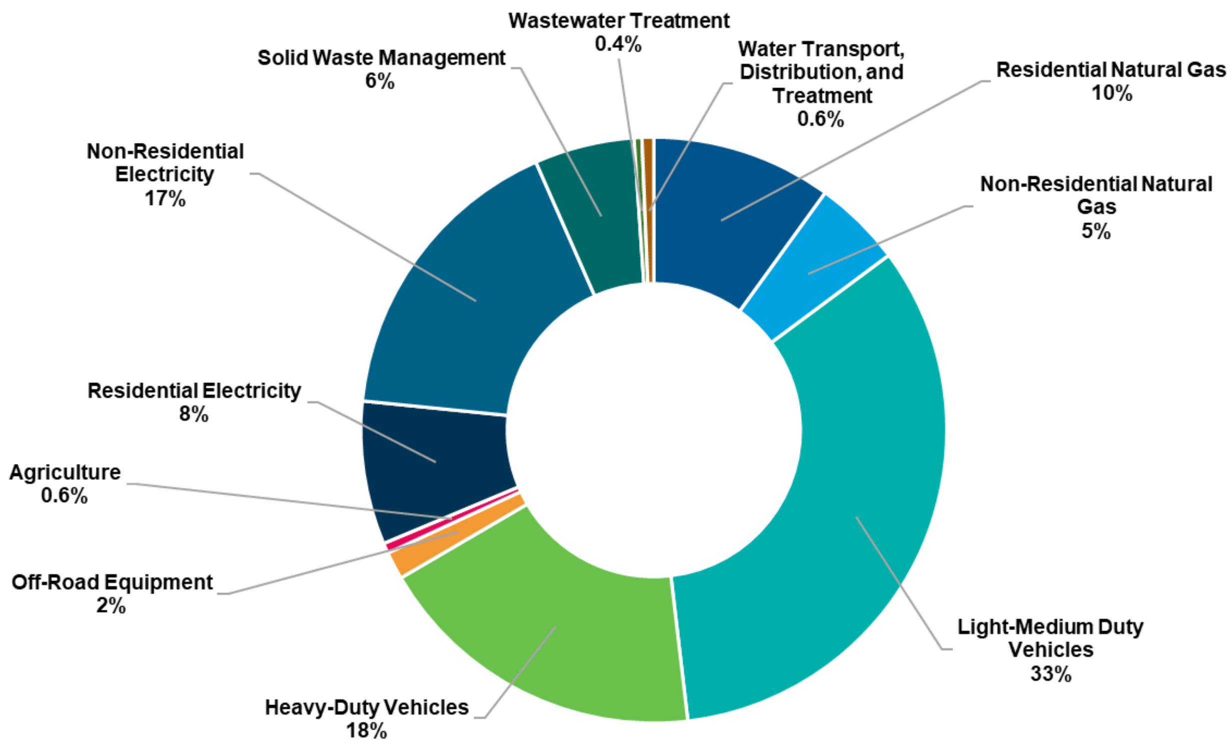
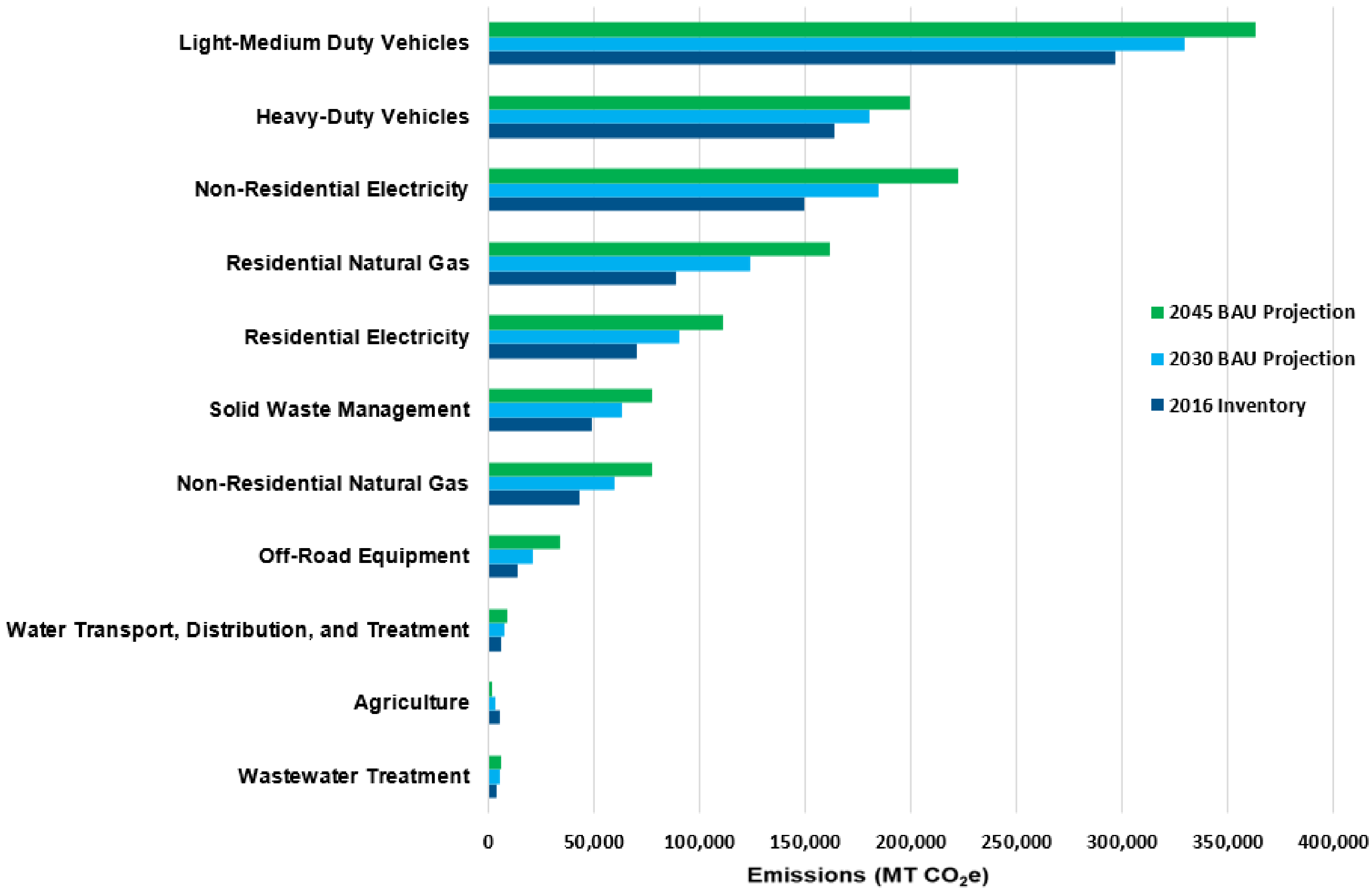


Figure 3-22b. Victorville GHG Emissions by Sector for 2016, 2030, and 2045



3.23 Yucaipa

Primary sources of GHG emissions in Yucaipa are on-road transportation (54%), building energy (35%), and waste (6%). Emissions are projected to increase by 20% from 2016 to 2030 and by 40% from 2016 to 2045 due to economic and population growth. In 2016, Yucaipa had per capita emissions of 5.2 $MTCO_2e$, which are lower than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-23. Yucaipa 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	44,718	16%	53,061	16%	61,189	16%
Non-Residential Natural Gas	5,739	2%	7,158	2%	9,344	2%
Light-Medium Duty Vehicles	117,130	42%	133,608	40%	151,587	38%
Heavy-Duty Vehicles	33,218	12%	43,970	13%	54,377	14%
Off-Road Equipment	5,929	2%	8,756	3%	12,812	3%
Agriculture	2,313	1%	1,302	0%	704	0%
Residential Electricity	35,552	13%	44,097	13%	49,718	13%
Non-Residential Electricity	10,828	4%	13,557	4%	19,411	5%
Solid Waste Management	16,422	6%	20,369	6%	22,966	6%
Wastewater Treatment	1,685	1%	2,090	1%	2,356	1%
Water Transport, Distribution, and Treatment	6,990	2%	8,318	2%	9,379	2%
Total Emissions	**280,522**	**100%**	**336,285**	**100%**	**393,842**	**100%**

Figure 3-23a. Yucaipa GHG Emissions by Sector for 2016

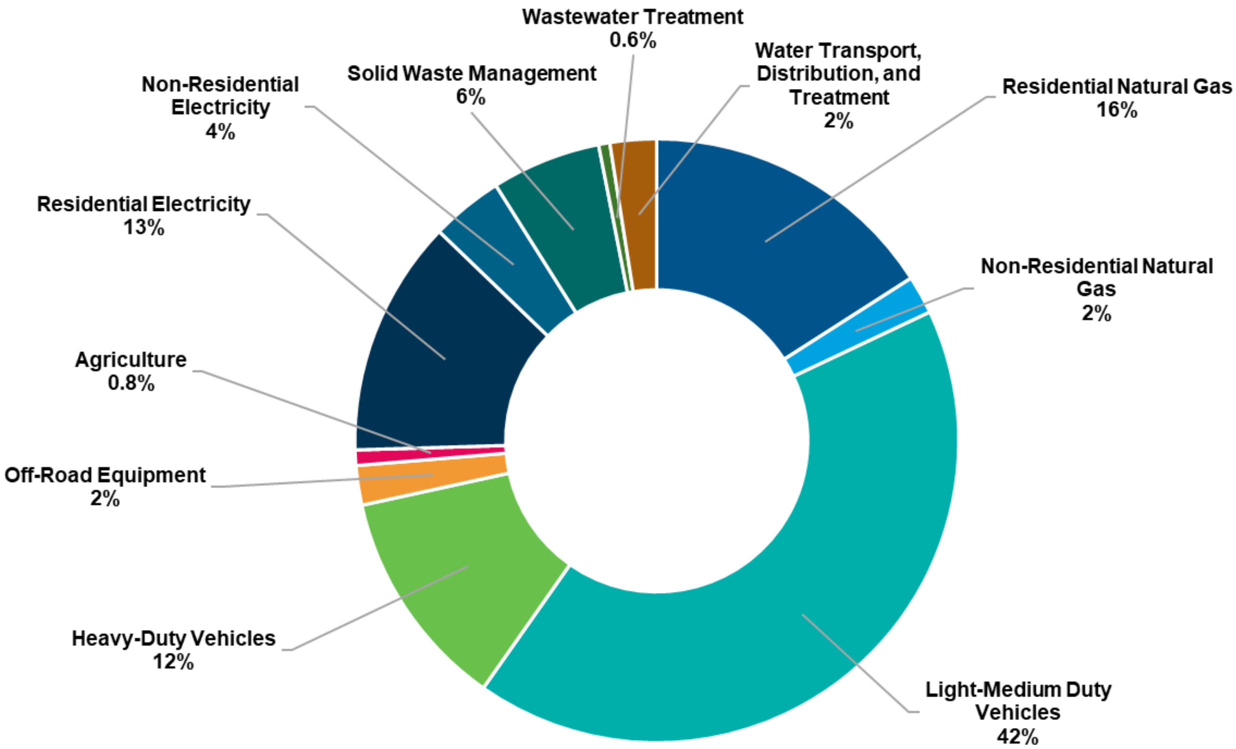
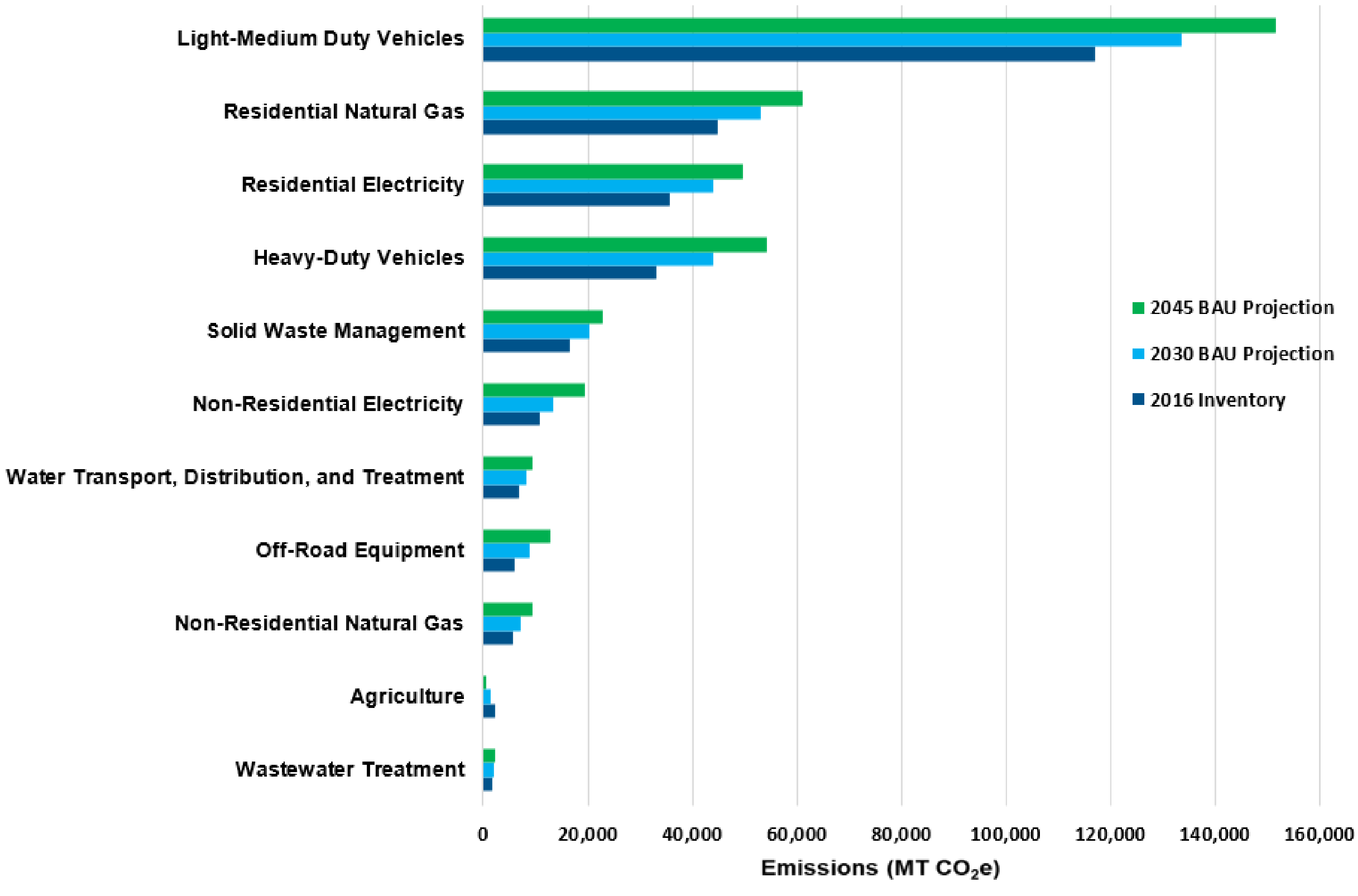


Figure 3-23b. Yucaipa GHG Emissions by Sector for 2016, 2030, and 2045



3.24 Yucca Valley

Primary sources of GHG emissions in Yucca Valley are on-road transportation (45%), building energy (27%), and waste (25%). Emissions are projected to increase by 12% from 2016 to 2030 and by 26% from 2016 to 2045 due to economic and population growth. In 2016, Yucca Valley had per capita emissions of 8.1 $MTCO_2e$, which is higher than the region's average per capita emissions of 7.5 $MTCO_2e$.

Table 3-24. Yucca Valley 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecasts ($MTCO_2e$)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	13,278	8%	15,197	8%	17,254	8%
Non-Residential Natural Gas	3,819	2%	4,375	2%	4,970	2%
Light-Medium Duty Vehicles	50,579	29%	57,034	30%	63,849	29%
Heavy-Duty Vehicles	27,986	16%	31,216	16%	35,033	16%
Off-Road Equipment	2,386	1%	3,199	2%	4,669	2%
Agriculture	-	0%	-	0%	-	0%
Residential Electricity	17,277	10%	18,890	10%	20,794	10%
Non-Residential Electricity	11,959	7%	15,336	8%	18,950	9%
Solid Waste Management	42,706	25%	46,694	24%	51,398	24%
Wastewater Treatment	2,347	1%	735	<1%	809	<1%
Water Transport, Distribution, and Treatment	394	<1%	414	<1%	455	<1%
Total Emissions	**172,732**	**100%**	**193,090**	**100%**	**218,180**	**100%**

Figure 3-24a. Yucca Valley GHG Emissions by Sector for 2016

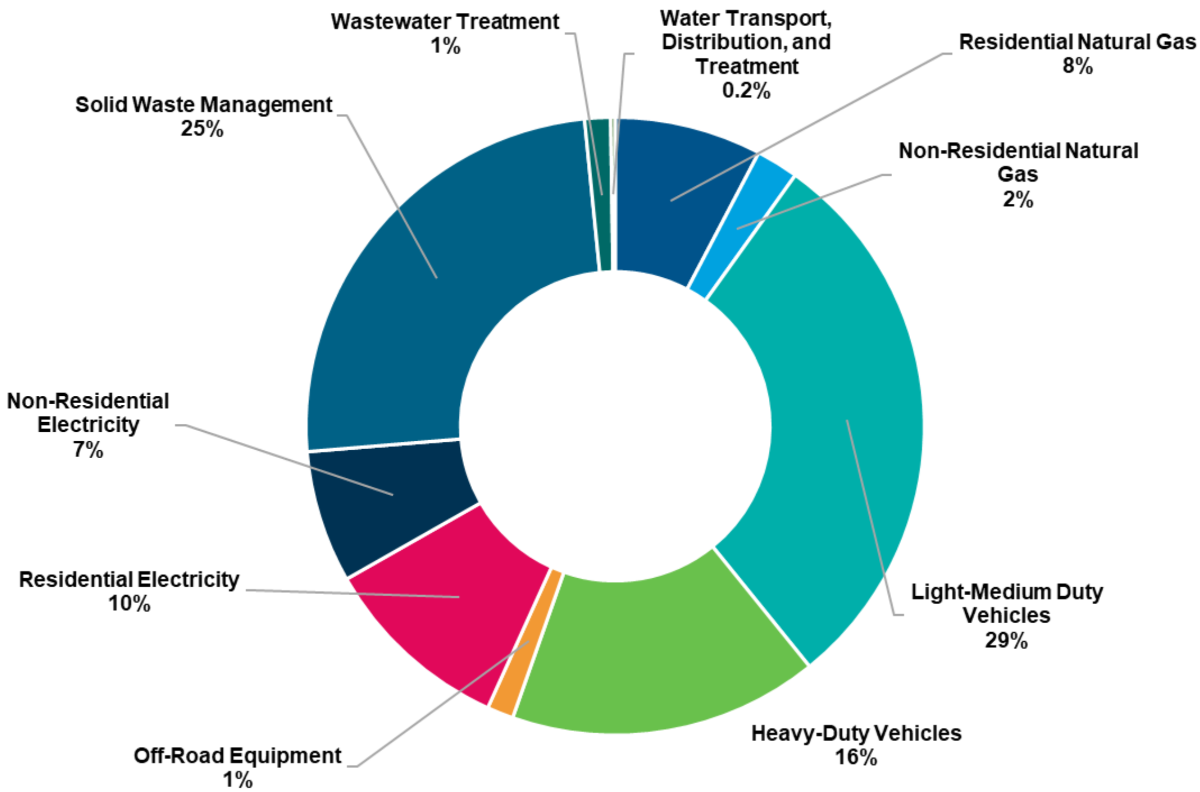
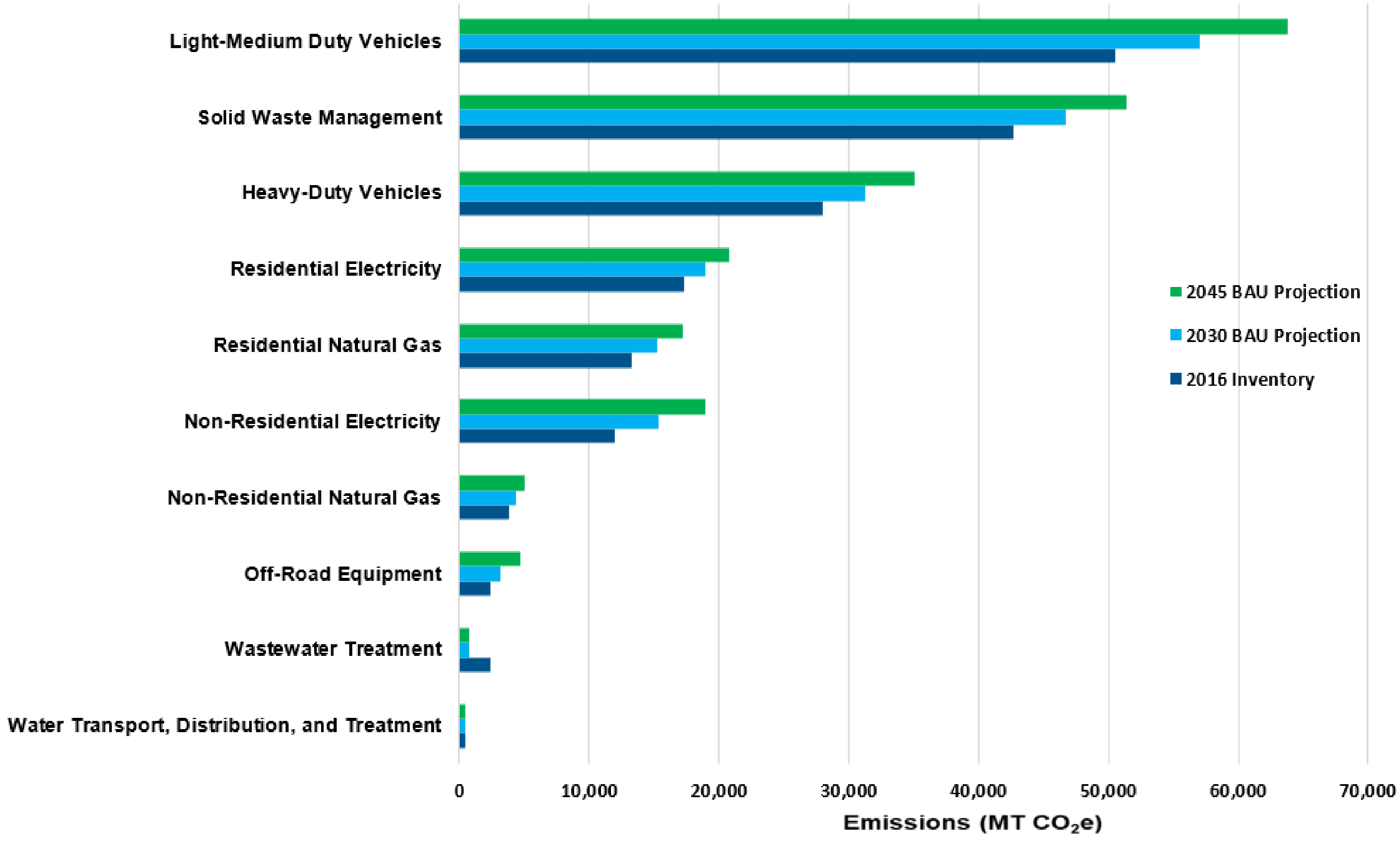


Figure 3-21b. Yucca Valley GHG Emissions by Sector for 2016, 2030, and 2045



3.25 Unincorporated San Bernardino County

Primary sources of GHG emissions in Unincorporated San Bernardino County are on-road transportation (53%), building energy (33%), and waste (7%). Emissions are projected to increase by 6% from 2016 to 2030 and by 14% from 2016 to 2045 due to economic and population growth. In 2016, Unincorporated San Bernardino County had per capita emissions of 9.3 MTCO2e, which are higher than the region's average per capita emissions of 7.5 MTCO2e.

Table 3-25. Unincorporated County 2016 Community Greenhouse Gas Inventory and 2030 and 2045 Forecast (MTCO$_2$e)

	2016 Inventory		2030 Forecast		2045 Forecast	
Sector	Emissions	Percent	Emissions	Percent	Emissions	Percent
Residential Natural Gas	195,318	7%	212,691	7%	231,305	7%
Non-Residential Natural Gas	132,470	5%	147,475	5%	163,552	5%
Light-Medium Duty Vehicles	1,075,196	37%	1,144,161	37%	1,219,311	37%
Heavy-Duty Vehicles	443,950	15%	497,090	16%	549,662	17%
Off-Road Equipment	35,618	1%	44,682	1%	60,700	2%
Agriculture	143,146	5%	80,591	3%	43,549	1%
Residential Electricity	194,972	7%	208,147	7%	223,434	7%
Non-Residential Electricity	425,423	15%	475,268	16%	528,588	16%
Solid Waste Management	197,260	7%	210,590	7%	226,055	7%
Wastewater Treatment	9,651	<1%	10,304	<1%	11,060	<1%
Water Transport, Distribution, and Treatment	20,465	1%	20,960	1%	22,500	1%
Total Emissions	**2,873,469**	**100%**	**3,051,959**	**100%**	**3,279,716**	**100%**

Figure 3-25a. Unincorporated County GHG Emissions by Sector for 2016

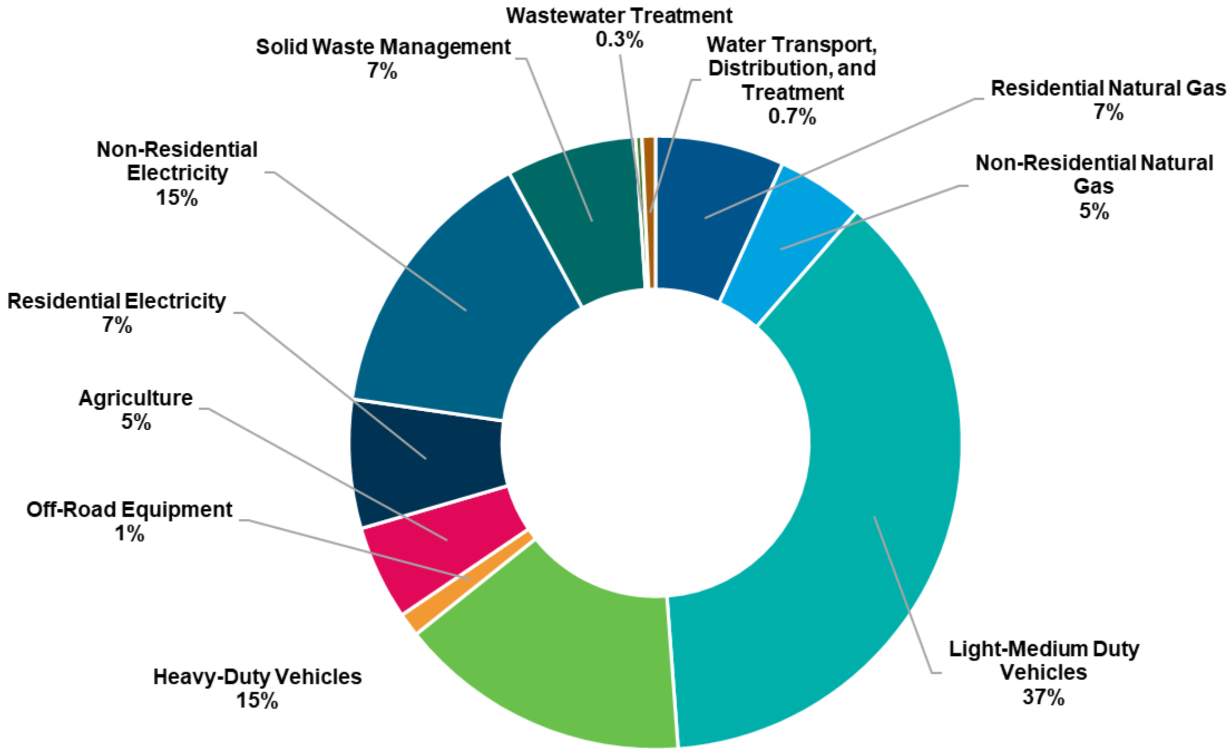
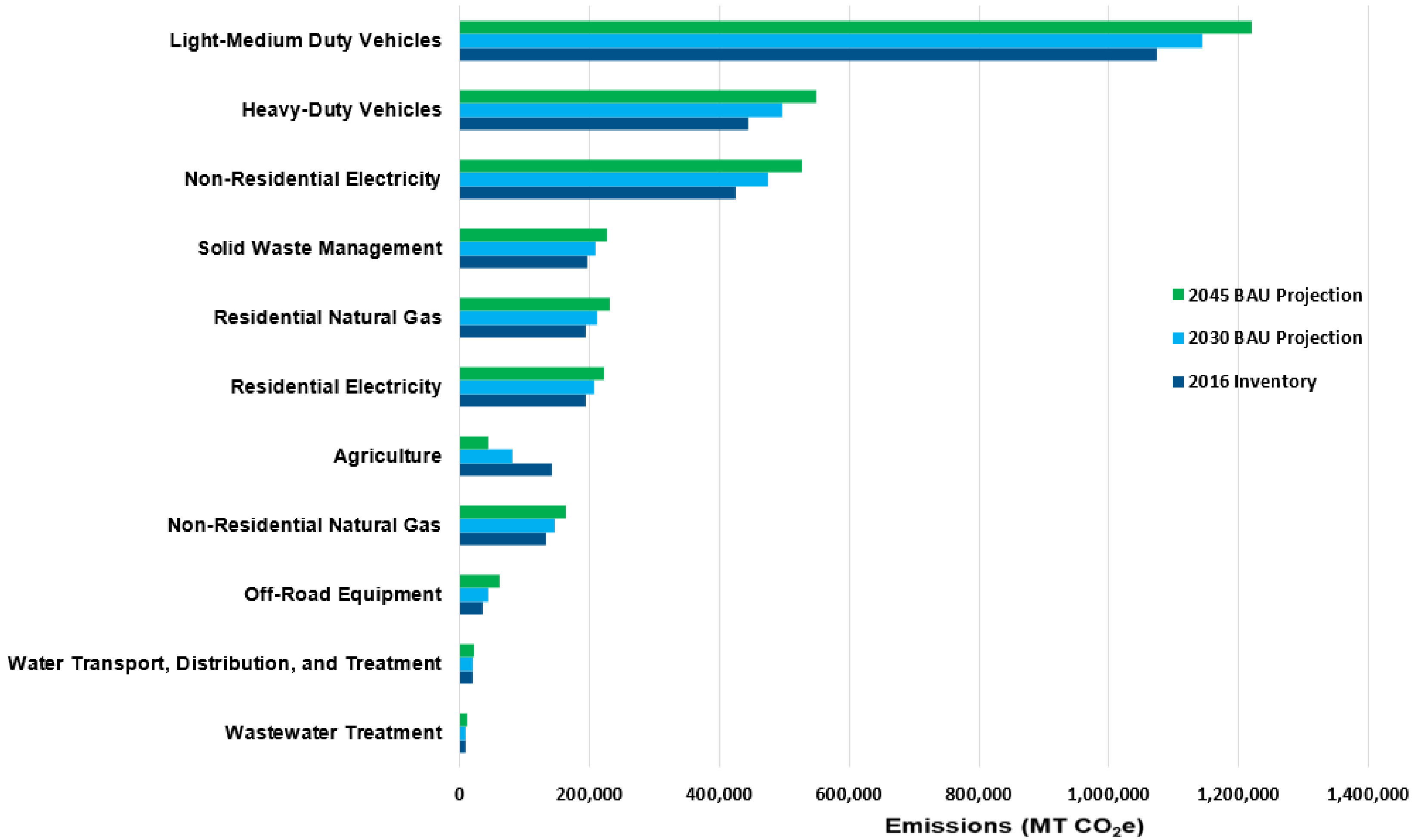


Figure 3-25b. Unincorporated County GHG Emissions by Sector for 2016, 2030, and 2045



Appendix A
Section 4: Inventory Results by Sector

This section presents the San Bernardino Regional Community GHG Emissions Inventories and BAU forecasts for each jurisdiction at the sector level. The sections below provide information for the individual sectors included in the inventories and forecasts. Introductory information for each sector is followed by a table and figure showing emissions. Activity data have also been included for the sectors where such data are relevant. Additional discussion with respect to data acquisition, calculations and methodologies, and data gaps can be found in Section 5.

4.1 Building Energy Use Emissions

Building energy use from residential, commercial, industrial, and municipal buildings and from street and outdoor lighting is a large component of the regional GHG inventory, accounting for 26% of the total regional emissions in 2016. Building energy consumption includes both electricity and natural gas usage.[1] Electricity use in buildings or in lighting fixtures results in indirect emissions released from the power plants that produce the electricity, which are largely outside of the jurisdiction where the end user is located. Natural gas consumption in building furnaces, stoves, and other appliances results in direct emissions that are released at the site of the natural gas combustion.

Primary Utilties Serving San Bernardino County Jurisdictions

Electricity
- Southern California Edison
- Victorville Municipal Utility Services
- Needles Municipal Utility
- Bear Valley Electric Services
- Rancho Cucamonga Municipal Utility
- Colton Municipal Utility

Natural Gas
- Southwest Gas
- Southern California Gas

Tables 4-1 and 4-2 and Figures 4-1 and 4-2 show the 2016, 2030 BAU, and 2045 BAU emissions inventory for electricity and natural gas use for each jurisdiction. The emissions in Tables 4-1 and 4-2 are shown by both residential and non-residential end uses. Non-residential emissions are generated by commercial, industrial, municipal, and institutional buildings and by municipally owned streetlights, traffic signals, and outdoor light fixtures. Building energy use emissions are generally a function of the size of a jurisdiction's boundaries, the number of residents, the types and ages of buildings, the composition of the power supply, and the number of employees.

Tables 4-3 and 4-4 show the electricity and natural gas consumption, respectively, for each jurisdiction for 2016, 2030 BAU, and 2045 BAU. The consumption data are shown for residential and non-residential uses.

[1] Emissions from electricity or natural gas consumption by on-site stationary equipment are not included in the activity estimates for building energy. Please refer to Section 4.9 "Stationary Sources," for a discussion of these emissions.

Table 4-1. Electricity Emissions by Jurisdiction and Sector

Jurisdiction	2016 ($MT CO_2e$)			2030 ($MT CO_2e$)			2045 ($MT CO_2e$)		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Adelanto	16,102	14,669	30,771	23,793	18,947	42,740	31,659	23,568	55,227
Apple Valley	51,684	26,892	78,576	62,195	36,353	98,547	70,527	46,800	117,327
Barstow	13,336	26,330	39,667	15,564	33,809	49,374	18,027	41,819	59,846
Big Bear Lake	7,672	8,976	16,649	8,901	9,978	18,880	10,219	11,051	21,270
Chino	44,159	121,468	165,627	53,201	128,089	181,290	62,888	135,179	198,067
Chino Hills	45,729	16,529	62,259	49,105	16,880	65,985	53,234	17,093	70,327
Colton	53,996	133,926	187,922	64,532	165,729	230,261	71,093	199,964	271,057
Fontana	96,888	134,422	231,310	113,518	155,516	269,033	131,643	178,072	309,715
Grand Terrace	8,642	6,576	15,218	9,310	9,080	18,391	10,106	11,759	21,865
Hesperia	54,657	33,929	88,586	75,498	51,595	127,093	98,050	70,511	168,561
Highland	31,329	13,626	44,955	35,046	18,134	53,179	39,849	22,896	62,745
Loma Linda	14,701	23,366	38,067	16,274	25,257	41,531	18,088	27,272	45,360
Montclair	15,971	25,899	41,870	17,733	27,002	44,735	20,283	27,496	47,779
Needles	2,650	2,579	5,229	8,523	6,195	14,718	11,475	6,807	18,281
Ontario	78,302	370,754	449,055	100,829	467,687	568,516	122,306	550,584	672,890
Rancho Cucamonga	111,554	249,180	360,734	117,632	272,612	390,244	127,198	297,334	424,532
Redlands	50,607	74,495	125,101	54,361	86,522	140,884	58,832	99,367	158,199
Rialto	47,894	75,299	123,193	57,478	91,248	148,726	67,062	105,013	172,075
San Bernardino	104,756	211,906	316,662	106,809	237,285	344,094	111,635	264,244	375,880
Twentynine Palms	12,454	6,858	19,312	13,997	10,187	24,183	15,642	13,753	29,395
Upland	49,443	30,854	80,297	54,494	33,229	87,723	60,159	35,680	95,839
Victorville	70,435	149,553	219,988	90,594	184,582	275,176	111,112	222,207	333,319
Yucaipa	35,552	10,828	46,380	44,097	13,557	57,654	49,718	19,411	69,129
Yucca Valley	17,277	11,959	29,237	18,890	15,336	34,227	20,794	18,950	39,743
Unincorporated County	194,972	425,423	620,395	208,147	475,268	683,415	223,434	528,588	752,022
Total	**1,230,762**	**2,206,297**	**3,437,058**	**1,420,522**	**2,590,075**	**4,010,597**	**1,615,033**	**2,975,418**	**4,590,451**

Table 4-2. Natural Gas Emissions by Jurisdiction and Sector

Jurisdiction	2016 (MT CO2e)			2030 (MT CO2e)			2045 (MT CO2e)		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Adelanto	18,728	15,334	34,062	31,415	22,039	53,454	45,453	29,362	74,815
Apple Valley	60,544	13,175	73,719	77,221	16,806	94,027	91,514	19,920	111,434
Barstow	15,897	12,745	28,643	19,938	15,985	35,923	24,267	19,456	43,723
Big Bear Lake	28,151	10,263	38,415	32,814	11,956	44,770	37,800	13,765	51,565
Chino	38,623	39,143	77,766	46,532	41,774	88,306	55,004	44,592	99,596
Chino Hills	47,130	8,921	56,052	51,144	9,319	60,463	55,444	9,745	65,189
Colton	24,799	23,847	48,646	31,361	29,472	60,833	35,761	35,499	71,260
Fontana	86,355	68,268	154,623	107,599	81,745	189,345	130,362	96,186	226,548
Grand Terrace	7,983	986	8,968	8,984	1,342	10,325	10,056	1,723	11,779
Hesperia	66,422	12,308	78,730	98,038	18,189	116,227	131,913	24,489	156,402
Highland	30,477	4,440	34,917	35,556	5,729	41,285	42,395	7,114	49,509
Loma Linda	14,424	468	14,892	16,700	506	17,206	19,138	547	19,685
Montclair	17,177	7,873	25,049	18,266	8,260	26,526	19,433	8,518	27,951
Needles	1,509	1,261	2,770	2,387	1,994	4,381	3,327	2,780	6,107
Ontario	79,225	188,412	267,637	104,371	245,509	349,880	128,343	298,730	427,072
Rancho Cucamonga	108,984	198,337	307,321	117,935	216,221	334,156	127,525	235,385	362,910
Redlands	52,105	20,800	72,904	58,708	24,055	82,763	65,783	27,543	93,326
Rialto	48,290	29,231	77,521	57,954	35,256	93,210	67,617	40,837	108,454
San Bernardino	108,920	82,966	191,885	116,900	92,545	209,445	125,450	102,809	228,259
Twentynine Palms	7,532	2,323	9,855	9,030	2,785	11,815	10,635	3,280	13,916
Upland	41,422	39,522	80,944	46,579	42,899	89,479	52,105	46,518	98,623
Victorville	88,564	43,307	131,871	123,695	59,717	183,412	161,335	77,299	238,633
Yucaipa	44,718	5,739	50,457	53,061	7,158	60,218	61,189	9,344	70,533
Yucca Valley	13,278	3,819	17,097	15,197	4,375	19,572	17,254	4,970	22,224
Unincorporated County	195,318	132,470	327,788	212,691	147,475	360,166	231,305	163,552	394,857
Total	**1,246,576**	**965,955**	**2,212,531**	**1,494,075**	**1,143,111**	**2,637,186**	**1,750,408**	**1,323,963**	**3,074,371**

Table 4-3. Electricity Consumption by Jurisdiction

Jurisdiction	2016 (MWh)			2030 (MWh)			2045 (MWh)		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Adelanto	64,379	58,709	123,153	95,128	75,814	170,942	126,576	94,289	220,865
Apple Valley	206,641	104,238	311,085	248,662	141,122	389,784	281,975	182,085	464,060
Barstow	53,320	105,278	158,652	62,229	135,180	197,409	72,075	167,202	239,277
Big Bear Lake	30,451	35,542	66,023	35,329	39,506	74,834	40,558	43,750	84,308
Chino	176,553	481,162	657,892	212,705	506,682	719,387	251,435	534,016	785,451
Chino Hills	182,831	62,893	245,907	196,328	64,009	260,337	212,835	64,558	277,392
Colton	102,370	248,395	350,867	122,344	307,402	429,746	134,784	371,465	506,249
Fontana	387,369	529,685	917,442	453,857	612,016	1,065,873	526,325	700,054	1,226,379
Grand Terrace	34,552	25,923	60,510	37,223	35,886	73,109	40,406	46,541	86,947
Hesperia	218,526	135,558	354,302	301,850	206,066	507,917	392,017	281,559	673,575
Highland	125,257	54,586	179,968	140,117	72,607	212,724	159,323	91,648	250,971
Loma Linda	58,777	92,529	151,365	65,066	99,942	165,007	72,317	107,842	180,159
Montclair	63,854	101,613	165,530	70,899	105,896	176,794	81,094	107,735	188,829
Needles	27,568	27,655	55,250	41,842	30,435	72,277	56,334	33,441	89,775
Ontario	313,060	1,472,234	1,785,607	403,129	1,856,483	2,259,612	488,994	2,184,770	2,673,763
Rancho Cucamonga	446,363	990,241	1,437,050	470,683	1,083,877	1,554,561	508,959	1,182,344	1,691,303
Redlands	202,332	294,878	497,413	217,344	342,552	559,896	235,217	393,464	628,682
Rialto	191,486	297,801	489,478	229,805	360,881	590,686	268,124	415,228	683,351
San Bernardino	418,828	847,620	1,266,867	427,035	949,088	1,376,123	446,333	1,056,875	1,503,208
Twentynine Palms	49,793	27,072	76,915	55,961	40,312	96,272	62,538	54,499	117,037
Upland	197,678	120,095	317,971	217,874	129,163	347,037	240,525	138,507	379,032
Victorville	281,607	587,920	869,809	362,206	724,488	1,086,694	444,240	871,269	1,315,509
Yucaipa	142,140	42,450	184,732	176,306	53,186	229,493	198,780	76,418	275,198
Yucca Valley	69,076	47,554	116,700	75,526	61,017	136,543	83,135	75,425	158,560
Unincorporated County	779,187	1,699,028	2,478,994	831,839	1,898,096	2,729,935	892,935	2,111,041	3,003,976
Total	**4,823,999**	**8,490,659**	**13,319,482**	**5,551,287**	**9,931,707**	**15,482,994**	**6,317,832**	**11,386,025**	**17,703,857**

Table 4-4. Natural Gas Consumption by Jurisdiction

Jurisdiction	2016 (MMBtu)			2030 (MMBtu)			2045 (MMBtu)		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Adelanto	346,064	288,722	634,786	580,491	414,908	995,399	839,901	552,728	1,392,629
Apple Valley	1,119,978	247,977	1,479,952	1,428,476	316,139	1,744,615	1,692,871	374,717	2,067,588
Barstow	292,649	239,632	561,546	367,032	300,539	667,571	446,728	365,797	812,524
Big Bear Lake	527,740	263,687	844,201	615,151	265,780	880,931	708,608	305,858	1,014,466
Chino	708,949	737,522	1,517,366	854,114	787,083	1,641,197	1,009,627	840,179	1,849,805
Chino Hills	868,437	168,108	1,123,389	942,392	175,591	1,117,982	1,021,629	183,616	1,205,245
Colton	455,110	449,320	949,941	575,535	555,300	1,130,835	656,283	668,856	1,325,139
Fontana	1,585,386	1,285,069	3,028,993	1,975,409	1,538,685	3,514,094	2,393,312	1,810,445	4,203,757
Grand Terrace	146,810	18,573	180,064	165,214	25,278	190,492	184,932	32,464	217,396
Hesperia	1,228,987	231,456	1,583,342	1,813,967	342,033	2,156,000	2,440,732	460,518	2,901,250
Highland	561,590	83,667	701,416	655,182	107,948	763,129	781,212	134,042	915,254
Loma Linda	264,499	8,818	299,766	306,228	9,532	315,760	350,937	10,301	361,238
Montclair	315,627	148,343	495,533	335,643	155,637	491,280	357,088	160,500	517,588
Needles	26,929	23,706	53,328	42,595	37,496	80,091	59,380	52,271	111,651
Ontario	1,455,417	3,544,445	5,145,404	1,917,375	4,618,455	6,535,831	2,357,756	5,619,536	7,977,292
Rancho Cucamonga	2,006,955	3,735,553	5,943,203	2,171,785	4,072,386	6,244,171	2,348,389	4,433,332	6,781,720
Redlands	961,531	394,464	1,452,147	1,083,389	454,614	1,538,004	1,213,952	520,437	1,734,389
Rialto	888,281	550,278	1,527,387	1,066,038	663,687	1,729,725	1,243,795	768,741	2,012,535
San Bernardino	2,003,563	1,563,229	3,767,148	2,150,352	1,743,703	3,894,055	2,307,625	1,937,093	4,244,718
Twentynine Palms	135,409	43,680	192,630	162,340	52,367	214,707	191,194	61,675	252,869
Upland	759,436	744,662	1,580,042	853,994	808,293	1,662,287	955,306	876,477	1,831,784
Victorville	1,639,972	814,458	2,618,427	2,290,509	1,123,029	3,413,538	2,987,492	1,453,646	4,441,138
Yucaipa	825,935	108,138	1,016,666	980,031	134,866	1,114,897	1,130,160	176,064	1,306,224
Yucca Valley	243,446	71,803	339,594	278,635	82,255	360,890	316,337	93,453	409,791
Unincorporated County	3,600,278	2,495,619	6,455,924	3,920,509	2,024,188	5,944,697	4,263,614	2,248,778	6,512,392
Total	**22,968,976**	**18,260,927**	**43,492,194**	**27,532,384**	**20,809,792**	**48,342,177**	**32,258,859**	**24,141,524**	**56,400,382**

Figure 4-1. Electricity Emissions by Jurisdiction

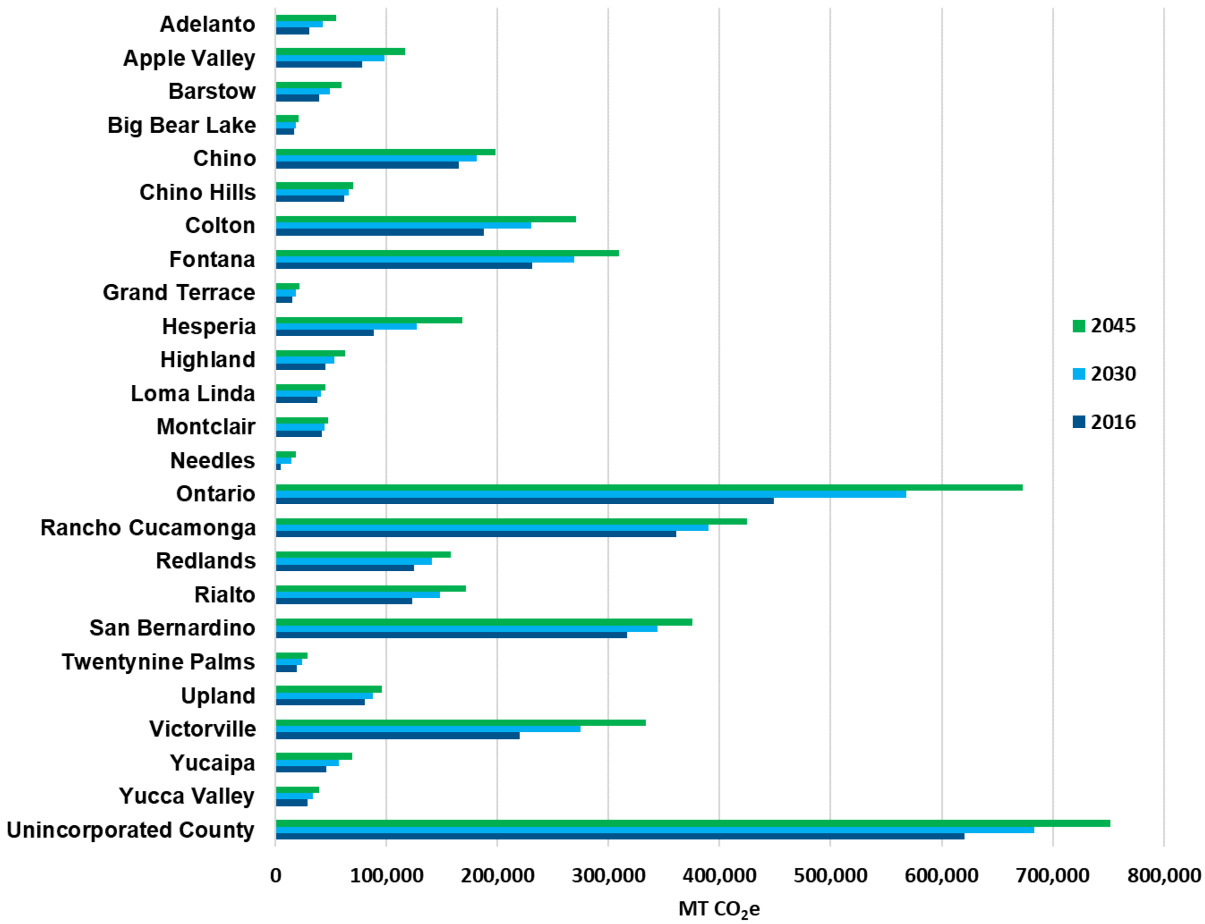
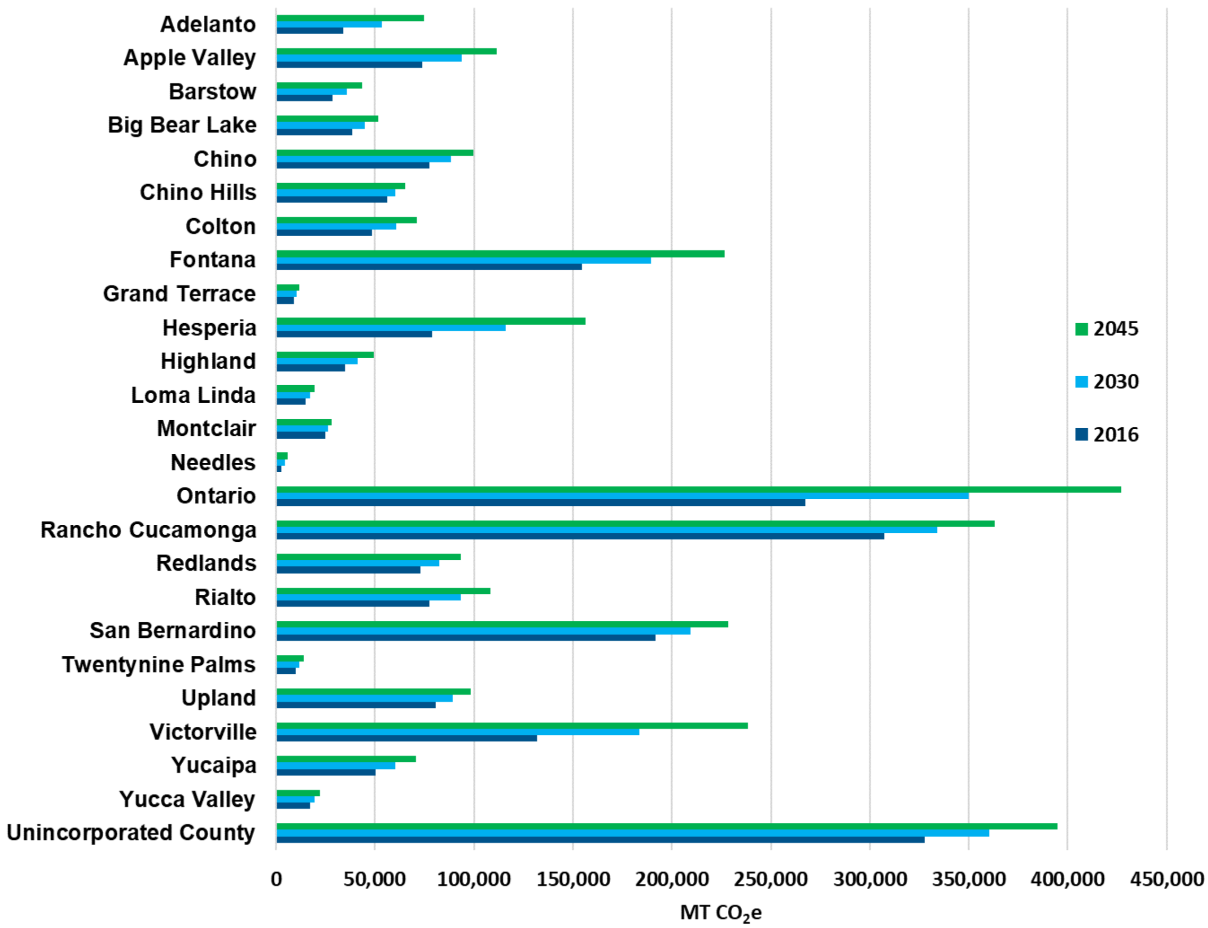


Figure 4-2. Natural Gas Emissions by Jurisdiction



4.2 Light/Medium-Duty Vehicle Emissions

This emissions sector includes emissions released from the exhaust pipes of light- and medium-duty vehicles in each jurisdiction, namely passenger vehicles and small trucks. Emissions in this sector are governed by the amount of vehicle miles traveled (VMT) related to land uses in the jurisdiction, because fossil fuels are used to propel the vast majority of vehicles. VMT from vehicle trips that both start and end within a jurisdiction are apportioned entirely to that jurisdiction. VMT from trips that start or end in a jurisdiction, but not both (i.e., one end of the trip is outside of that jurisdiction), are apportioned 50% to that jurisdiction. VMT from trips that neither begin nor end within a jurisdiction's limits are not included in that jurisdiction's inventory. This method of VMT accounting is known as the origin-destination method.

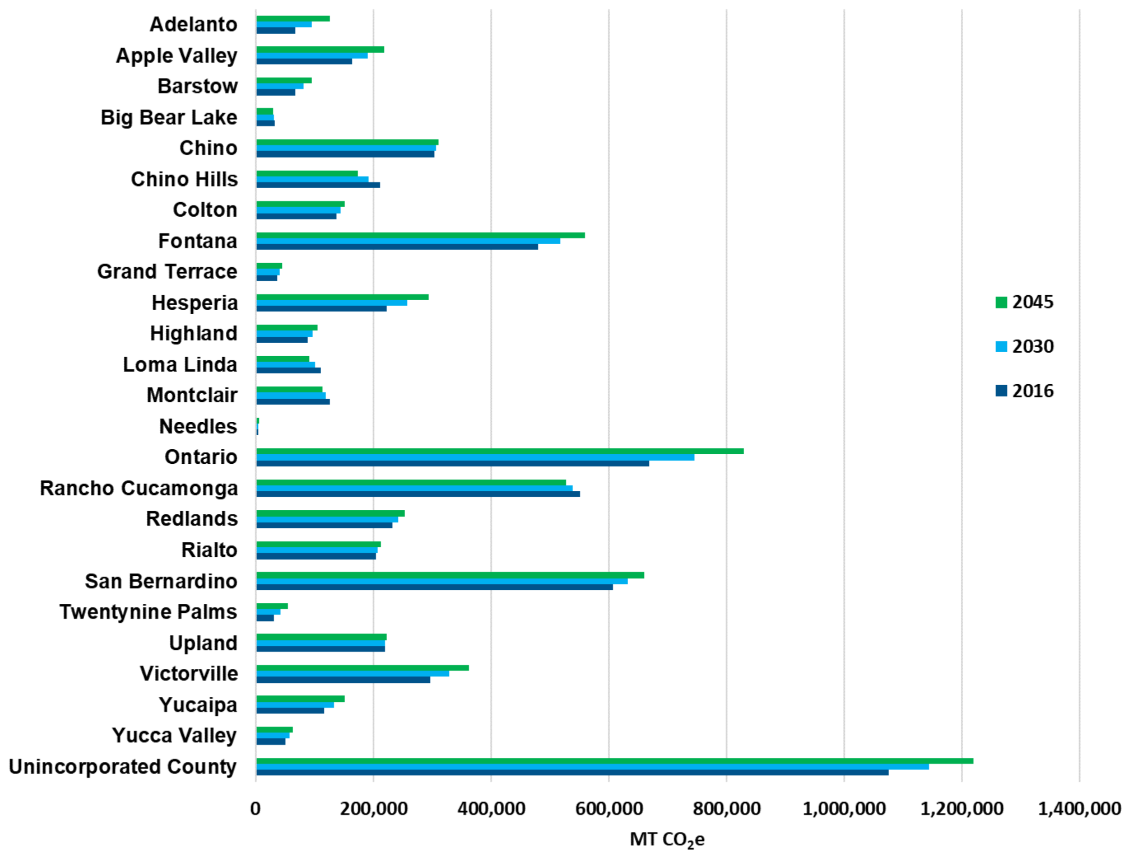
Emissions are created through the combustion of fossil fuels (such as diesel, gasoline, compressed natural gas, etc.) in the engines of light- and medium-duty vehicles and are released into the atmosphere through the exhaust pipes. These are considered direct emissions and accounts for approximately 28% of the region's total emissions in 2016.

Table 4-5 shows the 2016, 2030 BAU, and 2045 BAU emissions and vehicle miles travelled (VMT) for the light- and medium-duty sector for each jurisdiction. Figure 4-3 graphically shows the light- and medium-duty emissions for each jurisdiction for all three years.

Table 4-5. Light and Medium-Duty Vehicle VMT and Emissions by Jurisdictions

Jurisdiction	2016 Annual VMT	2016 GHG Emissions ($MTCO_2e$)	2030 Annual VMT	2030 GHG Emissions ($MTCO_2e$)	2045 Annual VMT	2045 GHG Emissions ($MTCO_2e$)
Adelanto	187,726,797	67,323	267,698,405	96,003	352,964,563	126,582
Apple Valley	458,265,427	164,345	531,381,618	190,567	608,785,940	218,326
Barstow	188,344,756	67,545	226,506,134	81,231	267,003,608	95,754
Big Bear Lake	88,118,798	31,974	84,572,995	30,687	81,274,932	29,490
Chino	837,814,943	303,999	845,482,952	306,781	857,793,519	311,248
Chino Hills	582,107,471	211,216	530,253,828	192,401	478,465,400	173,610
Colton	379,669,358	137,762	397,517,192	144,238	418,263,267	151,766
Fontana	1,324,152,418	480,465	1,427,808,166	518,076	1,543,860,609	560,186
Grand Terrace	101,141,711	36,699	112,579,307	40,849	125,158,348	45,413
Hesperia	621,668,306	222,946	717,719,934	257,392	819,366,931	293,845
Highland	244,718,451	88,795	265,705,184	96,410	289,084,110	104,893
Loma Linda	305,270,445	110,767	277,748,386	100,780	250,242,353	90,800
Montclair	347,360,818	126,039	329,536,604	119,571	312,476,356	113,381
Needles	13,256,149	4,754	14,664,681	5,259	16,147,284	5,791
Ontario	1,843,389,271	668,869	2,054,200,216	745,361	2,285,944,878	829,449
Rancho Cucamonga	1,519,599,624	551,383	1,484,651,120	538,702	1,455,422,841	528,096
Redlands	641,419,692	232,737	668,480,903	242,557	700,267,598	254,090
Rialto	562,204,061	203,994	572,783,811	207,833	586,779,235	212,911
San Bernardino	1,672,974,820	607,035	1,741,299,374	631,826	1,821,824,342	661,044
Twentynine Palms	86,218,086	30,920	118,584,609	42,527	153,074,229	54,896
Upland	604,182,345	219,226	607,354,503	220,377	613,744,297	222,696
Victorville	826,900,241	296,547	917,415,132	329,008	1,012,738,139	363,193
Yucaipa	322,808,066	117,130	368,221,146	133,608	417,769,672	151,587
Yucca Valley	141,035,130	50,579	159,036,492	57,034	178,039,220	63,849
Unincorporated County	2,980,561,679	1,075,196	3,171,741,022	1,144,161	3,380,063,907	1,219,311
Total	**16,880,908,863**	**6,108,245**	**17,892,943,716**	**6,473,242**	**19,026,555,577**	**6,882,208**

Figure 4-3. Light/Medium-Duty Vehicle VMT and Emissions by Jurisdiction



4.3 Heavy-Duty Vehicles

This emissions sector includes emissions released from the exhaust pipes of heavy-duty vehicles in each jurisdiction, namely large trucks and buses. As noted above for light- and medium-duty vehicles, VMT from heavy-duty vehicle trips are also apportioned to each jurisdiction using the origin-destination method. Heavy-duty vehicle emissions are generally a function of employment and goods movement activity in each jurisdiction.

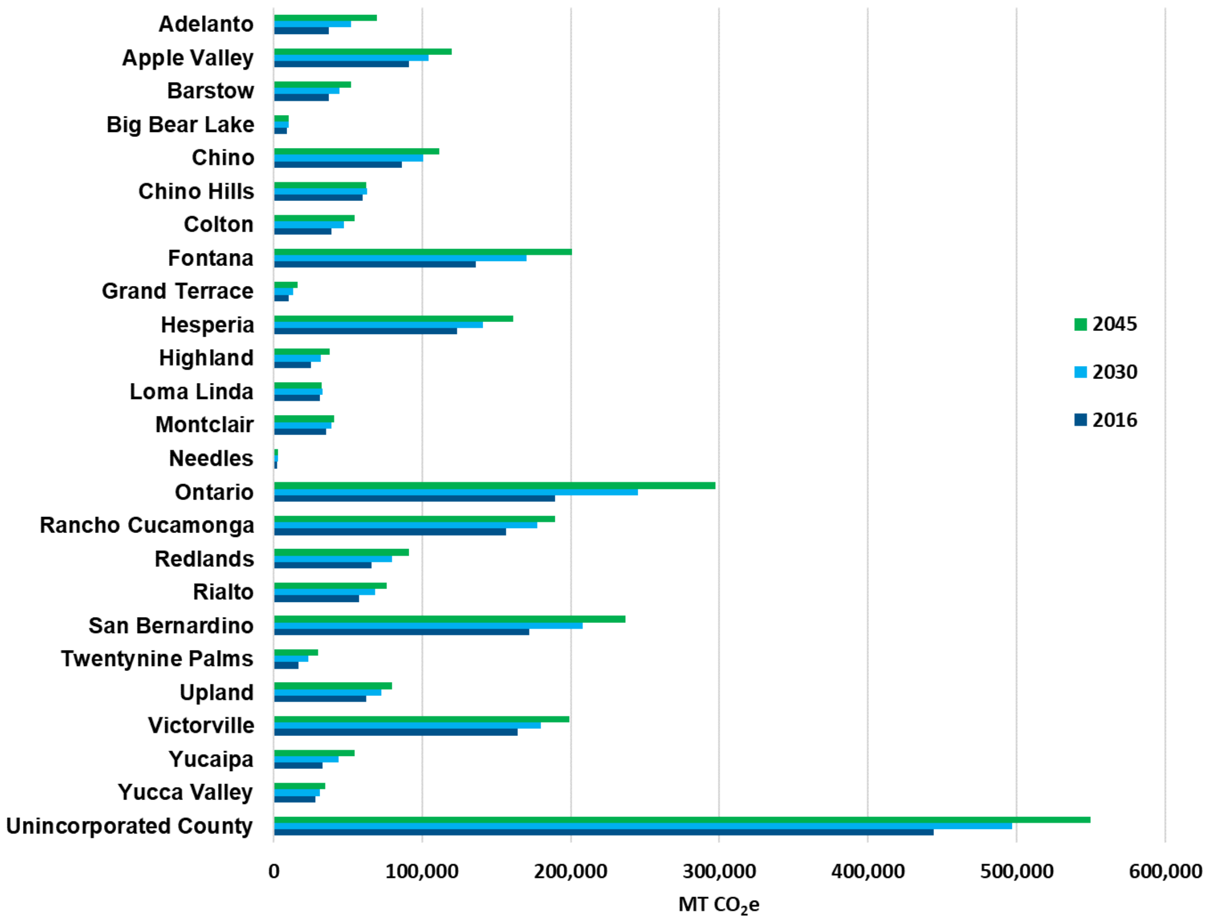
As with light- and medium-duty vehicles, emissions from heavy-duty vehicles originate from the combustion of fossil fuels and are considered direct emissions. This source of emissions accounts for approximately 10% of the region's total emissions in 2016.

Table 4-6 shows the 2016, 2030 BAU, and 2045 BAU emissions and VMT for the heavy-duty vehicle sector for each jurisdiction. Figure 4-4 graphically shows the heavy-duty emissions for each jurisdiction for all three years.

Table 4-6. Heavy-Duty Vehicle VMT and Emissions by Jurisdictions

Jurisdiction	2016 Annual VMT	2016 GHG Emissions ($MTCO_2e$)	2030 Annual VMT	2030 GHG Emissions ($MTCO_2e$)	2045 Annual VMT	2045 GHG Emissions ($MTCO_2e$)
Adelanto	29,704,752	37,252	41,899,148	52,544	55,382,280	69,453
Apple Valley	72,513,148	90,936	83,169,853	104,300	95,522,206	119,791
Barstow	29,802,534	37,374	35,451,888	44,459	41,894,485	52,538
Big Bear Lake	7,266,492	9,068	8,093,006	10,099	8,477,545	10,579
Chino	69,088,273	86,213	80,906,421	100,960	89,473,880	111,652
Chino Hills	48,002,008	59,900	50,741,342	63,318	49,907,297	62,278
Colton	31,308,465	39,069	38,039,435	47,468	43,627,792	54,442
Fontana	109,192,852	136,258	136,630,607	170,497	161,035,489	200,951
Grand Terrace	8,340,393	10,408	10,773,001	13,443	13,054,893	16,291
Hesperia	98,369,030	123,361	112,334,826	140,875	128,563,640	161,227
Highland	20,180,083	25,182	25,426,007	31,728	30,153,500	37,628
Loma Linda	25,173,349	31,413	26,578,452	33,166	26,102,032	32,572
Montclair	28,644,224	35,744	31,534,199	39,350	32,593,475	40,672
Needles	2,097,573	2,630	2,295,261	2,878	2,533,607	3,177
Ontario	152,010,395	189,689	196,571,661	245,295	238,440,082	297,542
Rancho Cucamonga	125,309,907	156,370	142,070,055	177,285	151,810,809	189,440
Redlands	52,893,039	66,003	63,968,644	79,824	73,042,822	91,148
Rialto	46,360,724	57,852	54,811,145	68,397	61,205,189	76,376
San Bernardino	137,957,602	172,153	166,629,381	207,931	190,029,056	237,131
Twentynine Palms	13,642,628	17,109	18,560,417	23,276	24,018,275	30,120
Upland	49,822,356	62,172	58,119,302	72,525	64,017,834	79,886
Victorville	130,843,690	164,086	143,590,367	180,071	158,904,755	199,276
Yucaipa	26,619,544	33,218	35,236,021	43,970	43,576,307	54,377
Yucca Valley	22,316,545	27,986	24,891,794	31,216	27,935,433	35,033
Unincorporated County	354,886,694	443,950	397,365,505	497,090	439,390,643	549,662
Total	**1,692,346,301**	**2,115,395**	**1,985,687,736**	**2,481,967**	**2,250,693,327**	**2,813,239**

Figure 4-4. Heavy-Duty Vehicle Emissions by Jurisdiction



4.4 Off-Road Equipment Emissions

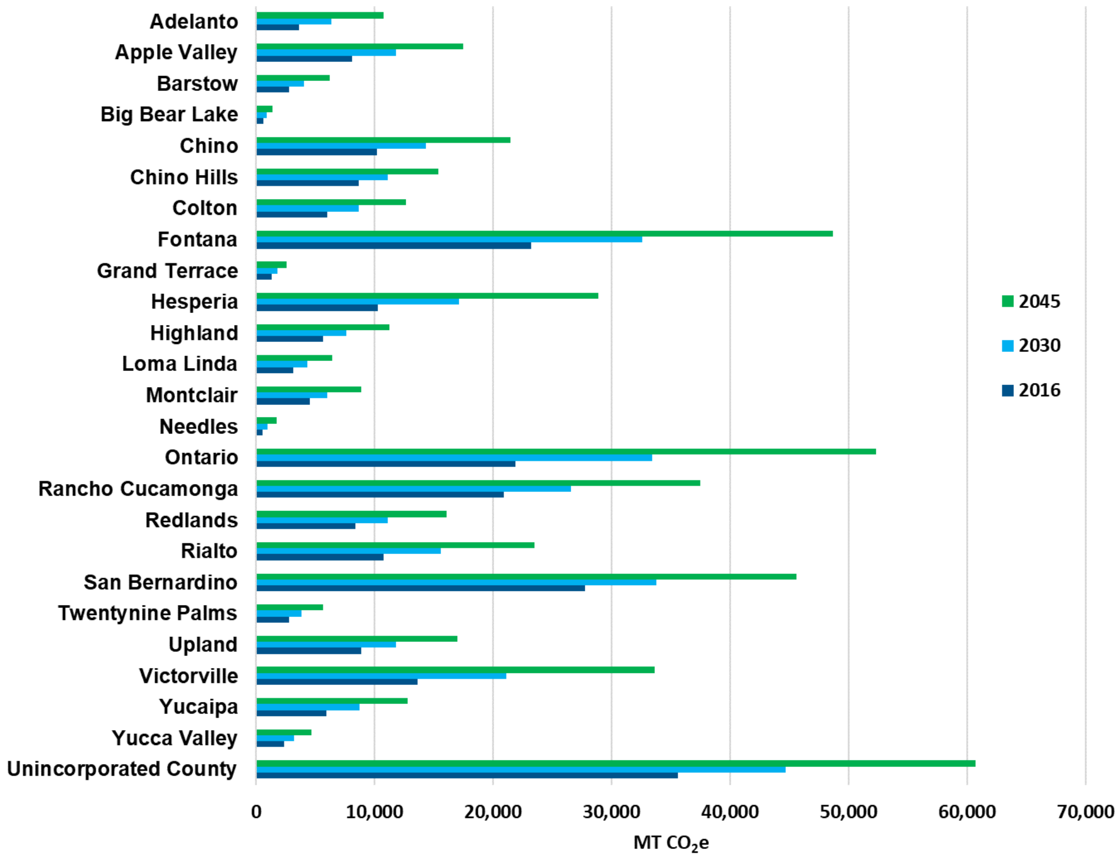
Off-road equipment emissions account for approximately 1% of the total region's emissions in 2016. This source is considered to be a direct source of emissions, resulting from fuel combustion in off-road equipment. Off-road equipment includes recreational vehicles, industrial equipment, construction and mining equipment, lawn and garden equipment, and agricultural equipment. Off-road equipment emissions are generally a function of non-retail and industrial employment in each jurisdiction.

Table 4-7 shows the 2016, 2030 BAU, and 2045 BAU emissions for off-road equipment for each jurisdiction. Figure 4-5 graphically shows the emissions for each jurisdiction for all three years.

Table 4-7. Off-Road Equipment Emissions by Jurisdiction

Jurisdiction	2016 (MT CO_2e)	2030 (MT CO_2e)	2045 (MT CO_2e)
Adelanto	3,622	6,356	10,785
Apple Valley	8,092	11,792	17,500
Barstow	2,814	4,034	6,222
Big Bear Lake	631	897	1,375
Chino	10,210	14,314	21,474
Chino Hills	8,651	11,098	15,419
Colton	5,997	8,687	12,626
Fontana	23,220	32,595	48,700
Grand Terrace	1,362	1,803	2,598
Hesperia	10,296	17,152	28,848
Highland	5,671	7,654	11,242
Loma Linda	3,180	4,320	6,429
Montclair	4,531	6,023	8,850
Needles	573	1,010	1,722
Ontario	21,904	33,452	52,319
Rancho Cucamonga	20,897	26,598	37,495
Redlands	8,424	11,114	16,085
Rialto	10,796	15,597	23,496
San Bernardino	27,788	33,744	45,595
Twentynine Palms	2,802	3,843	5,642
Upland	8,909	11,824	17,002
Victorville	13,609	21,094	33,610
Yucaipa	5,929	8,756	12,812
Yucca Valley	2,386	3,199	4,669
Unincorporated County	35,618	44,682	60,700
Total	**247,911**	**341,637**	**503,215**

Figure 4-5. Off-Road Equipment Emissions by Jurisdiction



4.5 Agricultural Emissions

Agriculture emissions account for approximately 3% of the region's total regional emissions in 2016. These are direct emissions resulting from livestock activity, manure management, and the application of fertilizer on crops. Emissions of CH_4 and N_2O from livestock are released through enteric fermentation (e.g., belching of gas from cattle) and manure management (e.g., gases released directly from livestock manure). Additionally, emissions of N_2O can result from applying nitrogen fertilizers to soils by way of direct (directly from the soils to which the nitrogen is added/released) and indirect (following volatilization of NH_3 and NO_X from managed soils) pathways (Intergovernmental Panel on Climate Change 2006). Both direct and indirect emissions of N_2O have been included in the inventory and forecast.

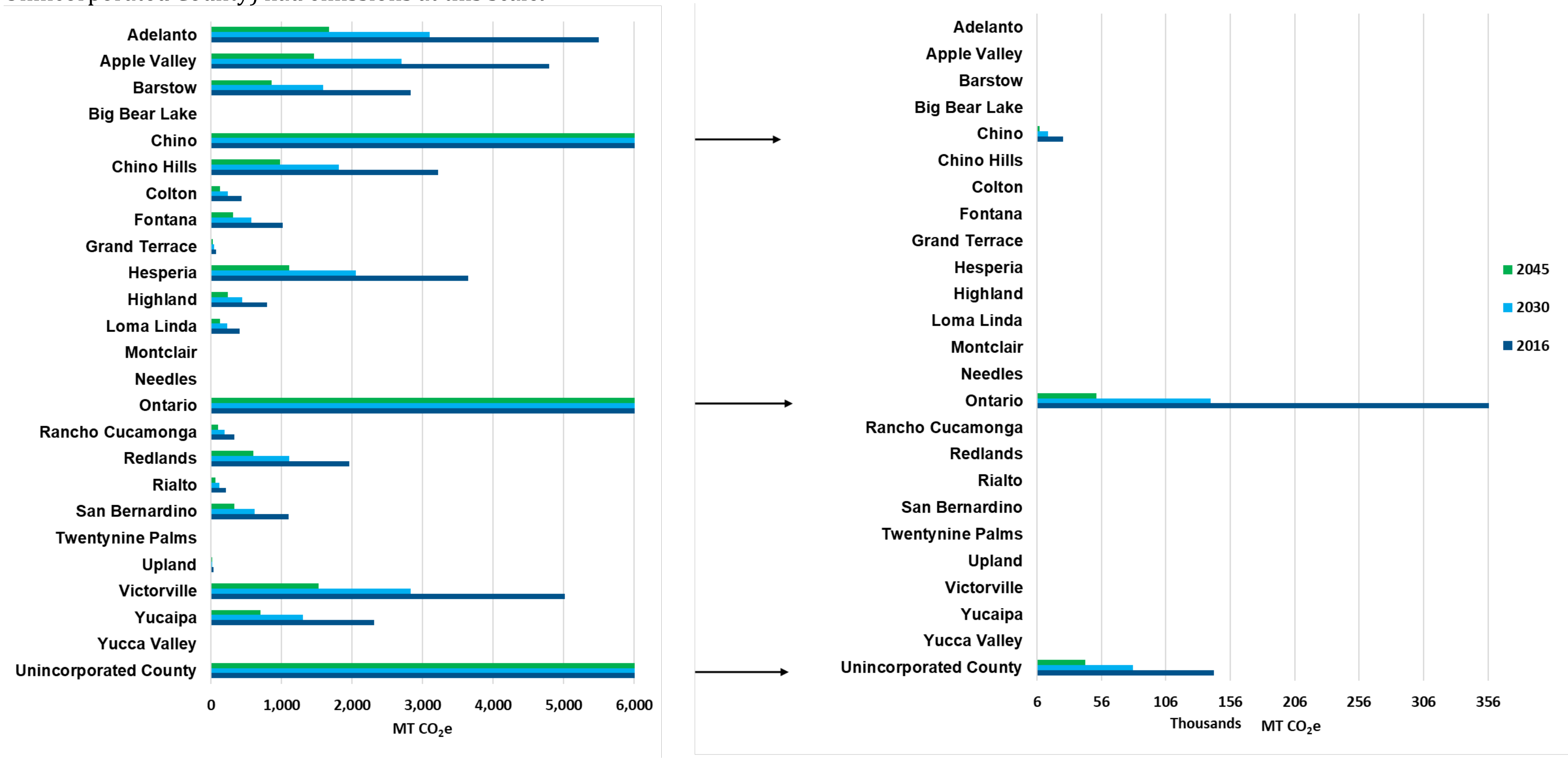
Table 4-8 shows the 2016, 2030 BAU, and 2045 BAU agriculture emissions for each jurisdiction for both CH_4 and N_2O; Figure 4-6 graphically shows the total emissions for each jurisdiction. Agriculture emissions are a function of agricultural activity, such as livestock population, and size of farmland. The majority of agricultural emissions occur in Chino and Ontario because there are large dairies located in these jurisdictions, while unincorporated San Bernardino County contains most of the farmland in the County.

Table 4-8. Agriculture Emissions by GHG and Jurisdiction

	2016 (MT)			2030 (MT)			2045 (MT)		
Jurisdictions	CH_4	N_2O	CO_2e	CH_4	N_2O	CO_2e	CH_4	N_2O	CO_2e
Adelanto	168	3	5,501	94	2	3,097	51	< 1	1,674
Apple Valley	145	3	4,793	82	2	2,698	44	< 1	1,458
Barstow	88	1	2,826	50	< 1	1,591	27	< 1	860
Big Bear Lake	-	-	-	-	-	-	-	-	-
Chino	874	7	26,295	492	4	14,804	266	2	8,000
Chino Hills	100	2	3,222	56	< 1	1,814	30	< 1	980
Colton	13	< 1	426	8	< 1	240	4	< 1	130
Fontana	26	1	1,016	14	< 1	572	8	< 1	309
Grand Terrace	2	< 1	73	1	< 1	41	< 1	< 1	22
Hesperia	114	2	3,642	64	< 1	2,051	35	< 1	1,108
Highland	23	< 1	788	13	< 1	444	7	< 1	240
Loma Linda	10	< 1	400	6	< 1	225	3	< 1	122
Montclair	-	-	-	-	-	-	-	-	-
Needles	-	-	-	-	-	-	-	-	-
Ontario	12,233	53	356,588	4,823	21	140,594	1,779	8	51,868
Rancho Cucamonga	9	< 1	330	5	< 1	186	3	< 1	101
Redlands	52	2	1,964	29	1	1,106	16	< 1	598
Rialto	6	< 1	212	3	< 1	119	2	< 1	64
San Bernardino	34	< 1	1,096	19	< 1	617	10	< 1	334
Twentynine Palms	-	-	-	-	-	-	-	-	-
Upland	< 1	< 1	32	< 1	< 1	18	< 1	< 1	10
Victorville	158	2	5,020	89	1	2,826	48	< 1	1,527
Yucaipa	58	3	2,313	33	1	1,302	18	< 1	704
Yucca Valley	-	-	-	-	-	-	-	-	-
Unincorporated County	4,381	77	143,146	2,466	44	80,591	1,333	24	43,549
Total	**18,494**	**158**	**559,685**	**8,348**	**80**	**254,938**	**3,684**	**40**	**113,656**

Figure 4-6. Agriculture Emissions by Jurisdiction

Agricultural emissions by jurisdiction are shown below. Three jurisdictions account for the majority of agricultural sector emissions—Chino, Ontario, and the Unincorporated County. The two figures below show total agricultural emissions across all jurisdictions but show them on different scales. Note that the units on the left image are $MTCO_2e$; the units on the right image are *thousands* $MTCO_2e$—only three jurisdiction (Chino, Ontario, and Unincorporated County) had emissions at this scale.



4.6 Solid Waste Management Emissions

Total emissions from solid waste generated by the jurisdictions account for approximately 5% of the region's 2016 inventory. This source of emissions is the result of fugitive emissions of CH_4 that occur at numerous landfills spread throughout California and Arizona. The solid waste materials disposed by each jurisdiction in the region are recycled, composted, or deposited in a landfill. This sector only includes emissions from waste that is sent to landfills. Landfill-related emissions from waste occur when the waste decomposes via anaerobic bacteria. Organic waste material that is buried in landfills decomposes under anaerobic conditions because landfills are packed tightly and are thus low oxygen environments, resulting in the production of CH_4. CH_4 is a GHG with a global warming potential (GWP) that is 28 times greater than CO_2, in other words, 1 ton of CH4 will warm the atmosphere 28 times as much as 1 ton of CO_2.

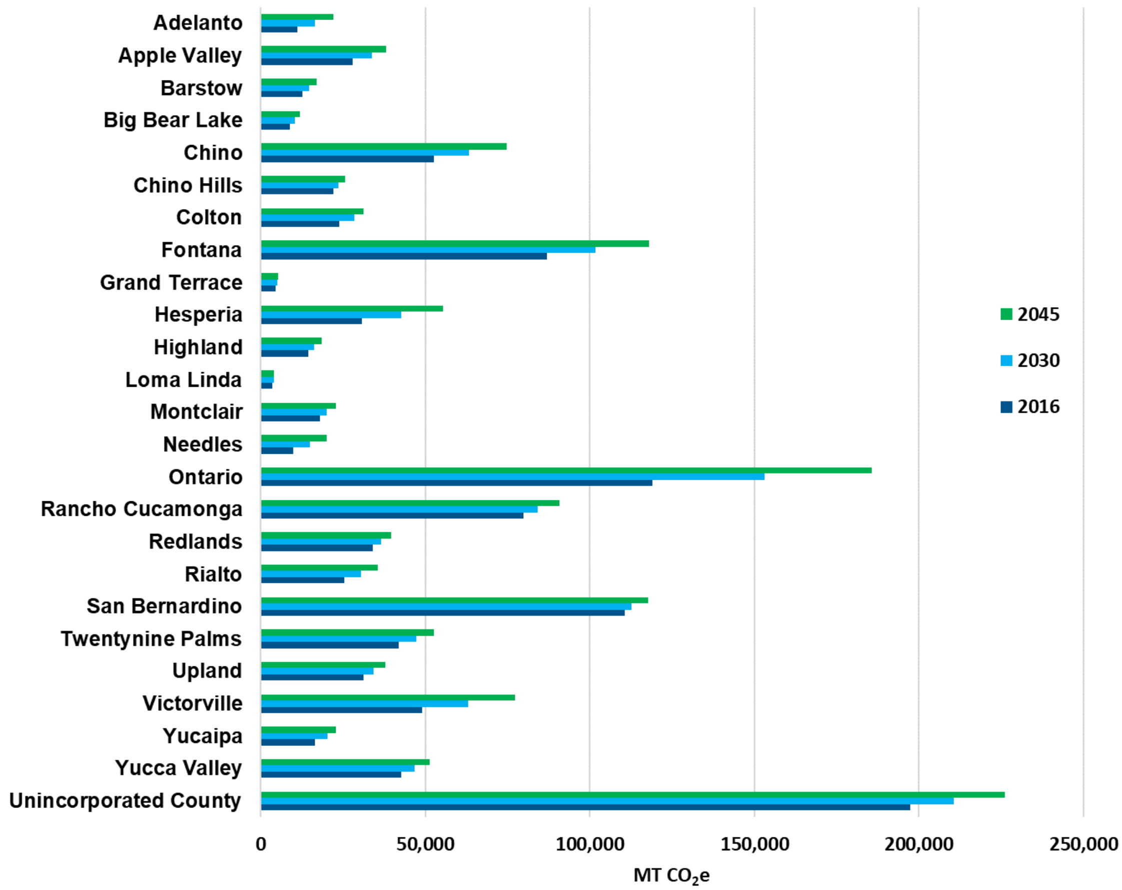
Waste generated in the jurisdictions will be either diverted through recycling or composting or transported to a landfill. Many of these landfills are located outside of the jurisdiction where the waste originates, and, as such, the majority of the emissions will not occur within the boundaries of each jurisdiction generating the waste. However, each jurisdiction is responsible for creating the waste, and the emissions are attributed to the jurisdiction responsible for the waste origin.

Table 4-9 shows the 2016, 2030 BAU, and 2045 BAU emissions for solid waste emissions and the quantities of waste that each jurisdiction sends to landfills. Figure 4-7 graphically shows the total emissions for each jurisdiction. Solid waste management emissions are generally a function of population and employment in each jurisdiction.

Table 4-9. Solid Waste Management Tons and GHG Emissions by Jurisdiction

Jurisdiction	2016		2030		2045	
	Landfilled Waste (tons)	GHG Emissions ($MTCO_2e$)	Landfilled Waste (tons)	GHG Emissions ($MTCO_2e$)	Landfilled Waste (tons)	GHG Emissions ($MTCO_2e$)
Adelanto	20,721	11,187	28,836	16,531	38,405	21,995
Apple Valley	50,138	28,032	63,355	33,732	78,974	38,251
Barstow	22,699	12,567	27,769	14,667	34,391	16,961
Big Bear Lake	15,850	8,889	18,011	10,313	20,639	11,840
Chino	95,681	52,509	108,770	63,261	123,926	74,721
Chino Hills	39,701	22,057	42,057	23,686	45,119	25,675
Colton	43,608	23,755	52,995	28,390	62,937	31,271
Fontana	159,813	86,844	186,072	101,750	218,887	117,932
Grand Terrace	8,456	4,581	10,296	4,935	12,846	5,357
Hesperia	55,531	30,825	80,172	42,579	111,661	55,297
Highland	26,469	14,511	31,854	16,232	39,343	18,457
Loma Linda	5,796	3,574	6,343	3,957	7,037	3,954
Montclair	32,563	17,991	35,172	19,976	38,597	22,848
Needles	4,463	9,827	5,884	14,916	7,430	20,081
Ontario	220,371	118,949	280,982	153,171	346,220	185,646
Rancho Cucamonga	145,700	79,716	156,335	84,059	172,112	90,690
Redlands	61,334	34,147	68,372	36,680	77,878	39,652
Rialto	47,215	25,459	56,909	30,554	67,233	35,637
San Bernardino	201,813	110,556	215,329	112,723	236,482	117,697
Twentynine Palms	20,172	41,972	25,968	47,171	33,789	52,715
Upland	56,527	31,210	61,835	34,399	68,522	37,975
Victorville	87,953	49,081	110,891	63,129	138,428	77,254
Yucaipa	29,773	16,422	37,030	20,369	46,583	22,966
Yucca Valley	19,564	42,706	23,164	46,694	28,076	51,398
Unincorporated County	260,864	197,260	284,672	210,590	316,291	226,055
Total	**1,732,776**	**1,074,629**	**2,019,071**	**1,234,462**	**2,371,808**	**1,402,324**

Figure 4-7. Solid Waste Management GHG Emissions by Jurisdiction



4.7 Wastewater Treatment Emissions

Total emissions from wastewater treatment account for approximately 0.3% of the region's 2016 inventory. There are 12 large wastewater treatment plants (WWTPs) located within the boundaries of this inventory that serve the majority of the region's residents and businesses. The Inland Empire Utilities Agency (IEUA) operates four of these plants; the other is operated by the Jurisdictions of San Bernardino's Municipal Water Department.

GHG emissions result from electricity and/or natural gas used to power the facilities. These are indirect emissions and are included in the inventory in either the building energy or the water sectors, depending on where the WWTP is located. Additional emissions of CH_4 and N_2O result from the treatment and breakdown of waste in the facility. These are commonly referred to as *fugitive emissions*. Three of the five facilities capture the fugitive emissions (biogas) on site and use it for local power; the other two facilities do not capture and combust the biogas. About 80% of the total biogas produced by the region's WWTPs is assumed to be used for local power; the remaining biogas produces fugitive emissions that are included in the inventory.

Wastewater generated in each jurisdictions will be sent to WWTPs, which may be located outside of the jurisdictions. Consequently, some of these emissions will not occur within the boundaries of each jurisdictions generating the wastewater, but each jurisdictions is responsible for creating this wastewater. GHG emissions attributable to fugitive emissions at these facilities are listed in Table 4-10.

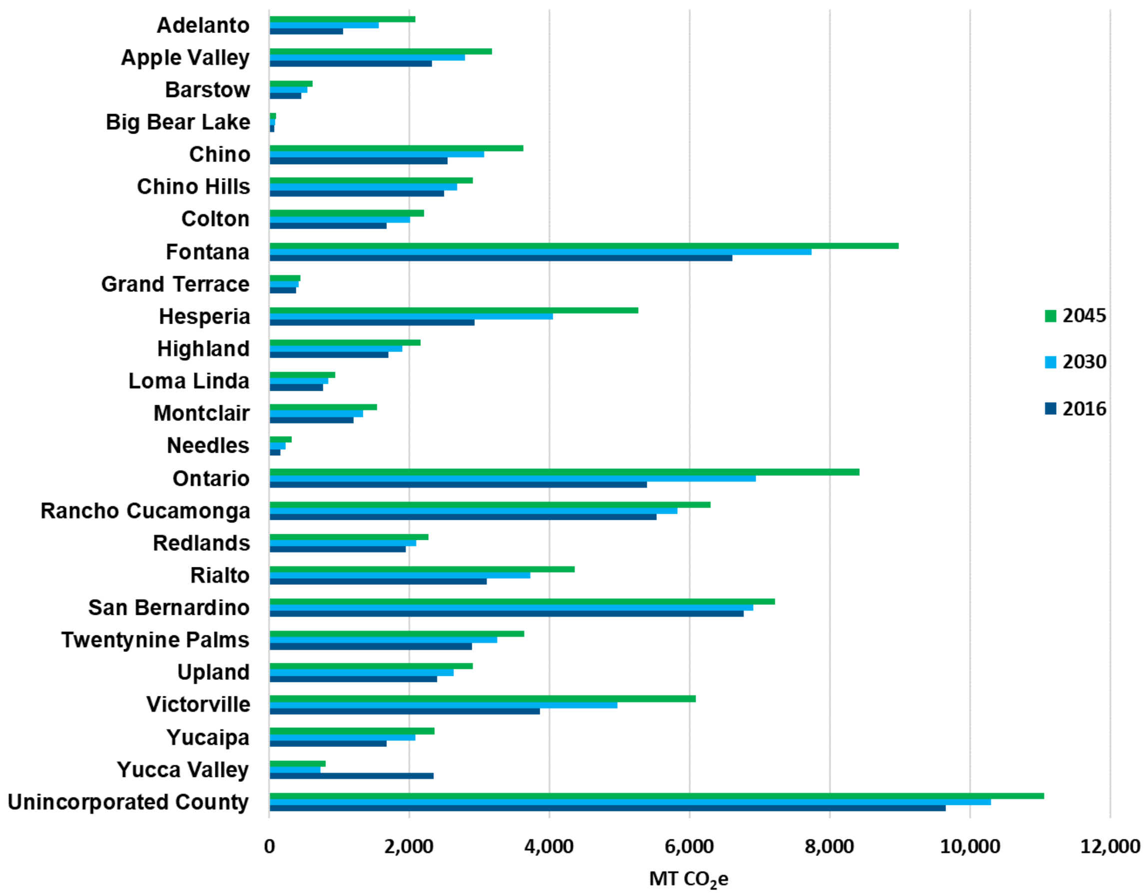
In addition, some jurisdictions rely on municipal septic systems as opposed to centralized WWTPs, including Twentynine Palms and Yucca Valley. Septic systems also release fugitive emissions of CH_4. These emissions are included in the inventory and in Table 4-11.

Table 4-10 and Figure 4-8 present the 2016, 2030 BAU, and 2045 BAU emissions forecast wastewater treatment for each jurisdictions. Wastewater treatment emissions are generally a function of a jurisdiction's population.

Table 4-10. Fugitive Wastewater Treatment Emissions by GHG and Jurisdiction

Jurisdictions	2016 (MT)			2030 (MT)			2045 (MT)		
	CH_4	N_2O	CO_2e	CH_4	N_2O	CO_2e	CH_4	N_2O	CO_2e
Adelanto	13	3	1,062	20	4	1,569	26	5	2,088
Apple Valley	29	6	2,328	35	7	2,801	40	8	3,177
Barstow	-	2	465	-	2	543	-	2	629
Big Bear Lake	-	< 1	79	-	< 1	92	-	< 1	106
Chino	32	6	2,547	38	8	3,068	45	9	3,627
Chino Hills	31	6	2,498	34	7	2,682	36	7	2,908
Colton	21	4	1,682	25	5	2,011	28	5	2,215
Fontana	83	16	6,610	97	19	7,744	113	22	8,981
Grand Terrace	5	< 1	388	5	1	418	6	1	454
Hesperia	37	7	2,935	51	10	4,054	66	13	5,265
Highland	21	4	1,698	24	5	1,899	27	5	2,160
Loma Linda	10	2	767	11	2	849	12	2	943
Montclair	15	3	1,212	17	3	1,346	19	4	1,540
Needles	2	< 1	158	3	< 1	239	4	< 1	322
Ontario	68	13	5,396	87	17	6,949	106	21	8,429
Rancho Cucamonga	69	14	5,529	73	14	5,831	79	15	6,305
Redlands	27	5	1,958	29	5	2,103	32	5	2,276
Rialto	39	8	3,111	47	9	3,734	55	11	4,357
San Bernardino	85	17	6,777	87	17	6,910	91	18	7,222
Twentynine Palms	104	-	2,898	116	-	3,257	130	-	3,640
Upland	30	6	2,394	33	6	2,638	37	7	2,912
Victorville	48	9	3,863	62	12	4,969	76	15	6,094
Yucaipa	21	4	1,685	26	5	2,090	30	6	2,356
Yucca Valley	84	-	2,347	9	2	735	10	2	809
Unincorporated County	121	24	9,651	129	25	10,304	139	27	11,060
Total	**996**	**159**	**70,039**	**1,059**	**186**	**78,835**	**1,206**	**212**	**89,874**

Figure 4-8. Wastewater Treatment Emissions by Jurisdiction



4.8 Water Transport, Distribution, and Treatment Emissions

Water consumption emissions accounted for approximately 0.7% of the region's total emissions in 2016. Water consumption generally requires the following processes, all of which consume electricity, resulting in indirect GHG emissions:

- Procuring water from its source, such as pumping water from a groundwater basin, diverting water from a surface reservoir, desalinating ocean water, importing water from a different region in the state, or transferring water from a nearby location;
- Treating water to make it potable; and
- Distributing water locally to homes and businesses.

Emissions associated with wastewater treatment are included in the wastewater treatment sector, because wastewater treatment occurs after the water has been delivered to its end users. Water transport, distribution, and treatment emissions are generally a function of population and employment in each jurisdiction.

Table 4-11 shows the water-related emissions for 2016, 2030 BAU, and 2045 BAU for each jurisdiction in units of MT CO_2e; it also shows the water consumed within each jurisdiction in units of acre-feet and the corresponding electricity generated as a result of that water consumption in units of megawatt-hours. Table 4-12 shows the per capita water consumption rate and the water source profile for each jurisdiction. The water source profile data indicate the percentage of water where each jurisdiction receives its water from. Figure 4-9 graphically shows the total water-related emissions for each jurisdiction for all three years.

Table 4-11. Water Transport, Distribution, and Treatment – Water Consumption, Electricity and GHG Emissions by Jurisdiction

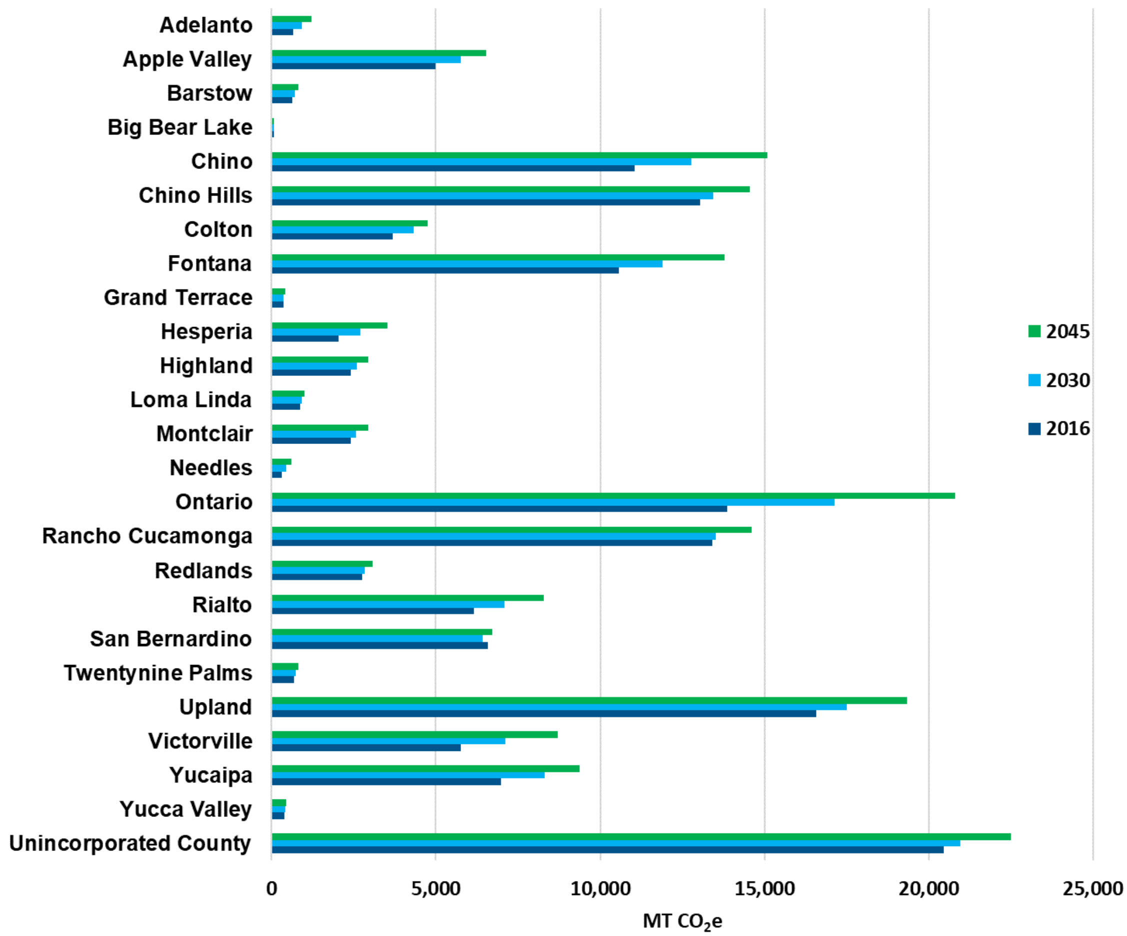
Jurisdiction	2016 (Consumption/Electricity/ Emissions)			2030 (Consumption/Electricity/ Emissions)			2045 (Consumption/Electricity/ Emissions)		
Adelanto	4,149	2,598	650	6,130	3,839	921	8,156	5,109	1,226
Apple Valley	11,898	19,894	4,981	14,318	23,940	5,751	16,236	27,147	6,521
Barstow	4,013	2,552	638	4,683	2,979	715	5,424	3,450	828
Big Bear Lake	404	257	64	468	298	71	538	342	82
Chino	23,640	44,160	11,049	28,481	53,202	12,770	33,667	62,890	15,095
Chino Hills	16,990	52,109	13,043	18,244	55,956	13,437	19,778	60,660	14,566
Colton	10,879	6,919	3,689	13,002	8,269	4,324	14,324	9,110	4,764
Fontana	32,979	42,266	10,581	38,639	49,521	11,893	44,809	57,428	13,792
Grand Terrace	2,320	1,476	369	2,499	1,590	381	2,713	1,726	414
Hesperia	12,876	8,189	2,048	17,785	11,312	2,714	23,098	14,691	3,525
Highland	9,345	9,680	2,423	10,453	10,829	2,600	11,886	12,313	2,957
Loma Linda	5,423	3,452	863	6,003	3,822	917	6,672	4,248	1,019
Montclair	4,891	9,643	2,415	5,431	10,707	2,572	6,212	12,247	2,942
Needles	906	1,335	307	1,374	2,026	445	1,850	2,728	600
Ontario	36,686	55,427	13,878	47,241	71,374	17,145	57,304	86,576	20,796
Rancho Cucamonga	37,562	57,986	13,406	39,609	61,146	13,515	42,830	66,118	14,614
Redlands	21,046	11,038	2,761	22,608	11,857	2,845	24,467	12,832	3,079
Rialto	17,577	24,628	6,166	21,095	29,556	7,099	24,612	34,484	8,283
San Bernardino	41,320	26,281	6,573	42,130	26,795	6,430	44,033	28,006	6,720
Twentynine Palms	4,249	2,703	676	4,776	3,037	729	5,337	3,394	814
Upland	22,765	66,133	16,563	25,091	72,889	17,514	27,700	80,467	19,335
Victorville	20,668	22,990	5,759	26,583	29,571	7,107	32,604	36,268	8,717
Yucaipa	13,687	27,915	6,990	16,977	34,625	8,318	19,141	39,038	9,379
Yucca Valley	2,479	1,577	394	2,711	1,724	414	2,984	1,898	455
Unincorporated County	55,452	81,746	20,465	59,199	87,270	20,960	63,546	93,680	22,500
Total	**414,203**	**582,955**	**146,750**	**475,529**	**668,133**	**161,588**	**539,920**	**756,849**	**183,023**

Notes: Consumption refers to the quantities of water consumed: the units are **acre-feet**. Electricity refers to the electricity used to transport, distribute, and treat water: the units are **megawatt hours**. Emissions refers to the indirect emissions associated with the water-related electricity: the units are **MTCO$_2$e**.

Table 4-12. Water Transport, Distribution, and Treatment – Per Capita Consumption and Water Sources by Jurisdiction

	Per Capita Water Consumption	Water Sources (percentages)					
Jurisdiction	(acre-feet/year/capita)	Surface Water	Groundwater	Recycled Water	Desalinated Water	Purchased or Imported Water	Transfers
Adelanto	0.12	-	94%	-	-	-	6%
Apple Valley	0.16	-	65%	-	-	35%	-
Barstow	0.17	-	100%	-	-	-	-
Big Bear Lake	0.08	-	100%	-	-	-	-
Chino	0.29	-	27%	37%	24%	11%	-
Chino Hills	0.21	-	18%	11%	28%	43%	-
Colton	0.20	-	100%	-	-	-	-
Fontana	0.16	5%	73%	-	-	22%	-
Grand Terrace	0.19	-	100%	-	-	-	-
Hesperia	0.14	-	100%	-	-	-	-
Highland	0.17	18%	67%	-	-	14%	-
Loma Linda	0.22	-	100%	-	-	< 1%	-
Montclair	0.13	-	50%	5%	-	45%	-
Needles	0.18	4%	65%	4%	2%	26%	< 1%
Ontario	0.21	-	58%	11%	-	31%	-
Rancho Cucamonga	0.21	2%	64%	3%	-	31%	< 1%
Redlands	0.30	45%	43%	12%	-	-	-
Rialto	0.18	11%	62%	< 1%	-	26%	-
San Bernardino	0.19	-	100%	-	-	-	-
Twentynine Palms	0.16	-	100%	-	-	-	-
Upland	0.30	-	24%	-	-	76%	-
Victorville	0.17	-	81%	3%	-	16%	-
Yucaipa	0.25	2%	50%	-	-	47%	-
Yucca Valley	0.12	-	100%	-	-	-	-
Unincorporated County	0.18	4%	65%	4%	2%	26%	< 1%
Total Average	**0.19**	**12%**	**72%**	**10%**	**14%**	**32%**	**6%**

Figure 4-9. Water Transport, Distribution, and Treatment Emissions by Jurisdiction



4.9 Stationary Source Emissions

This sector represents the emissions resulting from fuel combustion (such as diesel, gasoline, propane, and natural gas) and fugitive emissions of CH_4 and N_2O at very large facilities located in each jurisdiction. These facilities are regulated at the state level, and thus municipal governments have limited control over such facilities. As such, emissions from these sources are not included in the inventory total, because the jurisdictions cannot generally affect these sources through municipal planning or activity.

In general, GHG emissions from stationary sources result from fuel use other than natural gas consumption, which is accounted for in the building energy category. However, some very large consumers of natural gas are included in the stationary source sector rather than the building energy sector because of natural gas dataset limitations. For instance, some natural gas consumption data were excluded from the dataset provided by Southern California Gas Company due to privacy rules established by the California Public Utilities Commission. Typically, the data that are excluded due to the privacy rules are data associated with very large facilities. As noted above, these very large facilities are generally regulated at the state level and are better suited for the stationary sources sector rather than the building energy sector.

Because the stationary source sector is only limited to very large sources that are regulated by the state, there is only a small subset of jurisdictions that contain such facilities. As such, most jurisdictions have zero emissions for this sector. There may be industrial facilities that combust non-natural gas fuel in the jurisdictions with zero emissions, but those facilities are not large enough or do not produce enough emissions to be regulated by the state. Thus, data from those facilities are not available, and the emissions cannot be quantified at this time.

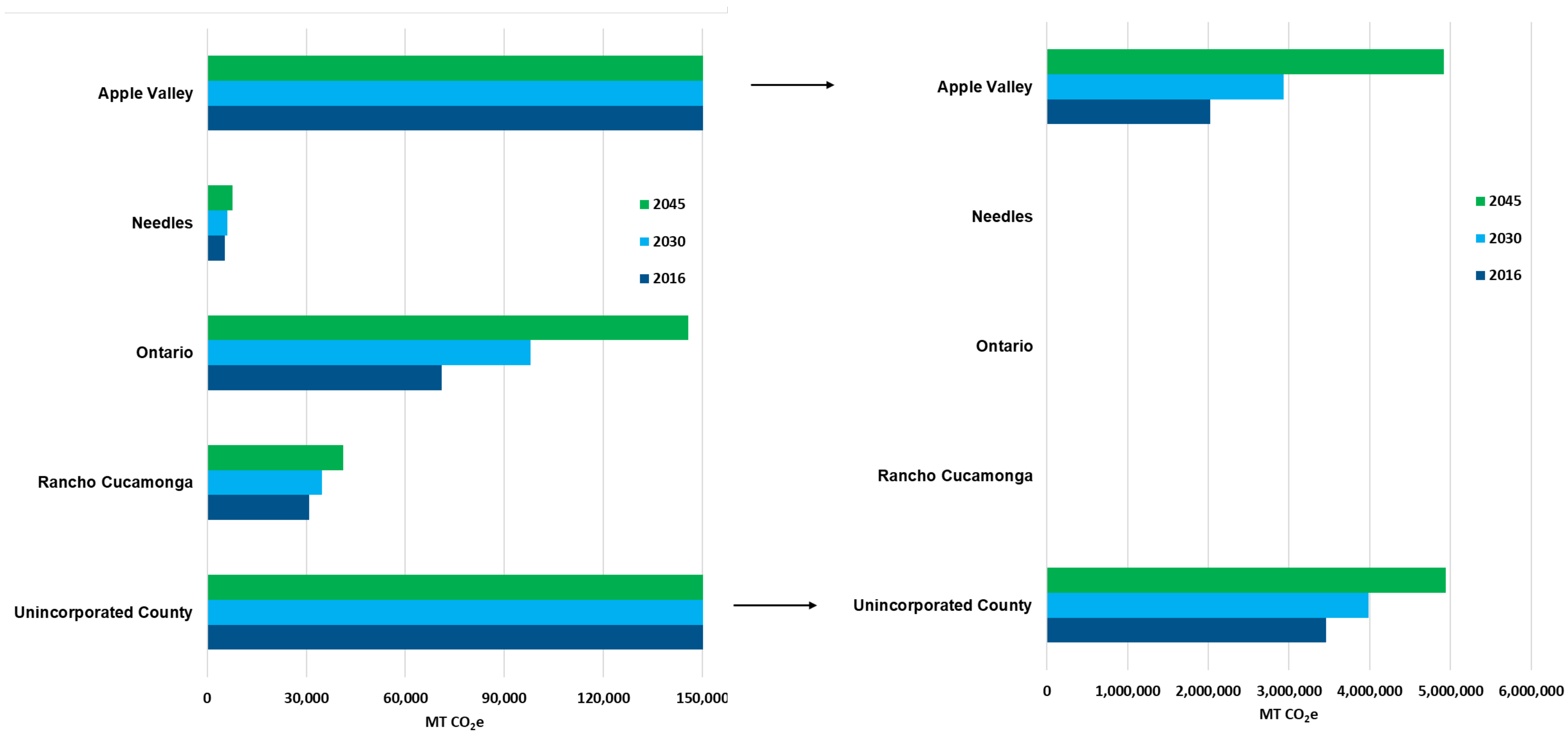
Table 4-13 and Figure 4-10 show the 2016, 2030 BAU, and 2045 BAU emissions from stationary sources.

Table 4-13. Stationary Source Emissions by Jurisdiction

Jurisdiction	2016 (MT CO_2e)	2030 (MT CO_2e)	2045 (MT CO_2e)
Adelanto	-	-	-
Apple Valley	2,026,887	2,934,656	4,913,904
Barstow	-	-	-
Big Bear Lake	-	-	-
Chino	-	-	-
Chino Hills	-	-	-
Colton	-	-	-
Fontana	-	-	-
Grand Terrace	-	-	-
Hesperia	-	-	-
Highland	-	-	-
Loma Linda	-	-	-
Montclair	-	-	-
Needles	5,361	6,167	7,624
Ontario	70,952	97,972	145,703
Rancho Cucamonga	30,943	34,676	41,280
Redlands	-	-	-
Rialto	-	-	-
San Bernardino	-	-	-
Twentynine Palms	-	-	-
Upland	-	-	-
Victorville	-	-	-
Yucaipa	-	-	-
Yucca Valley	-	-	-
Unincorporated County	3,461,005	3,988,244	4,942,587
Total	**5,595,148**	**7,061,714**	**10,051,098**

Figure 4-10. Stationary Source Emissions by Jurisdiction

Stationary source emissions only occur in five jurisdictions throughout the County—Apple Valley, Needles, Ontario, Rancho Cucamonga, and the Unincorporated County. The two figures below show the same data but account for the different GHG emissions scales among jurisdictions. The two figures below show the same data but account for the different GHG emissions scales among jurisdictions. Note that the units for the left image end at 150,000 $MTCO_2e$; the units for the right image show the full picture, up to 6,000,000 $MTCO_2e$—only two jurisdictions (Apple Valley and Unincorporated County) had emissions at this larger scale.



Appendix A
Section 5: Methods

This section presents the overall methods used to prepare the community GHG emissions inventories and BAU forecasts. This section discusses the terminology relevant to the inventories, inventory accounting protocols used, emissions factors, and analysis methods.

5.1 Inventory Definitions

Community Inventory. A community inventory includes GHG emissions occurring within the geographic or jurisdictional boundaries of a local government, or as a result of activity within those boundaries. A community inventory only includes emissions that are under the control or subject to the influence of that jurisdiction. The boundaries of the community inventory are “geographical” such that the emissions included in the inventory, or the activities that lead to emissions, must occur inside the jurisdictional boundary of the local government, as long as the emissions source or activity is subject to the local government’s control.

For direct emissions, such as natural gas combustion in buildings, those emissions are included in the inventory if a jurisdiction can affect those emissions by influencing energy use (such as through green building codes). For indirect emissions (such as solid waste that is initially disposed of within the jurisdiction but is ultimately sent to a landfill outside of the jurisdiction), those emissions would be included if the jurisdiction can affect waste quantities among the population (such as through waste minimization and diversion programs).

By only including emissions that are controlled by or subject to the influence of the jurisdictions, the inventory forms the basis for local climate action planning. For the inventory year, SBCTA chose 2016 for the community inventory updates because it was the most recent year with the necessary datasets to perform a comprehensive inventory.

Municipal Inventory. A municipal inventory includes GHG emissions that are generated by the services and municipal operations of a local government. Municipal inventories have not been prepared as part of this report, but some individual jurisdictions have developed or will be developing municipal inventories separately.

BAU Forecasts. The emissions forecasts for 2030 and 2045 represent BAU emissions associated with each jurisdiction’s community emissions in each future year. This forecast accounts for any programs, measures, or activities intended to reduce emissions that were already active in the inventory year of 2016, as such actions would affect the 2016 baseline inventory. The BAU forecasts do not account for any programs, measures, or activities implemented after 2016 or changes to those actions that occurred after 2016.

Unit of Measure: The unit of measure used throughout the GHG inventories and forecasts is the metric ton of CO_2 equivalent ($MTCO_2e$). This is the internationally-used unit that combines the varying warming-effectiveness of the primary greenhouse gases (e.g., CO_2, CH_4, and N_2O) into a single unit, by multiplying each gas by its global warming potential (GWP). GWP is the measure of how much a given mass of GHG contributes to global warming. GWP compares the relative warming effect of other gases to that of CO_2.[1]

Emissions Type: GHG emissions can be defined as either *direct* (emissions that occur at the end use location such as natural gas combustion for building heating) or *indirect* (emissions that result from consumption at the end use location but occur at another location such as emissions from a power plant that create electricity off-site).

Both direct and indirect emissions have been quantified and are included in the community inventories to the extent that the jurisdictions have influence or control over each source of emissions. For example, direct emissions associated with on-site natural gas use are included, because these emissions occur within each jurisdiction and are subject to each jurisdiction's influence or control. Indirect GHG emissions associated with electricity use are included, because these emissions can occur outside of each jurisdiction but the activity that generates emissions (i.e. using electric appliances and lighting) are subject to each jurisdiction's influence or control. Additionally, all references to *emissions* are equivalent to *GHG emissions.*

5.2 Business as Usual Forecasts for 2030 and 2045

BAU forecast projections were developed for 2030 and 2045. The projections estimate the quantity of emissions resulting from each jurisdiction in each of the forecast years. Because it does not account for any programs, measures, or activities that would reduce emissions, the projections reflect the impacts of socioeconomic growth. The projections do, however, account for the impact of any programs, measures, or activities that were implemented prior to 2016, as these would have already lowered the baseline year emissions.

As such, the future year-projections can be used to determine the magnitude of the reductions that need to be achieved in those future years to reach each jurisdiction's emissions-reduction target. The BAU projections are based on current energy consumption and activity data, the anticipated growth rates in socioeconomic data provided by the jurisdictions and SBCTA, and other appropriate data sources, as listed in this report. Consistent with California's BAU projections, the future year BAU emissions projections do not assume the implementation of any federal, state, or local reduction measures. Rather, the future emissions are projected based on current energy and carbon intensity in the existing economy. The specific assumptions associated with the growth rates are discussed in Section 5.5, "Analysis Methods."

As the population and workforce in each jurisdiction grow, emissions will increase over time. Total regional emissions are projected to increase by approximately 11% from 2016 to 2030 and 20% from 2016 to 2045. The largest increases in emissions will occur in the building energy use, off-road equipment, and stationary source sectors, as those sectors are primarily tied to growing population and employment. Modest growth in emissions will occur in most other sectors as well (on-road vehicles; solid waste management; wastewater treatment; and water transport, distribution, and treatment). Agriculture emissions will decrease over time as the activity occurring at the dairies in

[1] The GWP of CO_2 is, by definition, one (1). The GWP values used in this report are based on the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report reporting guidelines and are as follows: CO_2 = 1, CH_4 = 28, N_2O = 265, SF_6 = 23,500 (Intergovernmental Panel on Climate Change 2013).

Chino and Ontario is anticipated to decline. Population, employment, and housing projections were provided by SBCTA.

The methods and assumptions for the projections discussed in the following sections are intended to produce a reasonable estimate of emissions for the future years. Although these assumptions are supported by established inventory protocols and widely used inventory methodologies, the methods for estimating BAU forecast emissions for the 25-jurisdiction region is subject to certain limitations. Specifically, in cases where future emission factor data are limited, the emission factors were assumed to remain constant from the current year's inventory. Additionally, emissions were estimated based on historical trends in some emissions-generating activities. However, it is possible that future emissions may not actually follow past trends.

5.3 Inventory Protocols

There are several accepted protocols for estimating emissions to prepare GHG inventories. Consistent with the previous inventory analysis and with standard practice among other municipal governments in California and the United States, the ICLEI U.S. Community Protocol for Accounting and reporting of Greenhouse Gas Emissions was the primary protocol used to prepare the inventories (ICLEI–Local Governments for Sustainability USA 2012). This inventory includes the following emissions activities from the ICLEI Community Protocol: use of electricity, use of fuel in stationary applications, use of on-road motor vehicles, water consumption, solid waste disposal, wastewater treatment and agricultural activity. The protocol includes these activities, because a municipal government typically has control or substantial influence over such activities.

Although the ICLEI Community Protocol is the primary tool that was used for this analysis, other resources relevant to GHG emissions accounting were also used. The ICLEI Community Protocol was supplemented with factors, methods, and assumptions from these other resources, which include the following: California Air Resources Board, U.S. Environmental Protection Agency, California Energy Commission, and California Air Pollution Control Officer's Association. The next section includes a table of emission factors and constants used in the inventory calculations.

5.4 Emission Factors and Constants

Emission factors, conversion factors, constants and their references are summarized in Table 5-1. These values were used to calculate GHG emissions from activity data, such as kilowatt-hour (kWh) of electricity consumed for lighting or gallons of gasoline fuel combusted for on-road transportation.

Table 5-1. Greenhouse Gas Emission Factors and Constants

Source	Emission Factor	Reference
Building Energy		
Electricity		
Southern California Edison	0.239 kg CO_2e/kWh	3
Colton Municipal Utility	0.519 kg CO_2/kWh	1, 2
	0.053 g CH_4/kWh	1, 2
	0.008 g N_2O/kWh	1, 2

Source	Emission Factor	Reference
	6.131 x10^{-5} g SF_6/kWh	4
Needles Municipal Utility	0.086 kg CO_2e/kWh	1, 2, 6
Rancho Cucamonga Municipal Utility	0.187 kg CO_2/kWh	1, 2
	0.012 g CH_4/kWh	1, 2
	0.001 g N_2O/kWh	1, 2
	6.131 x10^{-5} g SF_6/kWh	4
Victorville Municipal Utility	0.239 kg CO_2/kWh	1, 2
	0.015 g CH_4/kWh	1, 2
	0.002 g N_2O/kWh	1, 2
	6.131 x10^{-5} g SF_6/kWh	4
Bear Valley Electric Service Company	0.239 kg CO_2/kWh	2
	0.015 g CH_4/kWh	1, 2
	0.002 g N_2O/kWh	1, 2
	6.131 x10^{-5} g SF_6/kWh	4
Electricity Transmission & Distribution Loss Factor	4.23%	2
Natural Gas		
All uses	53.02 kg CO_2/MMBtu	5
Residential & Commercial uses	0.005 kg CH_4/MMBtu	5
Industrial uses	0.001 kg CH_4/MMBtu	5
All uses	0.0001 kg N_2O/MMBtu	5
Residential Fuels		
Kerosene	75.2 kg CO_2/MMBtu	11
	0.01 kg CH_4/MMBtu	11
	0.0006 kg N_2O/MMBtu	11
Liquefied Petroleum Gas	61.7 kg CO_2/MMBtu	11
	0.01 kg CH_4/MMBtu	11
	0.0006 kg N_2O/MMBtu	11
Wood	0 kg CO_2/MMBtu (biogenic)	11
	0.25 kg CH_4/MMBtu	11
	0.0034 kg N_2O/MMBtu	11
<u>On-Road</u>		
Light Duty Emission Factors - 2016		
South Coast Air Basin	359.5 grams CO_2/mile	12
	0.011 grams CH_4/mile	12
	0.012 grams N_2O/mile	12
Mojave Desert Air Basin	354.7 grams CO_2/mile	12
	0.013 grams CH_4/mile	12
	0.014 grams N_2O/mile	12
Heavy Duty Emission Factors - 2016		
South Coast Air Basin	1,203.6 grams CO_2/mile	12
	0.166 grams CH_4/mile	12
	0.149 grams N_2O/mile	12

Source	Emission Factor	Reference
Mojave Desert Air Basin	1,208.9 grams CO_2/mile	12
	0.025 grams CH_4/mile	12
	0.168 grams N_2O/mile	12
Light Duty - 2030 Adjusted BAU		
South Coast Air Basin	239.1 grams CO_2/mile	12
	0.003 grams CH_4/mile	12
	0.004 grams N_2O/mile	12
Mojave Desert Air Basin	230.9 grams CO_2/mile	12
	0.004 grams CH_4/mile	12
	0.005 grams N_2O/mile	12
Heavy Duty - 2030 Adjusted BAU		
South Coast Air Basin	911.8 grams CO_2/mile	12
	0.12 grams CH_4/mile	12
	0.118 grams N_2O/mile	12
Mojave Desert Air Basin	944. grams CO_2/mile	12
	0.014 grams CH_4/mile	12
	0.133 grams N_2O/mile	12
Light Duty - 2045 Adjusted BAU		
South Coast Air Basin	207.9 grams CO_2/mile	12
	0.003 grams CH_4/mile	12
	0.004 grams N_2O/mile	12
Mojave Desert Air Basin	198.0 grams CO_2/mile	12
	0.003 grams CH_4/mile	12
	0.004 grams N_2O/mile	12
Heavy Duty - 2045 Adjusted BAU		
South Coast Air Basin	800.1 grams CO_2/mile	12
	0.115 grams CH_4/mile	12
	0.106 grams N_2O/mile	12
Mojave Desert Air Basin	841.1 grams CO_2/mile	12
	0.013 grams CH_4/mile	12
	0.119 grams N_2O/mile	12
Agriculture		
Enteric Fermentation & Manure Management		
Swine breeding	27.895 kilograms CH_4/head/year	14
	0.0299 kilograms N_2O/head/year	14
Swine market wight (average)	18.6316 kilograms CH_4/head/year	14
	0.017966 kilograms N_2O/head/year	14
Dairy Cows	378.1 kilograms CH_4/head/year	14
	1.30 kilograms N_2O/head/year	14
Beef Cattle	103.66 kilograms CH_4/head/year	14
	0.00 kilograms N_2O/head/year	14
Other Cattle (bulls, calves, feedlot heifers)	59.22 kilograms CH_4/head/year	14

Source	Emission Factor	Reference
	2.04 kilograms N_2O/head/year	14
Chickens	0.025715 grams CH_4/head/year	14
	0.00315867 grams N_2O/head/year	14
Direct and Indirect Nitrification		
Synthetic Fertilizer	0.016812 grams N_2O/acre/year	15
Wastewater Treatment		
Anaerobic Digesters (MDE = 99%)	Biogas Production * MDE = Remaining CH_4	16
Aerobic Digestion	0.60 grams CH_4/gallon/day	16
WWTP Effluent	3.20 grams N_2O/person/year	16
Electricity Use	kWh/plant/year	
Natural Gas Use	Therms/plant/year	
Off-Road Vehicles and Equipment		
Diesel	10.15 kg CO_2/US Gallon	17
	0.00015 kg CH_4/US Gallon	18
	0.00015 kg N_2O/US Gallon	18
Gasoline	8.78 kg CO_2/US Gallon	17
	0.00013 kg CH_4/US Gallon	18
	0.0002 kg N_2O/US Gallon	18
Propane	5.79 kg CO_2/US Gallon	17
	0.000992 kg CH_4/US Gallon	18, 19
	0.002631 kg N_2O/US Gallon	18, 19
CNG	1.906992 kg CO_2/m3	17
	0.011127 kg CH_4/m3	17
	0.00099kg N_2O/m3	17
Waste Material Emission Factors		
Mixed Municipal Solid Waste	0.060 MT CH_4/short ton waste	5
Newspaper	0.043 MT CH_4/short ton waste	5
Office Paper	0.203 MT CH_4/short ton waste	5
Corrugated Containers	0.120 MT CH_4/short ton waste	5
Magazines/Third-Class Mail	0.049 MT CH_4/short ton waste	5
Food Scraps	0.078 MT CH_4/short ton waste	5
Grass	0.038 MT CH_4/short ton waste	5
Leaves	0.013 MT CH_4/short ton waste	5
Branches	0.062 MT CH_4/short ton waste	5
Dimensional Lumber	0.062 MT CH_4/short ton waste	5
Leaves	0.013 MT CH_4/short ton waste	5
Branches	0.062 MT CH_4/short ton waste	5
Dimensional Lumber	0.062 MT CH_4/short ton waste	5
Water		
Groundwater Pumping Intensity	4.45 kWh/MG/foot depth	7
Average depth of water basins	128 feet	8

Source	Emission Factor	Reference
Imported Water Conveyance	9,727 kWh/MG	10
Local Water Conveyance	110 kWh/MG (median value)	5
Desalinated Water Conveyance	13,800 kWh/MG	7
Water Pre-Treatment	111 kWh/MG	7
Water Distribution (Local)	1,272 kWh/MG	7
Recycled Water Treatment & Distribution	800 kWh/MG (average of low and high values)	9
Global Warming Potentials		
CO_2	1	13
CH_4	28	13
N_2O	265	13

CO_2 = carbon dioxide; CH_4 = methane; IPCC = Intergovernmental Panel on Climate Control; KWh/MG = kilowatt hour per million gallons; CARB = California Air Resources Board;
EPA = U.S. Environmental Protection Agency; kg = kilogram; g = gram; N_20 = nitrous oxide.
CCAR = California Climate Action Registry; NAFA = National Association of Fleet Administrators;
SF_6 = sulfur hexafluoride; CNG = compressed natural gas; biogenic = of natural origin

References:

1 California Energy Commission n.d.
2 U.S. Environmental Protection Agency 2018.
3 Edison International 2018
4 California Air Resources Board 2018
5 ICLEI Local Government for Sustainability 2013
6 Lincus 2017
7 CAPCOA 2011
8 CNR 2019
9 CEC 2005
10 CEC2006
11 Climate Registry 2016
12 California Air Resources Board n.d.
13 Myhre, G., et. al. 2013.
14 IPCC 2006 Emissions from Livestock and Manure management
15 California Air Resources Board 2016
16 U.S. Environmental Protection Agency 2016
17 CCAR 2009
18 IPCC 2006
19 NAFA 2010

5.5 Analysis Methods

As defined above, the community inventories include GHG emissions occurring within the boundaries of each jurisdiction in the region. The analysis methods for each emissions sector in the inventory are described in this section. The primary data sources for each sector are also provided.

- **Building Energy - Residential:** natural gas (direct emissions) and electricity consumption (indirect emissions) for the residential sector. Data provided by Southern California Edison, Southern California Gas, Southwest Gas, Bear Valley Electric Service Company, and the municipal utilities of Needles, Rancho Cucamonga, Colton, and Victorville. Residential fuel use from sources not provided by utilities (i.e., propane, wood, fuel oil, and kerosene) was estimated using average household consumption data from the U.S. Energy Information Administration; namely, the Residential Energy Consumption Survey, and State Energy Data System.

- **Building Energy - Non-Residential:** natural gas (direct emissions) and electricity consumption (indirect emissions) for commercial, industrial, and other non-residential land uses. Data provided by the utilities is noted above for Residential.
- **Stationary Sources:** cement plants, fuel combustion, industrial process emissions etc. Data provided by CARB.
- **Light/Medium-Duty Vehicles:** emissions from combustion of fuel in light-duty and medium-duty passenger vehicles traveling in each jurisdiction. Vehicle miles traveled (VMT) data provided by Fehr and Peers using the San Bernardino County Transportation Analysis Model (SB TAM).
- **Heavy-Duty Vehicles:** emissions from combustion of fuel in heavy-duty trucks traveling in each jurisdiction. VMT data provided by Fehr and Peers using the SB TAM model.
- **Off-Road Equipment:** emissions from fuel combustion in off-road vehicles and equipment in each jurisdiction. Data provided by CARB's OFFROAD model for the entire County and apportioned to each jurisdiction using socioeconomic data.
- **Agriculture:** emissions resulting from enteric fermentation and manure management from livestock operations, and fertilizer application to crops. Data provided by the California Department of Food and Agriculture's Production Statistics and other sources provided by San Bernardino County.
- **Solid Waste Management:** CH_4 emissions from waste decomposition, generated by each jurisdiction and deposited in landfills. Data provided by CalRecycle.
- **Wastewater Treatment:** fugitive emissions from domestic wastewater treatment. Data provided by wastewater treatment providers.
- **Water Transport, Distribution, and Treatment:** electricity consumption associated with water transport, distribution, and treatment. Water demand data per capita calculated from the individual Urban Water Management Plans applicable to each jurisdiction. Water energy intensity factors provided by various sources, as noted in Table 5-1.

The inventory was conducted primarily using spreadsheet-based calculations informed by the methods established in the ICLEI Community Protocol. Table 5-2 presents the emissions sectors included in the community inventory, the data source for each emission sector, the methods for scaling the regional emissions to each jurisdiction where appropriate, and the methods for projecting emissions to 2030 and 2045. Population, housing, and employment estimates and forecasts for 2016, 2030, and 2045 are presented in Table 5-3. These projections were used to forecast emissions in 2030 and 2045.

Table 5-2. Community Inventory Data Sources and Methods

Sector	Emission Sources	Source of Data	Scaling Methods	Projection Methods
Residential (Natural Gas and Electricity)	-Electricity consumption -Natural gas consumption -Other fuels (propane, wood, fuel oil, kerosene) -Fugitive emissions of SF_6 from transport of electricity	-Electricity data from utilities (jurisdiction-level data)[b] -Natural gas data from utilities (jurisdiction-level data)[c] -SF_6 factor from SoCal Edison and estimate from CARB inventory	None	Employment growth factors
Non-Residential (Natural Gas and Electricity)	-Electricity consumption -Natural gas consumption - Fugitive emissions of SF_6 from transport of electricity	-Electricity data from utilities (jurisdiction-level data)[b] -Natural Gas data from utilities (jurisdiction-level data)[c] -SF_6 factor from SoCal Edison and estimate from CARB inventory	None	Employment growth factors
Stationary Sources	Cement plant process emissions Fuel combustion for other industrial processes	CARB (facility-level data)	None	Employment growth factors
Light/Medium-Duty Vehicles	Light and medium-duty passenger vehicle fuel combustion	SB TAM, EMFAC 2017 (VMT data)	None	VMT forecasts for future years
Heavy-Duty Vehicles	Heavy-duty truck fuel combustion	SB TAM, EMFAC 2017 (VMT data)	None	VMT forecasts for future years
Off-road Equipment	Off-road vehicles and equipment fuel combustion	CARB OFFROAD2007	Population and employment category (retail, non-retail, industrial, agricultural)	Population and employment growth factors
Agricultural Emissions	Enteric fermentation and manure management from dairy and other agricultural operations, fertilizer application from farm operations	San Bernardino County Crop and Livestock Report (2017) California Agricultural Statistics Review 2016-2017 (county-level data), San Bernardino County Public Health Department, Santa	Quantity of dairy, cattle, and swine; grazing land use	Linear projection of farmland acreage from 2016 to 2045

Sector	Emission Sources	Source of Data	Scaling Methods	Projection Methods
		Ana Regional Water Quality Control Board, Farmland Mapping and Monitoring Program, CARB Documentation of California's GHG Inventory		
Solid Waste Management	Methane emissions from landfilled waste	CalRecycle (jurisdiction-level data)	None	-Population growth forecasts (residential) -Employment growth forecasts (non-residential)
Wastewater Treatment	CH_4 and N_2O emissions from the treatment of wastewater	Inland Empire Utilities Agency, Big Bear Area Regional Wastewater Agency, Victor Valley Wastewater Reclamation Authority, San Bernardino Water Reclamation Facility, Barstow Wastewater Treatment Plant, Redlands Municipal Utilities and Engineering Department, CARB Documentation of California's GHG Inventory	Population	Population growth factors
Water Transport, Distribution, and Treatment	Indirect electricity emissions from water consumption	Urban Water Management Plans (jurisdiction-level data)	None	Population growth factors

Table 5-3. Population, Housing, and Employment Growth Factors

	2016-2030 Growth Factors			2016-2045 Growth Factors		
Jurisdiction	Population	Households	Employment	Population	Households	Employment
Adelanto	1.5	1.7	1.3	2.0	2.4	1.6
Apple Valley	1.2	1.3	1.3	1.4	1.5	1.7
Barstow	1.2	1.3	1.3	1.4	1.5	1.6
Big Bear Lake	1.2	1.2	1.1	1.3	1.3	1.2
Chino	1.2	1.2	1.1	1.4	1.4	1.1
Chino Hills	1.1	1.1	1.0	1.2	1.2	1.1
Colton	1.2	1.3	1.2	1.3	1.4	1.5
Fontana	1.2	1.2	1.2	1.4	1.5	1.3
Grand Terrace	1.1	1.1	1.4	1.2	1.3	1.7
Hesperia	1.4	1.5	1.5	1.8	2.0	2.1
Highland	1.1	1.2	1.3	1.3	1.4	1.6
Loma Linda	1.1	1.2	1.1	1.2	1.3	1.2
Montclair	1.1	1.1	1.0	1.3	1.1	1.1
Needles	1.5	1.6	1.1	2.0	2.2	1.2
Ontario	1.3	1.3	1.3	1.6	1.6	1.5
Rancho Cucamonga	1.1	1.1	1.1	1.1	1.2	1.2
Redlands	1.1	1.1	1.2	1.2	1.3	1.3
Rialto	1.2	1.2	1.2	1.4	1.4	1.4
San Bernardino	1.0	1.1	1.1	1.1	1.2	1.2
Twentynine Palms	1.1	1.2	1.5	1.3	1.4	1.9
Upland	1.1	1.1	1.1	1.2	1.3	1.2
Victorville	1.3	1.4	1.2	1.6	1.8	1.5
Yucaipa	1.2	1.2	1.2	1.4	1.4	1.6
Yucca Valley	1.1	1.1	1.3	1.2	1.3	1.6
Unincorporated County	1.1	1.1	1.1	1.1	1.2	1.2

Source: San Bernardino County Council of Governments 2019

5.6 Inventory Limitations and Recommendations

The regional inventory captures GHG emissions from operations and activities in the 25-jurisdiction region and serves as a baseline for emission reduction measures and as a starting point for future GHG emissions inventories. Future updates to the GHG emissions inventories presented in this report should be conducted annually to ensure that the inventory remains accurate and that data gaps are resolved in a timely manner. Annual updating also would enable efficient tracking of the effectiveness of any GHG reduction measures put in place to address these emission sources.

Although care was taken to ensure that data sets were as complete and accurate as possible, activities were appropriately attributed to the correct jurisdiction, and assumptions were based on reputable guidance, there are nevertheless a number of inventory limitations that have been identified. These limitations are discussed in the sections that follow.

5.6.1 Emissions Sinks

GHG emissions sinks[2] were not included in this report. Because these existing urban and natural forests are part of global atmospheric carbon cycling, ICLEI's Community Inventory Protocol recommends that this emissions sink be disclosed but not combined with other anthropogenic emissions in an inventory. As such, carbon stocks and GHG emissions sinks were not included in the community inventories. In some areas, it may benefit individual jurisdictions to add emissions sinks to the inventories where those sinks represent a meaningful part of the local inventory. The San Bernardino County region likely has relatively limited emissions sinks due to the relative lack of large forested or wetland areas within the County. The most substantial carbon sinks in the County are likely the National Forest areas that are under federal jurisdiction.

5.6.2 Data Availability Gaps and Other Limitations

Although considerable efforts were made to obtain activity data from 2016, in some cases these data were unavailable and data from another year were substituted. One example of this limitation is for the water sector, where Urban Water Management Plans (UWMP) for each water provider in the County were used to calculate water consumption. Water demand information in the UWMPs is prepared for five-year increments, with the most recent year being 2015 (with forecasts estimated for 2020, 2025, etc.). As such, water demand information for 2015 was used to determine 2015 water per capita rates, and then those rates were applied to the 2016 populations.

Additional data gaps and limitations at the sector-level are discussed in this section.

Building Energy

In other cases, some data were not available. Most notably, some electricity and natural consumption data for some jurisdictions were not available because utilities in California are subject to privacy rules,[3] which dictate that the utilities cannot disclose consumption data if certain criteria are not met.

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[2] A GHG emissions sink is a natural or human-made reservoir that absorbs and stores more CO_2 or other GHG from the atmosphere than it releases.

[3] The privacy rules were adopted by the California Public Utilities Commission (CPUC) in the Direct Access Proceeding (CPUC Decision 97-10-031) to protect customer confidentiality. The 15/15 rule requires that any

Very large consumers of energy are one example of a privacy restrictions that the utilities must adhere to, and thus some large consumers of electricity and natural gas could not be included in the utility data. With respect to electricity, datasets for two jurisdictions, Colton and Ontario, had data that was omitted due to the privacy rules.

For natural gas, the datasets from Southern California Gas Company for 12 jurisdictions had data omitted due to the privacy rules. These jurisdictions contain large, industrial uses that consume substantially more gas than typical uses. As such, the amount of gas they consume does not meet the privacy rules, and the data could not be provided. Because some of these industrial gas consumers are likely regulated by the California Air Resources Board, their corresponding emissions are likely included in the Stationary Sources sector. Due to the privacy rules, it cannot be determined with certainty which sources of emissions that were excluded from the utility data are included in the Stationary Sources sector. The CPUC privacy rules and the resulting omissions in the utility data thus represent an inventory data gap, which is presented here for full disclosure.

For a number of other jurisdictions, data were not omitted but were aggregated into broader categories to provide more anonymity. For example, if industrial electricity consumption did not meet the privacy criteria, SCE combined the industrial data with the commercial data and only provided the sum of these categories. For this reason, the non-residential energy emissions in the inventories have been grouped into one category rather than as sub-categories, such as commercial or industrial.

Additionally, electricity data for municipally owned streetlights, traffic lights, and outdoor lights were not included in the data set provided by SCE. As such, these data were obtained individually from each jurisdiction but were not available from the following jurisdictions: Adelanto, Barstow, Highland, and San Bernardino. The municipal lighting data for these jurisdictions were thus not included in the respective inventories, but such data is expected to be less than one percent of the total jurisdiction electricity consumption.

On-Road Transportation

For estimating On-Road emissions, the Origin-Destination based VMT DATA was provided for the year 2016 and 2040 by Fehr and Peers using the San Bernardino County Transportation Analysis Model (SB TAM). The SB TAM model was used for the regional VMT analysis and provided a more accurate measure of VMT. To determine the VMT for inventory years, the 2016 and 2040 VMT data were interpolated from 2016 to 2020 and 2030, and extrapolated to 2045. For the previous 2008 GHG Inventory, the VMT by speed bin data were used at the County level using a SCAG model. The current inventory update provided a more accurate analysis; however, it is not an "apples to apples" comparison between the VMT data for the 2008 inventory and 2016 inventory update, which may limit the assessment of progress between 2008 and 2016 for this sector.

aggregated information provided by the utilities must be made up of at least 15 customers and a single customer's load must be less than 15% of an assigned category. If the number of customers in the complied data is below 15, or if a single customer's load is more than 15% of the total data, categories must be combined before the information is released. The rule further requires that if the 15/15 Rule is triggered for a second time after the data have been screened once already using the 15/15 Rule, the customer be dropped from the information provided.

Agriculture

Agriculture in San Bernardino County is dominated by the dairy industry and the related industries of calf production and forage crops. The county's agricultural diversity includes fruit orchards in the east Valley area and nursery and vegetable production. In the Desert region, agriculture includes pistachio orchards, field crops (primarily alfalfa), and range-land cattle grazing. For the agriculture sector GHG inventory, the data available on agricultural crops did not correlate directly with the emission factors used for estimating the non-carbon GHG emissions. For example, for estimating the direct and indirect N_2O from Nitrogen applied in fertilizers, the percentage of farmland for each city was multiplied by the County's overall N_2O emissions, which were calculated from the County's total farmland acreage and emission factors from the CARB 2016 GHG Inventory. It was assumed that 140 lbs. of nitrogen are applied per acre and that all crops are the same. These assumptions were made due to limited data availability.

Water

Accurately apportioning emissions in the water sector to the correct jurisdiction was a challenging exercise and represents a limitation of the inventories. The water sector comprises indirect emissions from electricity that is consumed by pumps, treatment plants, lift stations, desalination facilities, and other infrastructure. This infrastructure is dispersed throughout the region and state. Some water that is imported into the County originates in northern California and is conveyed south via aqueducts. For water that originates from within the County, such as from a reservoir or a groundwater basin, that water may be diverted and extracted in one jurisdiction in the County and then conveyed to another where it is ultimately used.

As a result of this complicated network of water infrastructure, assigning responsibility of water-related emissions to the appropriate jurisdiction is a difficult task. Water-related electricity is included in the Building Energy sector because there is water infrastructure, such as a groundwater pump, within the County. However, the groundwater pump may be located in one jurisdiction, such as Ontario for example, but ultimately pumps water that will be consumed in other jurisdictions as well. In an ideal scenario, the portion of electricity used to pump water that will be consumed in non-Ontario jurisdictions would be subtracted from Ontario's Building Energy sector emissions (the total energy from this hypothetical groundwater pump would be included in the utility data for Ontario provided by SCE). The non-Ontario jurisdictions are consuming the water and thus the jurisdictional control over the water consumption would be in those non-Ontario jurisdictions, even though the energy via the groundwater pump is being consumed in Ontario.

Performing an ideal analysis would thus require a vast amount of detailed information, such as the exact locations of all water-related infrastructure within and outside of the County, the quantities of water served by that infrastructure, and which jurisdictions the water is ultimately conveyed to. That level of detail is beyond the scope of this analysis, however, but such an analysis could be conducted for individual jurisdiction inventories for those that are developed in the future.

As such, the approach for the Water sector of this analysis is that all water-related energy is assigned to each jurisdiction based on the amount of water that is consumed in that jurisdiction. That energy is subtracted from that jurisdiction's energy totals in the Building Energy sector, irrespective of where the water infrastructure is actually located. Conducting a more precise accounting of Building Energy emissions overlap is not within the scope of this effort.

Wastewater

Similar to the discussion above for the Water sector, apportioning Wastewater sectors accurately to the appropriate jurisdictions is also challenging due to the overlap between this sector and the Building Energy sector. Wastewater emissions comprise direct fugitive emissions that are a result of bacterial decomposition of solids in wastewater and of electricity and/or natural gas emissions resulting from operation of the wastewater treatment plants. The amount of wastewater generated by each jurisdiction was primarily determined by scaling the population number in each jurisdiction. While this is a reasonable method for apportioning Wastewater sector fugitive emissions, apportioning the building energy emissions from the treatment plants is more difficult. A treatment plant may be located in one jurisdiction, such as Victorville, that serves multiple other jurisdictions. Consequently, the Building Energy sector emissions from that treatment plant are attributed solely to Victorville, even though other jurisdictions have partial responsibility for those Building Energy emissions since they send wastewater to the Victorville plant.

In an ideal scenario, the Building Energy emissions at each wastewater treatment plant would be attributed to each jurisdiction that sends wastewater to treatment plants. However, such an analysis would require detailed information and calculations that are beyond the scope of this inventory, such as the origin and quantity of wastewater that enters all treatment plants that serve the County.

As such, the approach for the wastewater sector of this analysis is that all direct, fugitive emissions are apportioned to each jurisdiction based on the quantity of wastewater they generate. Any emissions associated with building energy, such as at the treatment plants, is not included in the Wastewater sector. Those emissions are included in the Building Energy sector, which results in a disproportionate share of emissions being attributed to jurisdictions that contain wastewater treatment plants within the boundaries. Those wastewater treatment plants are processing wastewater from multiple jurisdictions, but the level of detailed required to precisely account for the Building Energy overlap is beyond the scope of this effort.

5.6.3 High Global Warming Potential Gases

Emissions from the use of substitutes for ozone-depleting substances (ODS) (primarily hydrofluorocarbons [HFCs], and perfluorocarbons [PFCs])[4] were not included in the inventories. These substances are high GWP gases but are not specifically recommended for quantification in regional inventories. Quantification of these emissions is based on statewide emissions factors, which include a diverse set of possible sources; thus, scaling those statewide-based emissions to the regional- or local-scale likely introduces considerable uncertainty. Additionally, local governments have limited jurisdictional control or influence over these sources of emissions.

5.6.4 Business-as-Usual Forecasts

The BAU emissions forecasts are based on estimates, forecasts, and growth factors and not actual activity data for those years. BAU emissions for 2030 and 2045 are calculated based on the most appropriate growth data available for each sector. For example, future energy use emissions are estimated based on projected population, employment, and housing growth. Where possible, BAU

[4] Emissions of HFCs and PFCs occur from their use in refrigeration and air conditioning systems. These high GWP compounds were phased in as ODS substitutes. The majority of anthropogenic high GWP GHGs are SF_6, HFCs, and PFCs.

projections were made using the best available information and estimates provided by jurisdiction staff and experts on individual sectors. For many sectors, the projections of emissions were based on the future population estimates in 2030 and 2045 for the jurisdictions using data provided by SBCOG. This method assumes that emissions will remain proportionate to the current population, which may not be the case. For example, per capita energy consumption may change over time as habits and technology change. For other sectors, rather than population, BAU estimates were made based on employment levels, which requires a similar assumption regarding emissions remaining proportionate to current employment levels.

Appendix A
Section 6: References

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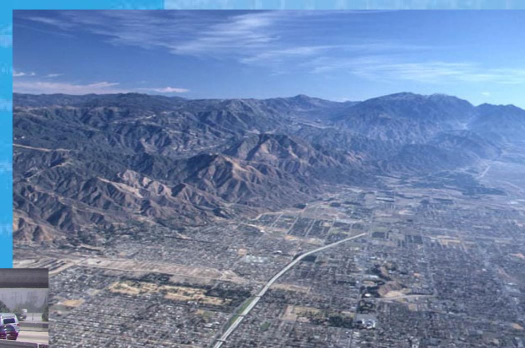
Appendix B
San Bernardino County Regional GHG Reduction Plan: GHG Reduction Measure Methods

March 2021



Adelanto
Apple Valley
Barstow
Big Bear Lake
Chino
Chino Hills
Colton
Fontana
Grand Terrace
Hesperia
Highland
Loma Linda
Montclair
Needles
Ontario
Rancho Cucamonga
Redlands
Rialto
San Bernardino
San Bernardino County
Twentynine Palms
Upland
Victorville
Yucaipa
Yucca Valley

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Appendix B
GHG Reduction Measure Methods

B.1 Introduction

This Appendix provides a detailed overview of the calculations and assumptions used to quantify greenhouse gas (GHG) emissions reductions for each of the GHG reduction measures in the San Bernardino Regional Greenhouse Gas Reduction Plan (Plan). A qualitative discussion of benefits is also presented. The following information is provided for each measure.

- **Measure Description**: Details the implementation requirement(s) and reduction goal for each measure.
- **Assumptions**: Includes all assumptions used in calculating emissions reductions.
- **GHG Analysis Details**: Presents the methods for calculating 2030 business as usual (BAU) emissions,[1] 2030 emissions with state measures, and 2030 emissions with local measures. A qualitative summary of benefits is also provided. For additional information, please refer to the citations provided for each measure.

As an introduction to the measure details, this Appendix begins with an overview of the general GHG quantification methods by emissions sector.

B.2 Overview of GHG Methods

The quantification of GHG reductions was based on guidance provided by the California Air Pollution Control Officers Association (CAPCOA), other reference sources (such as the U.S. Environmental Protection Agency), and professional experience obtained from preparing climate action plans (CAP) for other jurisdictions in California. The majority of calculations were performed using standard factors and references, rather than performing a specific analysis of individual technologies. The following sections provide an overview of general calculation methods by emissions sector.

To avoid double counting emissions savings achieved by state programs, emissions reductions attributed to the candidate measures subtract reductions achieved through the relevant state measures first. Likewise, emissions reductions attributed to certain candidate measures subtract reductions achieved by overlapping local measures. By removing overlapping reductions, one can combine GHG reduction strategies to determine the cumulative effect of several measures without double counting measure effectiveness.

[1] BAU emissions are defined as those that would occur without the implementation of state (e.g., renewable energy portfolio, Title 24) or local action (e.g., Energy-1, Energy-2).

B.2.1 State Measures

The Reduction Plan includes emissions benefits from seven statewide initiatives. These State measures span multiple emission sectors, but are primarily targeted at the building energy and transportation sectors. Emissions reductions achieved by these measures were apportioned to the city-level using statewide estimates of measure effectiveness and sector-specific information. For example, the California Air Resources Board (CARB) Senate Bill 350 requires a doubling of energy efficiency savings in the state by 2030. GHG reductions achieved by Senate Bill 350 within the Partnership cities were therefore quantified by determining the electricity and natural gas savings target in 2030 required by each jurisdiction to comply with Senate Bill 350 and applying utility-specific electricity emission factors and natural gas emission factors to each City's energy savings. It is important to note that while the Partnership jurisdictions will achieve emissions reductions as a result of State programs, implementing State measures does not require local action.

B.2.2 Local Measures

The section summarizes local efforts that the Reduction Plan proposes to further reduce community-wide GHG emissions. Measures that are required by State law, such as compliance with Senate Bill 350, or jurisdiction regulations, such as an Idling Ordinance, would be mandatory for either existing and/or new development (and are identified with a [M]). Each Partnership jurisdiction would require implementation of these measures, pursuant to state and new or existing local laws and regulations. Measures that would be implemented through incentive-based approaches, such as building retrofits, would be voluntary and are marked with a [V]. GHG reductions associated with these voluntary measures were quantified based on anticipated participation rates. Measures that would be implemented by each Partnership jurisdiction for municipal measures are marked with a [CITY] mark. An example of this is Land Use-1: Tree Planting Programs. Some measures are a combination of jurisdiction measures and voluntary or mandatory measures.

B.2.3 GHG Performance Standard for New Development

The GHG Performance Standard for New Development (PS) provides a streamlined and flexible program for new projects to reduce their emissions. This approach uses a performance standard for new private developments as part of the discretionary approval process under CEQA. New projects would be required to quantify project-generated GHG emissions and adopt feasible reduction measures to reduce project emissions to a level which is a certain percentage below BAU project emissions, as specified by each Partnership city. This approach does not require project applicants implement a pre-determined set of measures. Rather, project applicants are encouraged to choose the most appropriate measures for achieving the reduction goal, while taking into consideration cost, environmental or economic benefits, schedule, and other project requirements.

To quantify the reductions achieved for the PS approach, the amount of new development emissions from 2016 to 2030 was estimated for each Partnership jurisdiction along with the GHG reductions needed to achieve the overall PS reduction goal for each city. Then the value of the other state and local measures for new development was estimated for each Partnership jurisdiction and subtracted from the PS reduction goal to derive the net additional reductions that would result from the PS implementation. This does not mean that the state and local other measures would apply on an equal basis for every single project, and thus individual new development projects may have higher or lower project-level burdens than the average. Analysis of this measure indicates that the bulk of reductions needed to meet the PS would be from other state and local measures and a smaller portion from project-level reductions.

B.2.4 Building Energy Use

Reduction measures to address GHG emissions from building energy use are separated into two categories: energy efficiency and renewable energy. Emissions reductions associated with these measures were quantified using estimates of electricity kilowatt hour (kWh) and natural gas (therms) consumed by residential, commercial, and industrial buildings. Activity data was provided for the existing inventory year (2016), which was scaled to 2020, 2030, and 2045 under BAU conditions using the socioeconomic data summarized in the San Bernardino Regional Inventory Methods (GHG Inventory) (ICF, 2020).

Emissions reductions achieved by energy efficiency and renewable energy measures were quantified using a general standards and factors. Specifically, percent reductions in energy consumption for various actions, such as exceeding the Title 24 Standard, were obtained from CAPCOA and other literature sources. These reductions were applied to the expected 2020, 2030, and 2045 energy usage to quantify total reductions in energy consumption. GHG emissions that would have been emitted had the energy been consumed were then calculated using utility-specific emission factors.

B.2.5 On-Road Transportation

There is one state and five local transportation measures included in the Plan; two to reduce the number of vehicle trips and encourage mode shifts from single-occupancy vehicles to alternative transportation, two to increase the use of electric transit and vehicles, and one to improve traffic flow. GHG emission reductions are dependent on jurisdiction's commitment level to each measure, and were estimated using transit and vehicle miles traveled (VMT) data and standard transportation emission factors.

B.2.6 Off-Road Vehicle Activity

Measures within the off-road sector seek to increase the use of electricity and reduce the consumption of fossil fuels in heavy-duty off-road equipment. GHG emissions in 2030 and 2045 for off-road activity within the County were quantified using the CARB OFFROAD2007 emissions model. OFFROAD2007 provides detailed estimates of fuel consumption, hours of operation, and emissions by equipment type and horsepower. GHG emission reductions associated with electrifying off-road equipment were estimated using the OFFROAD2007 model outputs and the anticipated electrification level estimated by each jurisdiction. GHG emission reductions from vehicle idling restrictions were quantified using OFFROAD2007 model and standard fuel consumption factors.

B.2.7 Waste Generation

The waste reduction strategy aims to reduce the amount of waste produced by each community. Existing waste generation volumes and diversion rates were obtained from CalRecycle. GHG emissions that would have been generated by waste if they had not been diverted were quantified using the CARB First Order Decay (FOD) model and the methods described in the GHG Inventory (ICF International, 2012).

B.2.8 Water Consumption

The Reduction Plan seeks to reduce energy and GHG emissions associated with water consumption through adoption of the voluntary CALGreen water efficiency measures for existing and new development and encourage water-efficient landscaping practices in the participating cities. Fixture flow rates from CALGreen (2010) and CAPCOA (2010) along with socioeconomic data were used to estimate the water savings from CALGreen standards. Information from CAPCOA was used to estimate the water savings from water-efficient landscaping practices. Indirect GHG emissions from electricity required to pump, treat, distribute and/or heat the consumed water were calculated using state-specific emission factors.

B.2.9 Wastewater Treatment

The Plan includes two wastewater measures; one to capture methane produced during the wastewater treatment process and one to improve the energy efficiency of wastewater treatment and pumping equipment. GHG emission reductions from methane capture were calculated from the percentage of methane generated by wastewater treatment plants captured and not released into the atmosphere. GHG emission reductions associated with improvements in energy efficiency were calculated from levels of planned improvements.

B.2.10 Agriculture

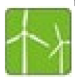
The Plan includes one agriculture measure to implement or improve methane capture and combustion at large dairies and animal operations facilities. The large dairies with more than 1,000 cattle are located in Chino, Ontario, and unincorporated areas of the County. Methane capture reduces fugitive methane emissions that are emitted from livestock as a result of decomposing manure. Capturing the fugitive methane prevents it from reaching the atmosphere. Captured methane can also be utilized as an energy source to generate electricity, which reduces the need for external energy from a utility.

B.3 Overview of Measure Benefits

Many of the GHG reduction measures would result in financial, environmental, and public benefits for the cities and communities that are additional to the expected GHG emission reductions. These benefits include cost savings over conventional activities, reductions in criteria pollutants, job growth, economic growth, and public health improvements. Based on literature reviews, a qualitative discussion of anticipated benefits is provided for each of the Partnership city's GHG reduction measures. Benefits are identified using the following icons in Table B.3-1.

Table B.3-1

Benefits for the Reduction Plan's GHG Reduction Measures

	Reduced Energy Use		Reduced Energy Price Volatility
	Reduced Waste Generation		Economic Growth
	Resource Conservation		Public Health Improvements
	Energy Diversification and/or Security		Increased Quality of Life
	Reduced Air Pollution		Reduced Urban Heat Island Effect
	Increased Property Values		Smart Growth

State-1: Senate Bill 100 (2018) Renewable Portfolio Standard

Measure Description

Senate Bill 100 was signed by Governor Jerry Brown on September 10, 2018. The RPS applies to all electricity retailers in the state and local publicly owned utilities. All of these entities must adopt the new RPS goals of 44 percent of retail sales from renewables by the end of 2024, 50 percent by the end of 2026, 52 percent by the end of 2027, 60 percent by the end of 2030, and the 100 percent requirement being met by the end of 2045.

Assumptions

Quantification of this measure employs the following assumptions:

- The 2016 renewable energy mix for each utility is as follows:
  - 28% for Southern California Edison (SCE) (California Energy Commission, 2019)
  - 25% for Bear Valley Electric Service (BVES) (California Energy Commission, 2019)
  - 25% for Colton Public Utilities (CPU) (California Energy Commission, 2019)
  - 0% for the City of Needles (City of Needles, 2019)
  - 0% for Victorville (California Energy Commission, 2019)
  - 22% for Rancho Cucamonga Municipal Utilities (RCMU) (California Energy Commission, 2019)

Analysis Details

GHG Analysis

Implementation of the Renewable Portfolio Standard (RPS) will increase the proportion of renewable energy within the energy supply mix of the utilities serving the participating cities. Renewable resources, such as wind and solar power, produce the same amount of energy as coal and other traditional sources, but do not emit any GHGs. By generating a greater amount of energy through renewable resources, electricity provided to each Partnership jurisdiction by their utilities will be cleaner and less GHG intensive.

Implementation of the Renewable Portfolio Standard (RPS) will increase the proportion of renewable energy within the energy supply mix of the utilities serving the participating cities. Renewable resources, such as wind and solar power, produce the same amount of energy as coal and other traditional sources, but do not emit any GHGs. By generating a greater amount of energy through renewable resources, electricity provided to each Partnership jurisdiction by their utilities will be cleaner and less GHG intensive.

<u>2030 BAU Emissions</u>

The GHG Inventory (ICF, 2020) estimates that community-wide electricity consumption[2] in 2030 for the participating cities would be approximately 16,327 gigawatt hours (GWh). The 2030 BAU renewable energy mix for each utility was determined as follows:

The GHG Inventory estimates that community-wide electricity consumption[3] in 2016 for the participating cities would be approximately 16,327 gigawatt hours (GWh). The 2016 renewable energy mix for each utility was determined as follows:

a) SCE, BVES, CPU, Victorville, and RCMU: the direct renewable percentage for 2016 from the CEC's Power Content Labels was used.

b) City of Needles: the direct renewable percentage for 2016 from the City of Needles AB32 Emission Verification Report was used.

<u>Emissions Reductions</u>

Based on the renewable energy mix assumptions listed above, achievement of the RPS will reduce the carbon intensity of the 2030 CO_2 emission factor for each utility as follows:

a) From 529 pounds per MWh to 294 pounds per MWh for SCE (California Energy Commission, 2019).

b) From 417 pounds per MWh to 222 pounds per MWh for BVES (California Energy Commission, 2019).

c) From 1,156 pounds per MWh to 617 pounds per MWh for CPU (California Energy Commission, 2019).

d) From 190 pounds per MWh to 76 pounds per MWh for the City of Needles (City of Needles, 2019).

e) From 416 pounds per MWh to 212 pounds per MWh for Victorville (California Energy Commission, 2019).

f) From 529 pounds per MWh to 282 pounds per MWh for RCMU (California Energy Commission, 2019).

GHG emissions generated from electricity consumption were calculating assuming implementation of the RPS by multiplying 2030 community-wide electricity consumption by the RPS-adjusted emissions factors. The difference in emissions between the 2030 BAU and 2030 RPS scenarios represents the emissions reductions achieved by this measure.

Co-Benefit Analysis

The RPS provides California with a flexible, market-based strategy to increase renewable energy generation and distribution. As discussed above, renewable energy provides the same amount of power as tradition sources (e.g., coal), but does not emit any GHGs or other criteria pollutants. Renewable energy therefore represents a clean source of power for the State and the participating cities. The following benefits are expected from implementation of the RPS (International Energy Agency, 2007; U.S. Environmental Protection Agency, 2009b).

Reduced Air Pollution: San Bernardino utilities generate power through a combination of sources, but the majority of electricity is provided by fossil fuels (e.g., coal, natural gas). The extraction and processing of fossil fuels generates localized pollutants emissions at the place of mining and at the source of power generation. These pollutants may be dispersed into the atmosphere, where they can be transported over long distances and result in regional air pollution. Reducing the amount of fossil fuels processed at power stations through increased generation of renewable energy would contribute to cumulative reductions in criteria pollutants throughout the State.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to, fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constraints and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, substations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Renewables would contribute to the diversification of the energy supply mix, thereby buffering local economies from the volatile global energy market.

Economic Development: Development of renewable energy infrastructure (e.g., solar farms, wind turbines) would create new jobs, taxes, and revenue for local and regional economies.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

[2] Includes electricity consumed by buildings.

[3] Includes electricity consumed by buildings.

State-2: Title 24 Standards for Non-Residential and Residential Buildings (Energy Efficiency Standards and CALGreen)

Measure Description

Requires that building shells and building components be designed to conserve energy and water. 2016 T24 standards are effective starting January 1, 2017, and 2019 T24 standards are effective starting January 1, 2020. The standards will be periodically updated between 2020 and 2045.

Assumptions

Quantification of this measure employs the following assumptions:

- The 2019 Title 24 standards are 8% and 4% more stringent than the 2008 T24 standards for single-family homes and multi-family homes, respectively (California Energy Commission, 2018). This is equivalent to an increase in stringency of approximately 7% on average for all residential buildings the county as a whole.
- The 2019 Title 24 standards are 30% more stringent than the 2016 T24 standards for nonresidential buildings (California Energy Commission, 2018).
- Stringency of the Title 24 energy efficiency standards will be increased by 7% every three years starting in 2019.
- Stringency of the Title 24 residential solar standards will remain at the 2019 level.

Analysis Details

GHG Analysis

Energy efficiency upgrades as a result of the Title 24 standards will reduce electricity and natural gas consumption, thereby resulting in GHG emissions savings.

BAU Energy Consumption

The GHG Inventory (ICF, 2020) estimates that community-wide electricity consumption in 2030 for the participating cities is approximately 13,996 GWh and community-wide natural gas consumption in 2030 for the participating cities is approximately 437 million therms. In 2030, electricity consumption is estimated to be approximately 15,483 GWh and natural gas consumption is estimated to be approximately 483 million therms. In 2045, electricity consumption is estimated to be approximately 17,704 GWh and natural gas consumption is estimated to be approximately 564 million therms.

Emissions Reductions

The stringency of the Title 24 energy efficiency standards will be increased nine times relative to the GHG inventory base year (2016) by 2045.[4] The 2019 standards represent a 7% and 30% increase in energy efficiency (electricity and natural gas) compared to the 2016 T24 standards for residential and non-residential buildings, respectively. Assuming a 7% tri-annual increase in the stringency of the Title 24 standards, after 2019, 2045 residential energy use would be reduced to 52.0% of the 2016 code. Non-residential energy use would likewise be reduced to 39.2% of the 2016 code.

Because the Title 24 code is revised on a semi tri-annual basis, only a fraction of total energy use is subject to each code revision. To avoid-double counting, estimated energy reductions were multiplied by the annual fraction of electricity subject to each code revision. The average reduction in residential energy use in 2020, 2030, and 2045 as a result of the Title 24 Standards was therefore estimated to be 1.8%, 16.3%, and 37.8%, respectively. The average non-residential reductions were estimated to be 7.5%, 37.0%, and 53.3%, respectively.

The stringency of the Title 24 standards' residential solar requirement was increased in 2019. The 2019 standards represent a 46% reduction in energy consumption compared to the 2016 base year. This analysis presumes the change from 2016 to 2019, but does not presume any changes after 2019 for solar requirements.

Energy reductions achieved by Title 24 were calculated by multiplying the 46% reduction in energy consumption from the residential solar requirement, and the corresponding years' reduction percentages for residential and non-residential development, by each Partnership city's BAU electricity and natural gas consumption for residential and non-residential development. GHG emissions reductions were quantified by multiplying the total energy reductions by the appropriate utility emission factors.[5]

Co-Benefit Analysis

The following benefits are expected from implementation of improvement of the Title 24 standards over time.

Reduced Energy Use: Energy retrofits and standards would improve the efficiency of residential and non-residential buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas).

Resource Conservation: Increased building efficiency would reduce water consumption, which would help conserve freshwater.

Increased Property Values: Energy-efficient bulidings have higher property values and resale prices than less efficient buildings.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health. A well-built, energy-efficient structure is also more durable and directly reduces certain health aliments. For example, properly sealed ducts help prevent mold and dust mites that can cause asthma.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life. Additionally, energy-efficient structures improve general comfort by equalizing room temperatures and reducing indoor humidity.

[4] Increases assumed in 2019, 2022, 2025, 2028, 2031, 2034, 203, 2040, and 2043.

[5] Utility emission factors account for decreased carbon intensities as a result of the State's RPS.

State-3: SB 350 Clean Energy and Pollution Reduction Act

Measure Description

SB 350 requires the state to double statewide energy efficiency savings in electricity and natural gas end uses by 2030.

Assumptions

Quantification of this measure employs the following assumptions:

- Statewide electricity and natural gas savings targets, developed by the California Energy Commission, may be adjusted to local jurisdictions based on statewide and city populations.
- All reductions in energy consumption resulting from Title 24 Standards and from solar water heater deployment overlap with SB 350 reductions.

Analysis Details

GHG Analysis

Lighting requires the production of electricity to power the lights, which represents an indirect source of GHG emissions. Different light fixtures have different efficacies; in other words, certain bulbs can utilize less energy to obtain the same output. Replacing less efficient bulbs with energy-efficient ones therefore reduces energy consumption, and thus GHG emissions.

Electricity and Natural Gas Savings Targets

Jurisdiction-level savings target are estimated by applying the statewide savings targets to the jurisdiction's proportion of the statewide population. CEC estimates a statewide electricity savings target of 900,250 GWh by 2020, and 2,071,750 GWh by 2030 (California Energy Commission, 2017). The community-wide savings targets for San Bernardino County are estimated to be 1,900 GWh by 2020, and 4,372 GWh by 2030. CEC estimates a statewide natural gas savings target of 385 million therms by 2020, and 1,174 million therms by 2030 (California Energy Commission, 2017). The community-wide savings targets for San Bernardino County are estimated to be approximately 21 million therms by 2020, and 41 million therms by 2030.

Co-Benefit Analysis

The following benefits are expected from implementation of SB350.

Reduced Energy Use: Doubling energy efficiency will result in a 50% reduction in energy use.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity).

Resource Conservation: Doubling energy efficiency would reduce the demand for natural gas.

State-4: AB 1470 (Huffman) Solar Water Heaters

Measure Description

AB 1470 was a 10-year program starting in 2007 encouraging the installation of 200,000 solar water heating systems by 2017. AB 797 revised the program to promote the installation of solar thermal systems throughout the state, reserve 50 percent of the total program budget for the installation of solar thermal systems in low-income residential housing or in buildings in disadvantaged communities, and extend the operation of the program through July 31, 2020.

The resulting program is the California Solar Initiative CSI-Thermal Program. It offers cash rebates of up to $4,366 on solar water heating systems for single-family residential customers. Multifamily and Commercial properties qualify for rebates of up to $800,000 on solar water heating systems and eligible solar pool heating systems qualify for rebates of up to $500,000.

Assumptions

Quantification of this measure employs the following assumptions:

- Solar water heaters reduce natural gas use by 128 therms (California Air Resources Board, 2019).
- An average of 0.004 water heaters per home will be replaced as a result of AB 1470 (California Air Resources Board, 2019; California Department of Finance, 2019).

Analysis Details

GHG Analysis

California relies heavily on natural gas for water heating. Rooftop solar water heating technologies are designed to reduce fuel consumption, and thus GHG emissions.

<u>Emissions Reductions</u>

CARB estimates that implementation of AB 1470 would result in the installation of 200,000 solar water heaters by 2020. Assuming that an average of 0.004 heaters per home would be replaced as a result of AB 1470, and that the participating cities would have 61,538 water heaters would be replaced with solar water heaters between 2016 and 2020. Each solar water heater will reduce natural gas use by 128 therms (California Air Resources Board, 2019). Natural gas reductions were calculated by multiplying 128 therms by the number of water heaters installed. GHG emissions reductions were then quantified by multiplying the total energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of AB 1470.

Reduced Energy Use: Solar water heaters consume, on average, 128 therms less natural gas than non-solar units.

Reduced Air Pollution: Reduced energy use would contribute to corresponding reductions in local air pollution (from reduced burning of natural gas).

Increased Property Values: Energy-efficient bulidings have higher property values and resale prices than less efficient buildings.

State-5: Co-generation Facilities

Measure Description

The CPUC administers a Qualifying Facilities and Combined Heat and Power Program. Qualifying facilities are CHP facilities that meet certain size and efficiency criteria. Qualifying facilities can sell the energy they generate to investor-owned utilities (IOUs) at predetermined prices and conditions. CPUC's QF/CHP Program, which implements the QF/CHP Settlement, requires that:

1. California's three largest Investor-owned utilities (Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric Company (SDG&E) and Southern California Edison Company (SCE)) collectively procure 3,000 megawatts (MW) of capacity from CHP facilities by 2018, and

2. Reduce GHG emissions by 2.72 Million Metric Tonnes (MMT) by 2020.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- 2.72 million metric tons of GHG emissions will be reduced from State-5 by 2020.
- Jurisdictions will reduce emissions in proportion to their population.

Analysis Details

GHG Analysis

For the same level of power output, combined heat and power (CHP) systems (or co-generation systems) utilize less input energy than traditional separate heat and power (SHP) generation, resulting in fewer CO_2 emissions. In traditional CHP systems, heat created as a by-product is wasted by being released into the environment. In contrast, CHP systems harvest the thermal energy and use it to heat onsite or nearby processes, thus reducing the amount of natural gas or other fuel that would otherwise need to be combusted to heat those processes. In addition, CHP systems lower the demand for grid electricity, thereby displacing the CO_2 emissions associated with the production of grid electricity.

BAU Electricity Emissions

The GHG Inventory quantified electricity emissions associated with existing nonresidential facilities in 2016. The 2016 values were projected to 2020 using employment data in order to determine electricity use and emissions for all new commercial buildings built from 2017 to 2020, which are subject to State-5.

Emissions Reductions

Energy reductions associated with other state and local measures were subtracted from the energy used by all new nonresidential buildings built from 2016 to 2020. This was done in order to determine the energy used by new buildings after the implementation of preceding measures, before the installation of co-generation. Emission reductions were estimated by determining the amount of emissions that need to be reduced to reach the goal of 2.72 million metric tons by 2020 based on current progress reports for the CHP program. Then, it was assumed that the remaining amount of reductions would be reached by jurisdictions by assuming they reduce GHG emissions from the CHP program in proportion to the respective populations of each jurisdiction.

Co-Benefit Analysis

The following benefits are expected from implementation of State-5.

Reduced Air Pollution: Co-generation systems use waste heat to reduce the amount of natural gas or other fuel that would otherwise need to be combusted to heat processes and also lower the demand for grid electricity. As such, combustion at regional power stations would be reduced, contributing to cumulative reductions in criteria pollutants.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to, fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constraints and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, sub-stations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Utilizing waste heat in co-generation systems would contribute to the diversification of the energy supply mix, thereby buffering the local economy from the volatile global energy market.

Economic Development: Development of co-generation systems and associated infrastructure would create new jobs, taxes, and revenue for the local economy.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

OnRoad-State: AB 1493 (Pavley I and II) Greenhouse Reductions from New Passenger Vehicles

Measure Description

AB 1493 (Pavley I) requires the CARB to adopt vehicle standards that will lower GHG emissions from new light-duty autos in 2009. Additional strengthening of the Pavley standards (Pavley II or Advanced Clean Cars measure) has been proposed for vehicle model years 2017–2025. Together, the two standards are expected to increase average fuel economy to roughly 43 miles per gallon by 2020 and reduce GHG emissions from the transportation sector in California by approximately 14 percent. The State would continue to benefit from these standards beyond 2020.

Assumptions

Quantification of this measure employs the following assumptions:

- Assumptions are embodied in the EMFAC2017 model.

Analysis Details

GHG Analysis

Engine efficiency improvements will reduce fuel consumption, thereby reducing GHG emissions from fossil fuel combustion.

Emissions Reductions

The EMFAC2017 model was used to generate emission factors for vehicles traveling within San Bernardino County (in the Mojave Desert Air Basin and South Coast Air Basin) for the years 2030 and 2045 with implementation of Pavley/Advanced Clean Cars. These emission factors were multiplied by the 2030 and 2045 BAU VMT for each jurisdiction and compared to the 2030 and 2045 BAU emissions. The difference in emissions equals the reductions associated with Pavley/Advanced Clean Cars.

Co-Benefit Analysis

The following benefits are expected from implementation of OnRoad-State measure.

Reduced Energy Use: Pavley/Advanced Clean Cars would increase the fuel efficiency of passenger vehicles, which would reduce the amount of fossil fuels consumed per mile traveled. The combustion of hydrocarbons generates a variety of air pollutants, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors. Reducing the consumption of transportation fuels would therefore reduce local and regional air pollution.

Reduced Air Pollution: Efficient vehicles burn less fuel per mile traveled than less efficient vehicles. Air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would therefore be reduced.

Public Health Improvements: Fossil fuel combustion releases several toxic air contaminants known to cause adverse human health effects. Improvements in vehicle efficiency would reduce the amount of fuel combusted, resulting in corresponding reductions in toxic air contaminants. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: Reducing fuel consumption by passenger vehicles would lessen the demand for petroleum and ultimately the demand for imported oil.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, fuel prices would likely be subject to fluctuations and frequent price spikes. Biofuels and other renewable technologies would contribute to the diversification of the energy supply mix, thereby buffering local economies from the volatile global energy market.

Economic Development: The development of biofuels and other clean technologies would create new jobs, taxes, and revenue for local and regional economies.

State-7: SB 1383 Methane Capture

Measure Description

The Landfill Methane Rule requires gas collection and control systems for landfills with greater than 450,000 tons of waste-in-place. The rule requires a 40% reduction in landfill methane emissions by 2030 from a 2013 baseline. As appropriate, install methane capture technology and associated monitoring systems on all landfills without methane capture with a goal of increasing the facility level methane capture rate to the highest extent feasible (i.e., approaching 100%) The measure also establishes statewide performance standards to maximize methane capture efficiencies.

Assumptions

Quantification of this measure employs the following assumptions:

- BAU methane capture rate = 75% (EPA default); Target methane capture rate = 95%.
- 40% reduction in methane emissions by 2030, from a 2013 baseline.

Analysis Details

GHG Analysis

Implementation of the landfill methane rule would reduce GHG emissions attributable to landfills. Using a 2016 baseline, a 40% reduction in baseline emissions was modeled through 2030.

<u>BAU Emissions</u>

The GHG Inventory projected 2020 and 2030 landfill emissions for each city using historic landfill data obtained from CalRecycle.

<u>Emissions Reductions</u>

Implementation of the State-7 measure would decrease emissions from landfills by 40%. The amount of reductions was calculated by reducing baseline emissions by 40%.

Co-Benefit Analysis

The following benefits are expected from implementation of State-7.

Reduced Air Pollution: The decomposition of landfilled waste emits methane, which can react with other species in the atmosphere to form local smog. By sending less waste to regional landfills, methane emissions would be reduced.

Reduced Energy Use: Energy retrofits would improve the efficiency of residential buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

PS-1: GHG Performance Standard for New Development

Measure Description

Individual jurisdictions could adopt a GHG Performance Standard for New Development (PS), which would provide a streamlined and flexible program for new projects to reduce their emissions. This measure would include a performance standard for new private developments as part of the discretionary approval process under CEQA. New projects would be required to quantify project-generated GHG emissions and adopt feasible reduction measures to reduce project emissions to a level which is a certain percent below BAU project emissions.

The recommended PS reduction goal is at least 29%, based on San Joaquin Air Pollution Control District's recommended CEQA significance threshold.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- Emissions were estimated for the year 2016 for each Partnership jurisdiction using socioeconomic data.
- The PS percent reduction in new development emissions was determined by the jurisdictions on an individual basis.
- Some state measures which will affect new development, and therefore might overlap with the PS measure, could not be broken down into reductions associated with new development only (e.g., RPS). Consequently, these measures were not included in the calculation of the PS.

Analysis Details

GHG Analysis

Implementation of the performance standard would reduce GHG emissions attributable to new discretionary development projects by 2030 by the percentage goal selected by individual cities selecting this measure. Measurable reductions of GHG emissions would be achieved through each city's review and discretionary approval of residential, commercial, and industrial development projects. It is expected that project proponents would often include energy efficiency and alternative energy strategies to help reduce their project's GHG emissions because these are often the most cost-effective approach to reducing GHG emissions but are free to propose any valid measures that would achieve the overall reduction goal.

<u>BAU Emissions</u>

The GHG Performance Standard for New Development would apply to all new buildings built in 2016 and later, so an estimate of emissions in 2016 was performed using inventory and socioeconomic data for 2008 and 2020. 2016 emissions were estimated using the same methods that were used to forecast 2008 emissions to 2020, as feasible.

<u>Emissions Reductions</u>

In order to calculate the reductions from this measure, a percent reduction from new development emissions from 2016 to 2020 was estimated for each city, depending on the PS percent reduction selected by each city (e.g., 29%). State measures and local mandatory measures were quantified for new development for each city. These measures achieve a certain portion of the PS goal, depending on the city. The PS contributes the remaining percent reduction required to achieve the PS goal in new developments.

The value of these state and local measures for new development were subtracted from the PS reduction to derive the net additional reductions that would result from the PS implementation. This does not mean that the other state and local measures would apply on an equal basis for every single project; individual new development projects may have higher or lower project-level burdens than the average. However, state and local mandatory measures are still expected to result in the largest share of the burden in meeting the PS reduction target for all cities (with a smaller portion from project-level reductions).

Co-Benefit Analysis

Co benefits will depend on the exact measures selected by individual project proponents, but would be the same as the corresponding strategies described below, i.e., if a project proponent were to select energy-efficiency measures as part of meeting their project reductions, the benefits would be similar in character to those described below for energy efficiency retrofits.

Energy-1: Energy Efficiency Incentives and Programs to Promote Retrofits for Existing Buildings

Measure Description

Promote energy efficiency in existing residential buildings and nonresidential buildings, and remove funding barriers for energy efficiency improvements. Actions may include, but are not limited to: implementing a low-income weatherization program, launching energy efficiency outreach/education campaigns targeted at residents and businesses, promoting the smart grid, leveraging funding mechanisms and grant funding, scheduling energy efficiency tune-ups and promoting energy efficiency management services for large energy users.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The assumed market penetration rate for buildings (residential and nonresidential) performing retrofits was determined by the jurisdiction on an individual basis.
- Participating residences perform weatherization for low-income households. To calculate reductions from low-income weatherization, the following assumptions were used:
  - The number of low-income households in each city was determined by multiplying the total number of households in each city (Inventory) by the percent of homes classified as very low income, and low income (Draft RHNA Methodology Data Appendix, 2019). This percent ranges from 18% to 64% of households, depending on the city.
  - Weatherization only applies to low-income households.
  - Each jurisdiction uses, on average, 1,553 kWh electrical energy, 10,000 cubic feet natural gas, and 5 gallons propane per household for heating, assuming each city is in the Mixed-dry/hot dry EIA climate zone (Energy Information Administration, 2015a, Energy Information Administration, 2015b).
  - Energy savings from low-income weatherization are 20%, 32%, and 32% for heating electricity, natural gas, and fuel oil, respectively (Schweitzer, 2005).
- Participating cities will launch energy efficiency campaigns targeted at residents and promote smart grid. This will result in a 5% energy savings (electricity and natural gas). This value was discounted from ICLEI's Climate and Air Pollution Planning Assistant (CAPPA) value of 10% for the measure "Energy Efficiency Education Targeted at Residents" in order to be more conservative (ICLEI Local Governments for Sustainability, 2010).
- Participating cities will support and/or incentivize energy efficiency tune-ups and promote energy efficiency management services for large nonresidential energy users. To calculate reductions from low-income weatherization, the following assumptions were used:
  - This will result in a 10% energy savings (electricity and natural gas) from the CAPPA "Energy Efficiency Retrofits of Existing Measures" measure (ICLEI Local Governments for Sustainability, 2010).
  - The penetration rate for participating nonresidential buildings, as determined by the participating jurisdictions individually, applies to the total nonresidential energy use in each. For example, for a penetration rate of 25%, 25% of total nonresidential energy use within a jurisdiction will be reduced by 10%.
- Participating jurisdictions will launch energy efficiency campaigns targeted at businesses. This will result in a 5% energy savings (electricity and natural gas). This value was discounted from the CAPPA value of 10% for the measure "Energy Efficiency Education Targeted at Businesses" in order to be more conservative (ICLEI Local Governments for Sustainability, 2010).

Analysis Details

GHG Analysis

Existing buildings generate a considerable amount of GHG emissions. Older developments are typically less energy-efficient and therefore consume greater amounts of electricity and natural gas, relative to newly constructed facilities.

BAU Energy Use

BAU electricity and natural gas use for residential and nonresidential buildings were used to calculate reductions for this measure. The GHG inventory documents the energy use and assumptions employed for the BAU analysis.

Emissions Reductions

Energy savings for each sub-measure were generally calculated by multiplying BAU energy use by a penetration rate, and then by a percent reduction in energy use. Emission reductions were then calculated by multiplying the energy savings by the appropriate emission factors.

For low-income weatherization, the total number of homes existing in 2016 (base inventory year) for each Partnership city was multiplied by the percent of low-income homes as determined by SCAG (SCAG, 2019). The number of low-income homes was then multiplied by the penetration rate for each jurisdiction. Then, the energy used for electric heating, natural gas heating, and propane use was estimated by multiplying the number of low-income households by the respective energy use factors as detailed in the assumptions section above. The resulting energy use was multiplied by the percent reduction in energy use for low-income weatherization by energy source (see assumptions above) to determine energy reductions.

For efficiency campaigns targeted at residents, the total residential energy use (electricity and natural gas) in 2016 for each Partnership jurisdiction was multiplied by the penetration rate for each jurisdiction. The resulting energy use was then multiplied by 5% to determine energy savings for residential buildings.

For energy efficiency tune-ups and promote energy efficiency management services for large energy users, the total nonresidential energy use (electricity and natural gas) in 2016 for each Partnership jurisdiction was multiplied by the penetration rate for each jurisdiction. The resulting energy use was then multiplied by 10% to determine energy savings for nonresidential buildings.

For energy efficiency campaigns targeted at businesses, the total nonresidential energy use (electricity and natural gas) in 2016 for each Partnership jurisdiction was multiplied by the penetration rate for each jurisdiction. The resulting energy use was then multiplied by 5% to determine energy savings for nonresidential buildings.

GHG emissions savings were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-1.

Reduced Energy Use: Energy retrofits would improve the efficiency of residential buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas and propane).

Increased Property Values: Energy-efficient homes have higher property values and resale prices than less efficient homes.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health. A well-built, energy-efficient structure is also more durable and directly reduces certain health aliments. For example, properly sealed ducts and air leaks helps prevent mold and dust mites that can cause asthma.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life. Additionally, energy-efficient homes improve general comfort by equalizing room temperatures and reducing indoor humidity.

Energy-2: Outdoor Lighting Upgrades for Existing Development

Measure Description

Adopt outdoor lighting standards in the Zoning Ordinance to reduce electricity consumption. Require a certain percentage of residential and nonresidential outdoor lighting fixtures use high efficiency light-emitting diodes (LEDs) and a certain percentage of traffic signals use LEDs by 2020.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- Approximately 5.27% of total residential electricity in each Partnership jurisdiction is used for residential outdoor lighting (California Energy Commission, 2006).[6]
- Approximately 6.21% of total commercial electricity in each Partnership city is used for commercial outdoor lighting (California Energy Commission, 2006).[7]
- The 2020 BAU percentage of outdoor LED lights in residences is 28% (Department of Energy, 2015).
- The percent of outdoor lights in residences and commercial buildings that will be LEDs by 2030 was identified by each Partnership jurisdiction on an individual basis.
- The 2020 BAU percentage of outdoor LED lights in commercial buildings is 28% (Department of Energy, 2015).
- Installation of an outdoor LED fixture achieves a 75% reduction in energy usage, relative to an incandescent bulb (U.S. Environmental Protection Agency, 2011a). This factor was used for residential outdoor lights and traffic signals.
- There are approximately 0.032 traffic signals per capita in the Participating jurisdiction (Lee personal communication, 2010).
- The wattage of an incandescent traffic light is 150 (U.S. Department of Energy, 2004), and there are 3 bulbs per traffic signal.
- Traffic signals operate 24 hours per day.
- The 2020 BAU percentage of LED traffic signals is 50% (estimate).
- The percent of traffic signals that will be LEDs by 2030 was identified by each Partnership jurisdiction on an individual basis.

[6] For the SCE service area, Table 10-3. This value is calculated by taking the exterior lighting electricity intensity for commercial lodging (0.7kWh/ft^2-year) and dividing by the total electricity intensity (13.28 kWh/ft^2-year) = 5.27%. Residential electricity intensity was not available, so commercial lodging was used as a proxy.

[7] For the SCE service area, Table 10-3. This value is calculated by taking the exterior lighting electricity intensity for all commercial buildings (0.85 kWh/ft^2-year) and dividing by the total electricity intensity (13.69 kWh/ft^2-year) = 6.21%.

Analysis Details

GHG Analysis

Electricity production is required to power the lights, which represents an indirect source of GHG emissions. Different light fixtures have different efficacies; in other words, certain bulbs can utilize less energy to obtain the same output. Replacing less efficient bulbs with energy-efficient ones therefore reduces energy consumption, and thus GHG emissions.

<u>2020 BAU Emissions and 2030 Emissions with State Measures</u>

Outdoor Lights (Private)

Electricity reductions achieved by overlapping State (e.g., Title 24 and Senate Bill [SB] 350) were first removed to obtain energy consumption after the implementation of state measures. Electricity usage from outdoor lighting in existing residential and commercial developments was then estimated by multiplying the total anticipated energy use in 2020 under BAU conditions by 5.27% and 6.21%, respectively.

Traffic Signals

The number of existing and future traffic signals within each Partnership jurisdiction was determined using 0.032 signals per capita. BAU electricity consumption by traffic signals was calculated using the following equation.

Energy Consumption = [(jurisdiction population * (0.032 traffic signals per person) * (50% non-LED lights) * (incandescent wattage per bulb) * (3 bulbs per traffic signal)] + [(jurisdiction population * (0.032 traffic signals per person) * (50% LED lights) * (incandescent wattage per bulb) * (3 bulbs per traffic signal) * (90% reduction in energy use due to LED lights)] * 365 days * 24 hours

<u>Emissions Reductions</u>

Outdoor Lights (Private)

Energy reductions associated with the installation of LED blubs in existing outdoor residential and commercial lighting fixtures was calculated by multiplying the BAU outdoor lighting energy consumption by the penetration rate for each Partnership jurisdiction and then by a scaling factor (jurisdiction-specific penetration rate for LED lights under the measure minus 10% LED lights in the BAU case). The resulting energy use was then multiplied by 75% for residential and 90% for commercial, which are the anticipated reduction in electrical demand associated with LED lights (U.S. Environmental Protection Agency, 2011a; California Air Pollution Control Officers Association, 2010). GHG emissions reductions were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Traffic Lights

Energy reductions associated with the installation of LED traffic signals was calculated by first calculating the number of LED traffic signals installed in each Partnership jurisdiction, which is equal to:

(jurisdiction population) * (0.032 traffic signals per person) * (jurisdiction-specific penetration rate for LED lights)

Electricity savings were calculated by using the following equation:

(Number of new LED traffic signals) * (incandescent wattage per bulb) * (3 bulbs per traffic signal) * (90% reduction in energy use due to LED lights) * 365 days * 24 hours

GHG emissions reductions savings were then quantified by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-2.

Reduced Energy Use: Energy-efficient lighting (e.g., LED fixtures) consumes, on average, 90% less electricity than incandescent bulbs.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity).

Increased Property Values: Energy efficient bulidings have higher property values and resale prices than less efficient buildings.

Increased Quality of Life: LEDs have a much longer lifetime than incandescent bulbs, resulting in reduced bulb turn-over and the need to purchase new fixtures.

Energy-3: Building Electrification

Measure Description

Adopt building electrification targets and incentives, for both new commercial and residential buildings and retrofits.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- Participating jurisdiction will incentivize electrification of existing and new residential and commercial buildings. To calculate reductions from electrification, the following assumptions were used:
  - The penetration rate of participating buildings, as determined by the participating jurisdiction individually, applies to the total natural gas consumption for existing and new residential and commercial buildings. For example, for a penetration rate of 25% for new commercial buildings, 25% of natural gas consumption within a city associated with new commercial buildings will be converted to electricity.
  - Fully electrified buildings consume 0 therms of natural gas.
  - No increase in energy intensity from switching from natural gas to electricity; energy use can be converted from therms and kWh to btu to calculate electricity use replacing natural gas use.

Analysis Details

GHG Analysis

<u>BAU Energy Use</u>

The GHG Inventory quantified energy consumption associated with existing residential and commercial facilities in 2016.

<u>Emissions Reductions</u>

Energy reductions achieved by overlapping State (e.g., Title 24 and Senate Bill [SB] 350) were first removed to obtain energy consumption after the implementation of state measures.

Energy consumption for new buildings was estimated by subtracting the energy consumption associated with existing residential and commercial facilities in 2016 from projected energy consumption in 2030.

Natural gas consumption reductions were then estimated by multiplying the existing and new building natural gas consumption by the penetration rates determined by participating jurisdictions. Increased electricity use to offset the reductions in natural gas consumption were estimated by converting the natural gas consumption reductions to btu, then to kWh.

GHG emissions reductions were quantified by multiplying the natural gas consumption reductions (and electricity use increases) for each building type by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-3.

Reduced Energy Use: Energy retrofits and standards would improve the efficiency of residential and non-residential buildings. As such, the amount of energy (e.g., electricity, natural gas) consumed per unit of activity would be lowered.

Reduced Air Pollution: Reduced natural gas consumption use would contribute to reductions in regional and local air pollution (from reduced burning of natural gas).

Resource Conservation: Increased reliance on electric HVAC and water heating systems would reduce natural gas consumption, conserving reserves of natural gas.

Public Health Improvements: Reduced regional and local air pollution would contribute to overall improvements in public health.

Increased Quality of Life: The reduction of health aliments (see above) contributes to increased quality of life.

Energy-5: Solar Installations for New Commercial/Industrial Development

Measure Description

Encourage new businesses to install rooftop solar using Power Purchase Agreements and other low or zero up-front cost options for installing solar photovoltaic systems. This could be implemented through discretionary approvals and permitting for new projects. Establish a goal for solar installations on new buildings to be achieved before 2020. Each Partnership jurisdiction will choose its own goal. Potential goals might be (or other options):

- 30% of energy requirements for new development supplied with solar power.
- 15% of energy requirements for new development supplied with solar power.
- 5% of energy requirements for new development supplied with solar power.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- This measure only affects new nonresidential buildings (buildings built in 2017 or after).
- The percent energy requirements for new development supplied with solar power were determined by the jurisdictions on an individual basis.
- The energy generated by solar PV is carbon neutral.
- Annual kWh generation of solar systems for 3, 5, and 10 kW systems for the Mojave and South Coast from CAPCOA were used.
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar PV panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such as solar, do not emit GHGs.

BAU Electricity Emissions

The GHG Inventory quantified electricity emissions associated with existing commercial facilities in 2016. The 2016 values were projected to 2030 using employment data in order to determine electricity use and emissions for all new commercial buildings built from 2017 to 2030.

Emissions Reductions

Energy reductions associated with other state and local measures were subtracted from the energy used by all new nonresidential buildings built from 2017 to 2030. This was done in order to determine the energy used by new buildings after the implementation of preceding measures, before installation of solar PV.

The remaining quantity of electricity used by new nonresidential buildings was then multiplied by the percent energy requirements for new development supplied with solar power penetration rate, as determined by the participating jurisdictions. The resulting number of kWh was assumed to be provided by solar PV under this strategy. The amount of solar PV in kW was then determined by dividing this kWh figure by 1,678 kWh per kW of solar PV (CAPCOA, 2019).

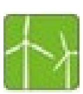
Carbon neutral sources do not emit GHGs. The kWh affected by this measure would result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by this strategy were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of this strategy.

Reduced Air Pollution: Generating community electricity through renewable sources would displace a portion of electricity generated by fossil fuels. As such, combustion at regional power stations would be reduced, contributing to cumulative reductions in criteria pollutants.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to, fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.



Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constraints and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, sub-stations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Renewables would contribute to the diversification of the energy supply mix, thereby buffering the local economy from the volatile global energy market.

Economic Development: Development of renewable energy infrastructure (e.g., solar farms, wind turbines) would create new jobs, taxes, and revenue for the local economy.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

Increased Property Values: If renewable infrastcuture is added to San Bernardino County buildings as a result of this measure, property and resale values of those structures may be increased.

Energy-6: Onsite Solar Energy for New and Existing Warehouse Space

Measure Description

Applies to new and existing warehouse space. Promote and incentivize solar installations on existing warehouse space through partnerships with SCE and other private sector funding sources including SunRun, SolarCity, and other solar lease or PPA companies. Establish goals such as the following:

- 15% of existing and new warehouse roof space install solar installations.
- 20% of existing and new warehouse roof space install solar installations.
- 30% of existing and new warehouse roof space install solar installations.

This goal could be supported through non-financial incentives or streamlined permitting. Jurisdictions may also act as a resource for connecting project proponents with funding opportunities.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percent of warehouses participating in this measure and installing solar PV was determined by the jurisdiction on an individual basis.
- The energy generated by solar PV is carbon neutral.
- Annual kWh generation of solar systems for 3, 5, and 10 kW systems for the Mojave and South Coast from CAPCOA were used.
- Warehouses are one story; this means that for each square foot of building floor space there is one square foot of building roof space (for which to install solar PV) in warehouses.
- Each square foot of solar PV produces 15 watts of electricity (BEST Contracting Services 2010).
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar PV panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (California Air Pollution Control Officers Association, 2010).

Emissions Reductions

The total amount of warehouse building square footage in each Partnership jurisdiction was multiplied by the penetration rate to determine the total square footage of warehouses installing solar under this measure. The participating square footage was then multiplied by 15 watts per square foot of solar PV to determine the total power output in kW of solar (BEST Contracting Services, 2010). The kW value was then multiplied by the average kWh per kW of solar PV to determine the total annual kWh of electricity produced by the panels (CAPCOA, 2019).

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by this strategy were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of this strategy.

Reduced Air Pollution: Generating community electricity through renewable sources would displace a portion of electricity generated by fossil fuels. As such, combustion at regional power stations would be reduced, contributing to cumulative reductions in criteria pollutants.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to, fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constraints and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, sub-stations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Renewables would contribute to the diversification of the energy supply mix, thereby buffering the local economy from the volatile global energy market.

Economic Development: Development of renewable energy infrastructure (e.g., solar farms, wind turbines) would create new jobs, taxes, and revenue for the local economy.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

Increased Property Values: If renewable infrastcuture is added to San Bernardino County buildings as a result of this measure, property and resale values of those structures may be increased.

Energy-7: Solar Installations for Existing Housing

Measure Description

Encourage residents to install rooftop solar using Power Purchase Agreements and other low or zero up-front cost options for installing solar photovoltaic systems. This could be implemented through discretionary approvals and permitting for new projects. Establish a goal for solar installations on existing homes to be achieved before 2030. Each Partnership jurisdiction will choose its own goal. Potential goals might be (or other options):

- 25% of existing single-family homes have solar installations.
- 20% of existing single-family homes have solar installations.
- 15% of existing single-family homes have solar installations .

Assumptions

The following assumptions were considered in the evaluation of this measure:

- This measure only affects existing single-family homes (those built before 2016).
- The market penetration rate for existing homes installing solar was determined by the jurisdiction on an individual basis.
- The energy generated by solar PV is carbon neutral.
- Annual kWh generation of solar systems for 3, 5, and 10 kW systems for the Mojave and South Coast from CAPCOA were used.
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar photovoltaic panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs.

Emissions Reductions

The number of single-family homes in each city in 2016 (those that are considered existing) was multiplied by the percent penetration rate as specified by each Partnership city to determine the number of new homes installing solar PV. This number was then multiplied by average annual generation, which is the annual amount of electricity provided by the average solar system in the county (CAPCOA, 2019). This determines the total amount of renewable energy provided by the panels, and offset from the utilities.

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by this strategy were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of this strategy.

Reduced Air Pollution: Generating community electricity through renewable sources would displace a portion of electricity generated by fossil fuels. As such, combustion at regional power stations would be reduced, contributing to cumulative reductions in criteria pollutants.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to, fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constraints and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, sub-stations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Renewables would contribute to the diversification of the energy supply mix, thereby buffering the local economy from the volatile global energy market.

Economic Development: Development of renewable energy infrastructure (e.g., solar farms, wind turbines) would create new jobs, taxes, and revenue for the local economy.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

Increased Property Values: If renewable infrastcuture is added to San Bernardino County buildings as a result of this measure, property and resale values of those structures may be increased.

Energy-8: Solar Installations for Existing Commercial / Industrial Buildings

Measure Description

Cities establish a goal for solar installations on existing commercial buildings to be achieved by 2030 and 2045. Potential goals might be:

- 15% of existing commercial buildings have solar installations
- 20% of existing commercial buildings have solar installations
- 25% of existing commercial buildings have solar installations

This measure does not apply to warehouses, which are addressed in this another strategy.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The percent of existing commercial/industrial buildings that install solar was determined by the cities on a city-by-city basis.
- The energy generated by solar PV is carbon neutral.
- Annual kWh generation of solar systems for 3, 5, and 10 kW systems for the Mojave and South Coast from CAPCOA were used.
- The amount of electricity generated by the panels will offset electricity provided by the utilities. For example, a system which generates 7,683 kWh in a year will offset 7,683 kWh produced by power plants, and therefore reduce emissions associated with 7,683 kWh of electricity generation.

Analysis Details

GHG Analysis

Utilizing electricity generated by solar PV panels displaces electricity demand that would ordinarily be provided by the utilities. Although SCE purchases a substantial amount of energy from renewable sources, electricity supplied by SCE still represents a source of indirect GHG emissions. Carbon neutral sources, such solar, do not emit GHGs (California Air Pollution Control Officers Association 2010).

BAU Electricity Emissions

The GHG Inventory quantified electricity emissions associated with existing commercial facilities in 2016. The 2016 values were projected to 2030 using employment data in order to determine electricity use and emissions for all existing commercial buildings built before 2030.

Emissions Reductions

Energy reductions associated with other state and local measures were subtracted from the energy used by all existing nonresidential buildings built before 2016. This was done in order to determine the energy used by existing nonresidential buildings after the implementation of preceding measures, before installation of solar PV.

The remaining quantity of electricity used by existing nonresidential buildings was then multiplied by the percent of existing commercial/industrial buildings that will install solar under this measure, as determined by the participating cities. This new kWh value was then multiplied by 15%, which is the amount of each existing building's energy demand that will be supplied by the solar PV panels.

Carbon neutral sources do not emit GHGs. The kWh affected by this measure would therefore result in a 100% reduction in emissions, relative to BAU conditions. GHG emissions reductions achieved by this strategy were quantified by multiplying the resulting solar electricity production for each city by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of this strategy.

Reduced Air Pollution: Generating community electricity through renewable sources would displace a portion of electricity generated by fossil fuels. As such, combustion at regional power stations would be reduced, contributing to cumulative reductions in criteria pollutants.

Waste Reduction: The generation of electricity from fossil fuels (e.g., coal, natural gas) generates a substantial amount of waste including, but not limited to, fly ash, bottom ash, flue gas, and sludge. These products can have detrimental effects on the environment if absorbed into groundwater, soil, and/or biota. The extraction and mining of fossil fuels also generates waste. Increasing renewable energy production would reduce waste created by fossil fuel supplied power.

Energy Diversity and Security: Fuels that are traded in the open market are subject to energy supply constraints and interruptions from political unrest, conflict, and trade embargoes. Centralized power structures (e.g., stations, sub-stations, refineries, ports) may also be targets of energy terrorism. Providing a diversified and domestic energy supply reduces foreign fuel dependency.

Reduced Price Volatility: Energy supply constraints and the uneven global distribution of fossil fuels increase the instability of the energy market. As the demand for global fossil fuels rises, energy prices would likely be subject to fluctuations and frequent price spikes. Renewables would contribute to the diversification of the energy supply mix, thereby buffering the local economy from the volatile global energy market.

Economic Development: Development of renewable energy infrastructure (e.g., solar farms, wind turbines) would create new jobs, taxes, and revenue for the local economy.

Public Health Improvements: Reduced regional air pollution and waste generation would contribute to overall improvements in public health.

Increased Property Values: If renewable infrastcuture is added to San Bernardino County buildings as a result of this measure, property and resale values of those structures may be increased.

Energy-9: Promote Rooftop Gardens

Measure Description

This measure promotes the construction of rooftop gardens, which insulate the building underneath and increase energy efficiency. Rooftop gardens also cool the surrounding area through moisture retention and surface reflectively. The construction of the rooftop gardens would reduce energy consumption and associated GHG emissions in the building energy sector.

Assumptions

The following assumptions were considered for the quantification of this measure.

- The market penetration rates for the number of new multifamily residences and square footage of new commercial facilities installing rooftop gardens was determined by the jurisdictions on a jurisdiction-by-jurisdiction basis.
- Multifamily residential building assumptions:
  - The average per-unit floor area in new multifamily buildings was 1,107 square feet in the western region of the U.S. (U.S. Census Bureau, 2013).
  - Among multifamily buildings in Western Region, 87 percent were 1 to 3 floors and 13 percent were 4 or more floors (U.S. Census Bureau, 2017).
  - The average per-unit floor area of lobby/hallway space was assumed to be 100 square feet per multifamily home.
  - Based on the above assumptions, the average roof space per multifamily unit was calculated as 565 square feet.
  - The green roof was assumed to be 25 percent of total roof space, which was calculated from above assumptions to be 141 square feet per multifamily home.
- Commercial building assumptions:
  - Roof space to floor space ratio of commercial buildings was assumed to be 1:3.
  - The green roof was assumed to be 50 percent of total roof space.
- Energy Savings:
  - Annual direct electricity savings is 0.45 kWh per roof per square foot.
  - Annual indirect electricity savings is 0.25 kWh per roof per square foot.
  - Total annual electricity savings is calculated as 0.70 kWh per roof per square foot.

Analysis Details

GHG Analysis

A green roof or rooftop garden is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Green roofs serve several purposes for a building, such as absorbing rainwater, providing insulation, creating a habitat for wildlife, and helping to lower urban air temperatures and mitigate the heat island effect.

<u>Emissions Reductions</u>

The following steps were performed to calculate electricity savings associated with green roofs:

a) Residential electricity savings (kWh) = total new multifamily homes in 2030/2045 × market penetration rate (number of new multifamily residences installing green roof) × 141 square feet of green roof per multifamily unit × 0.70 kWh saved per square foot of green roof per year

b) Commercial electricity savings (kWh) = total new commercial building square footage in 2030/2045 × market penetration rate (square footage of new commercial facilities installing

Energy-9: Promote Rooftop Gardens

rooftop roof) × 0.3 (roof space to floor space ratio) × 50% of roof space is a green roof × 0.70 kWh saved per square foot of green roof per year

GHG savings from electricity reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of measure Energy-9.

Reduced Energy Use: Green roofs can provide cooling and heating, which reduces the need for summertime air conditioning use and winter heating. As a result, less electricity is consumed.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution. Vegetation on buildings adjacent to congested roadways may also help filter particulate matter and other local pollutants.

Reduced Urban Heat Island Effect: Urban heat island effect occurs when the ambient temperature in urban areas increases as a result of high energy consumption (e.g., air conditioning use during the summertime). Rooftop vegetation provides shade, which reduces the cooling load of buildings and helps mitigate the urban heat island effect.

Increased Quality of Life: Trees and vegetation improve the aesthetic quality of buildings, as well as reduce storm water runoff during periods of heavy rain.

Energy-10: Urban Tree Planting for Shading and Energy Savings

Measure Description

Establish a jurisdiction-wide tree planting goal or tree preservation goal. Possible implementation mechanisms might include a requirement to account for trees removed and planted as part of new construction and/or establishing a goal and funding source for new trees planted on jurisdiction property. To maximize GHG and other environmental benefits, new trees would be targeted to the downtown and urban areas. This measure will reduce energy consumption and associated GHG emissions in the building energy sector by reducing the heat island effect.

Assumptions

The following assumptions were considered for the quantification of this measure (SANBAG, 2014).

- Annual energy savings of one mature tree is 204 kWh (ICLEI Local Governments for Sustainability 2010).
- Annual energy savings from planting one tree due to decreased heat Island effect is 7 kWh (ICLEI Local Governments for Sustainability, 2010).
- Tree shading effects were not considered.
- Carbon sequestration was not considered.

Analysis Details

GHG Analysis

The exact location of where the trees would be planted in each jurisdiction is not known at this point. Trees planted along transportation corridors and roadways, or in parks and open space areas, would not shade buildings (which can reduce summer cooling energy consumption). Therefore, to be conservative, tree shading effects were not considered for this measure. In addition, carbon sequestration benefits from new trees were not considered because the BAU inventories do not have a BAU assessment of carbon sequestration for each jurisdiction.

Trees can also reduce the urban heat island effect through both shading and evapotranspiration. Thus, quantification of this measure focused on reduced urban heat island effect. The GHG benefits achieved from tree planting would vary based on the species, age, and size of tree planted.

<u>Emissions Reductions</u>

The following steps were performed to calculate electricity savings associated with urban tree planting:

> Electricity savings (kWh) = total number of adult shade trees planted by each jurisdiction in 2030/2045 × 204 kWh saved per tree per year + total number of non-shade trees planted by each jurisdiction in 2030/2045 × 7 kWh saved per tree per year due to decreased heat island effect only

GHG savings from electricity reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Energy-10.

Reduced Energy Use: Trees planted adjacent to buildings shade, which cools buildings and reduces the need for summer-time air conditioning use. As a result, less electricity is consumed.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution. Trees planted adjacent to congested roadways may also help filter particulate matter and other local pollutants.

Energy-10: Urban Tree Planting for Shading and Energy Savings

Reduced Urban Heat Island Effect: Urban heat island effect occurs when the ambient temperature in urban areas increases as a result of high energy consumption (e.g., air conditioning use during the summertime). Trees provide shade, which reduces the cooling load of buildings and helps mitigate the urban heat island effect.

Increased Quality of Life: Trees improve the aesthetic quality of buildings, as well as reduce storm water runoff during periods of heavy rain.

OnRoad-1: Alternative Fueled Transit Fleets – CNG to Electric

Measure Description

The majority of the transit fleet in the County is currently compressed natural gas (CNG). Converting from CNG to electric would reduce GHG emissions as electricity from renewable sources has a lower emission rate than natural gas.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The market penetration rate for the conversion rate from CNG to electric transit fleets was determined by the transit authorities serving the County.
- According to EMFAC2017, CNG buses represent 0.055% of total countywide VMT in 2016.
- CNG bus fuel efficiency is 0.38 mile per standard cubic foot (CAPCOA 2010).
- Electric bus fuel efficiency is 2.84 kWh per mile (NREL 2018).

Analysis Details

GHG Analysis

Converting transit fleets from CNG to electric will reduce GHG emissions from the combustion of CNG. On the other hand, the increased electricity consumption will increase GHG emissions. However, the GHG emission reductions will be significant in the long term as electricity will be generated from more renewable sources and ultimately achieve zero emissions.

Emissions Reductions

The following steps were performed to calculate GHG emission reductions from reduced CNG consumption:

> GHG emission reductions ($MTCO_2e$) = total countywide VMT in 2030/2045 × 0.055% CNG buses VMT of total VMT × market penetration rate (conversion rate) / 0.38 mile per standard cubic foot of CNG × CNG emission factor

The following steps were performed to calculate electricity consumption from increased electric transit fleets:

> Electricity consumption (kWh) = total countywide VMT in 2030/2045 × 0.055% CNG buses VMT of total VMT × market penetration rate (conversion rate) × 2.84 kWh per mile

GHG emissions from electricity consumption were then calculated by multiplying the energy consumption by the appropriate utility emission factors.

GHG emission reductions from this measure were the difference between decreased CNG emissions and increased electricity emissions.

Countywide GHG emission reductions were allocated to each jurisdiction by 2020 population.

Co-Benefit Analysis

The following benefits are expected from implementation of measure OnRoad-1.

Reduced Air Pollution: Even though CNG is cleaner than petroleum, the combustion of CNG emits some level of air pollutants including particulate matter and ozone precursors. Because less CNG would be consumed and replaced by cleaner electricity, air pollutants emissions would be reduced.

Public Health Improvements: CNG combustion releases several toxic air contaminants known to cause adverse human health effects. Reductions in the amount of CNG combusted would result in corresponding reductions in toxic air contaminants. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

OnRoad-2: Encourage Use of Mass Transit, Carpooling, Ridesharing, and Telecommuting

Measure Description

Commute Trip Reduction programs aim to reduce commute trips and VMT through various strategies. The strategies include, but are not limited to, encouraging the use of mass transit, carpooling, ridesharing, and telecommuting. The level of VMT reductions that this measure could achieve is dependent on the level of commitment, from complete voluntary to required implementation with monitoring and performance standards. Jurisdictions could start implementing this measure from government employees and expand to adopting an ordinance to require businesses to implement Commute Trip Reduction programs. This measure only reduces commute trip VMT.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The market penetration rate for the percentage of employees eligible for this measure was determined by the jurisdictions on a jurisdiction-by-jurisdiction basis.
- All jurisdictions within the County have a population less than 400,000 and low transit use, so they were categorized as small low-density areas (Cambridge Systematics 2009).
- Employer support program was assumed.
- The highest commute VMT reduction level with employer support program was 6.2% (Cambridge Systematics 2009).
- Commute trips VMT was assumed to take 30% of total light-duty vehicles VMT.

Analysis Details

GHG Analysis

This measure will reduce GHG emissions by reducing commute VMT. Reductions are dependent on each jurisdiction's commitment to percentage of employees eligible for the commute trip reduction programs.

<u>Emissions Reductions</u>

The following steps were performed to calculate GHG emission reductions from reduced commute VMT:

> GHG emission reductions ($MTCO_2e$) = light-duty vehicles on-road GHG emissions in 2030/2045 × 30% commute trips × market penetration rate (percent employees eligible) × 6.2% commute VMT reduction

Co-Benefit Analysis

The following benefits are expected from implementation of measure OnRoad-2.

Reduced Energy Use: Commute trip reduction programs will reduce the number of single-occupied vehicle trips made by commuters within each jurisdiction. As a result, gasoline and diesel consumption would be reduced.

Increased Quality of Life: Some strategies of commute trips reduction program could reduce employees' commute time, thus improving life quality. Reductions in the number of single-occupied vehicle trips may also reduce congestion and travel times.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

OnRoad-2: Encourage Use of Mass Transit, Carpooling, Ridesharing, and Telecommuting

Public Health Improvements: Fossil fuel combustion releases several toxic air contaminants known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air contaminants. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: Reducing fuel consumption by passenger vehicles would lessen the demand for petroleum and ultimately the demand for imported oil.

OnRoad-3: Improved Efficiency through Signal Synchronization

Measure Description

This measure implements signal synchronization to improve traffic flow and reduce GHG emissions from less idling time and less stop-and-go driving. Signal timing optimization could be done with or without real-time traffic data.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- 1% of GHG emissions reduction from reduced idling time and reduced stop-and-go (CARB, 2014).

Analysis Details

GHG Analysis

Emissions Reductions

Jurisdictions implementing this measure will reduce on-road transportation GHG emissions by 1%.

Co-Benefit Analysis

The following benefits are expected from implementation of measure OnRoad-3.

Reduced Energy Use: Less idling time and less stop-and-go will decrease gasoline and diesel consumption by vehicles.

Increased Quality of Life: Reductions in idling time and better traffic flow will reduce congestion and travel times, and thus improving life quality.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors, would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

Public Health Improvements: Fossil fuel combustion releases several toxic air contaminants known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air contaminants. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: Reducing fuel consumption by passenger vehicles would lessen the demand for petroleum and ultimately the demand for imported oil.

OnRoad-4: Expand Bike Routes Including Pedestrian and Bicycle Friendly Streets

Measure Description

Pedestrian- and bicycle-friendly roads are crucial to promoting walking and bicycle use as a transportation method. People tend to walk or bicycle if sidewalks and bicycle routes are available to separate them from motor vehicles and pedestrians' and bicyclists' safety can be ensured. Adopting and implementing a bicycle master plan and constructing more bicycle routes would encourage more bicycle rides and would help to reduce VMT and associated GHG emissions.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- Population density data was obtained for the year of 2016 and assumed to grow through 2030 and 2045 at the same rate as population growth (Open Data Network, 2016).
- Unincorporated County areas do not have population density level data available, but given its large area, population density was assumed less than 500 people per square mile through 2045.
- It was assumed that less than two miles of bicycle lanes per square mile would not have any bicycle mode shares.
- Bicycle mode share rates are dependent on the population density and miles of bicycle lanes per square mile as shown in the table below.

Population Density (per square mile)	Bicycle Mode Share			
	2 miles bike lanes per square mile	4 miles bike lanes per square mile	8 miles bike lanes per square mile	less than 2 miles bike lanes per square mile
0–500	1.5%	2.7%	5.0%	0.0%
500–2,000	1.5%	2.7%	5.0%	0.0%
2,000–4,000	1.5%	2.7%	5.0%	0.0%
4,000–10,000	2.1%	3.7%	6.8%	0.0%
>10,000	4.4%	7.6%	14.0%	0.0%

Source: Cambridge Systematics, 2009.

- The existing miles of bicycle lanes per square mile data were provided by each jurisdiction, and the 2030/2045 planned miles of bicycle lanes per square mile data were determined by each jurisdiction on a jurisdiction-by-jurisdiction basis.

Analysis Details

GHG Analysis

Even though this measure is focused on both pedestrian and bicycle users, only GHG emission reductions from increased bicycle mode share were quantified. In addition, only light-duty vehicle trips VMT could be replaced by bicycle, so the VMT reduction was applied to light-duty vehicles VMT only.

<u>Emissions Reductions</u>

The following steps were performed to calculate GHG emission reductions from bicycle mode share:

> GHG emission reductions (MT CO_2e) = light-duty vehicles on-road GHG emissions in 2030/2045 × (bicycle mode share rate in 2030/2045 – existing bicycle mode share rate)

Co-Benefit Analysis

The following benefits are expected from implementation of measure OnRoad-4.

Reduced Energy Use: Increased pedestrian and bicycle mode share will reduce the number of vehicle trips within each jurisdiction. As a result, gasoline and diesel consumption would be reduced.

Increased Quality of Life: Walking and bicycle riding are good forms of exercises that could improve health condition and life quality. In addition, reductions in the number of vehicle trips may also reduce congestion and travel times.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors would be reduced. Likewise, reductions in congestion from fewer vehicles on the roadway network would contribute reductions in emissions generated by vehicle idling.

Public Health Improvements: Walking and bicycle riding are good forms of exercises that could improve health condition. In addition, fossil fuel combustion releases several toxic air contaminants known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air contaminants, and reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Energy Security: Reducing fuel consumption by passenger vehicles would lessen the demand for petroleum and ultimately the demand for imported oil.

OnRoad-5: Community Fleet Electrification

Measure Description

Hybrid electric vehicles, plug-in hybrid electric vehicles, and all-electric vehicles (EVs) produce lower emissions than conventional vehicles. Any type of electrified vehicle emits less GHG than conventional vehicles by at least 40 percent. However, more than 95% of people still drive conventional gasoline or diesel vehicles, so programs to encourage the use of EV or hybrid vehicle ownership are highly needed.

Executive Order (EO) B-16-2012 tasked the California Energy Commission (CEC) and other State agencies to support benchmarks to bring 1.5 million zero emission vehicles (ZEVs) to California's roads and in conjunction make sure that Californians have easy access to ZEV infrastructure to charge those vehicles by 2025. San Bernardino County Transportation Authority (SBCTA) projected that to comply with EO B-16-2012, there would be 44,846 ZEVs in San Bernardino County by 2025, and a total of 4,761 Level 2 and Level 3 charging stations would be needed to support the ZEVs (SBCOG, 2019). Each jurisdiction would be responsible for a portion of the charging station needs to support increased number of ZEVs.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- The number of ZEVs goal in San Bernardino County in compliance with EO B-16-2012 would be 21,894 and 44,846 in 2020 and 2025, respectively (SBCOG, 2019). Therefore, the annual growth rate between 2020 and 2025 was calculated as 15%.
- In order to serve the ZEVs goal in 2025, the required number of Level 2 and Level 3 charging stations would be 3,504/171/662 and 400/1/23 in urban/rural/unincorporated areas, respectively (SBCOG, 2019).
- The goal number of charging stations was allocated to each jurisdiction by population, and the percentage of charging stations goal implemented by 2030/2045 was determined by the jurisdictions on a jurisdiction-by-jurisdiction basis.
- Assuming the same annual growth rate of total vehicles (3.8%) in the County between 2017 and 2018 (DMV, 2018 and DMV, 2019), the ZEVs would represent 1.2% and 2.0% of total vehicles in 2020 and 2025, respectively.
- Assuming the same annual growth rate of ZEVs market share between 2020 and 2025, the ZEVs would account for 3.5% and 16.9% of total vehicles in 2030 and 2045, respectively.
- ZEVs fuel efficiency is 0.34 kWh per mile.

Analysis Details

GHG Analysis

Converting from conventional vehicles to ZEVs will reduce GHG emissions from the combustion of fossil fuels. On the other hand, the increased electricity consumption will increase GHG emissions. However, the GHG emission reductions will be significant in the long term as electricity will be generated from more renewable sources and ultimately achieve zero emissions in the future.

<u>Emissions Reductions</u>

The following steps were performed to calculate GHG emission reductions from reduced conventional fuel vehicles:

> GHG emission reductions ($MTCO_2e$) = total jurisdiction on-road GHG emissions in 2030/2045 × (3.5% ZEVs by 2030 OR 16.9% ZEVs by 2045 – 0.5% ZEVs in 2017) × percentage of charging stations goal implemented by 2030/2045

GHG emissions from electricity consumption were then calculated by multiplying the energy consumption by the appropriate utility emission factors.

GHG emission reductions from this measure were the difference between decreased conventional fuel vehicles emissions and increased electricity emissions.

Co-Benefit Analysis

The following benefits are expected from implementation of OnRoad-5.

Reduced Air Pollution: Because less petroleum would be consumed by vehicles, air pollutants generated by fossil fuel combustion, including particulate matter, carbon monoxide, sulfur dioxide, and ozone precursors would be reduced.

Public Health Improvements: Fossil fuel combustion releases several toxic air contaminants known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air contaminants. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

OffRoad-1: Electric-Powered Construction Equipment

Measure Description

This measure reduces diesel-powered construction equipment use and encourages electric-powered construction equipment by establishing a goal such that a portion of construction equipment is electric-powered. With current technology, equipment with relatively low horsepower could be converted to electric. Potential goals might be to require 80-100% of equipment that is less than 120 horsepower to be electric-powered.

Under this measure, incentives would be offered (e.g., reduced procedural requirements; preference points when bidding on jurisdiction contracts, partner with CARB or SCAQMD to leverage funding) to construction contractors that utilize electric equipment in a certain percentage of their fleet.

Achieving the goal would require close coordination with the SCAQMD, which sets air quality related requirements on construction vehicles and also provides mitigation options related to construction vehicles through Voluntary Emission Reduction Agreement (VERA) programs, which may overlap with this measure.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- It was assumed that only equipment less than 120 horsepower could be replaced by electric-powered equipment.
- The market penetration rate for the conversion from diesel equipment to electric equipment was determined by the jurisdictions on a jurisdiction-by-jurisdiction basis. This was done by allowing the individual jurisdictions to choose a percentage change of construction equipment to electric.
- GHG reductions and electricity consumption in 2045 are calculated from 2030 data using the same growth rate as GHG forecast.

Analysis Details

GHG Analysis

Utilizing electric power would offset direct GHG emissions from fuel combustion. Indirect emissions from electricity are significantly lower than direct emissions from fuel combustion. Electrifying construction vehicles therefore results in a reduction in GHG emissions.

<u>Emissions Reductions</u>

The OFFROAD2007 model calculates vehicle operating emissions by fuel type and average horsepower. Model emissions outputs by vehicle class were filtered to only include less than 120 horsepower equipment and then multiplied by the percent of construction equipment electrified by 2030 and 2045 (determined by the jurisdictions) to calculate the GHG emission reductions from reduced use of fuel.

Electricity consumption by equipment is calculated by Horsepower × Load Factor × Hours of Operation × 0.7457 (horsepower to kWh conversion factor) using OFFROAD2007 outputs. GHG emissions from electricity consumption were then calculated by multiplying the energy consumption by the appropriate utility emission factors.

The GHG emission reductions were calculated from the difference of reduced fuel emissions and increased electricity emissions.

Co-Benefit Analysis

The following benefits are expected from implementation of measure OffRoad-1.

Reduced Air Pollution: Utilizing electricity in place of diesel would reduce local air pollution.

OffRoad-1: Electric-Powered Construction Equipment

Public Health Improvements: Diesel combustion releases several toxic air contaminants known to cause adverse human health effects to construction workers. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air contaminants. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Increased Quality of Life: Electric equipment is quieter and typically easier to maneuver than diesel-powered equipment.

OffRoad-2: Idling Ordinance

Measure Description

Adopt an ordinance that limits idling time for heavy-duty construction equipment beyond CARB or local air district regulations and if not already required as part of CEQA mitigation. Recommended idling limit is three minutes. As part of permitting requirements or City contracts, encourage contractors a to submit a construction vehicle management plan that includes such things as idling time requirements; requiring hour meters on equipment; and documenting the serial number, horsepower, age, and fuel of all on-site equipment. State law currently requires all off-road equipment fleets to limit idling to no more than five minutes.

Assumptions

The following assumptions were considered in the evaluation of this measure (SANBAG, 2014):

- 0.90 gallon of diesel fuel is consumed per hour of idling (U.S. EPA, 2009a).
- 6.28 gallons of diesel fuel are consumed per hour of operation for construction equipment.
- On average, construction equipment spends approximately 29.4% of daily operating time idling (U.S. EPA, 2009a).
- Construction equipment estimated operating time is assumed as eight hours per day.
- Calculated from above information, diesel fuel consumption for idling takes 5.63% of total fuel consumption of the equipment.
- Current idling standard is five minutes and the idling ordinance requirement is assumed as three minutes, unless specified by jurisdictions.

Analysis Details

GHG Analysis

Equipment idles during rest periods, which requires fuel and results in GHG emissions. Regulating idling time would therefore reduce fuel consumption and GHG emissions.

Emissions Reductions

Implementation of this measure would reduce idling time to no more than three minutes at any one time. The CARB's regulation for heavy-duty vehicle (five minutes) was used as a proxy to determine the percent reduction in potential idling emissions from implementation of this measure. Reducing idling time from 5 minutes to three minutes is a 40% reduction. Emissions savings associated with this measure were therefore calculated by multiplying baseline idling emissions by 0.40, and baseline idling emissions is calculated by multiplying the total construction equipment emissions by 5.63% fuel consumption due to idling.

Co-Benefit Analysis

The following benefits are expected from implementation of measure OffRoad-2.

Reduced Energy Use: Equipment idles during rest periods, which requires fuel. Regulating idling time therefore reduces fossil fuel consumption.

Reduced Air Pollution: Reduced idling and fuel combustion would contribute to reductions in toxic air contaminants, ozone precursors, and other inorganic and organic air pollutants.

Public Health Improvements: Construction workers are exposed to pollutants that cause adverse health effects when they work near idling vehicles. By reducing vehicle idling time, exposure periods would be decreased, which may contribute to long-term health improvements.

OffRoad-3: Electric Landscaping Equipment

Measure Description

Under this measure the participating jurisdiction will adopt an ordinance that reduces gasoline or diesel-powered landscaping equipment use and/or reduces the amount and operating time of such equipment. With current technology, equipment with relatively low horsepower could be converted to electric. Potential goals might be to require 80 to 100% of equipment that is less than 120 horsepower to be electric-powered. Jurisdictions would work in close cooperation with the air district in drafting an ordinance or developing outreach programs to be consistent with current air district rules and CEQA guidelines. The ordinance could also include the following provisions for community landscaping equipment.

- Sponsor a lawnmower exchange program that allows residents to trade in their gasoline or diesel-powered mower for an electric mower at a low or discounted price.
- Require exterior electrical outlets on all new building developments.

Assumptions

The following assumptions were considered in the evaluation of this measure:

- It was assumed that only equipment less than 120 horsepower could be replaced by electric-powered equipment.
- The market penetration rate for the conversion from gasoline and diesel equipment to electric was determined by the jurisdictions on a jurisdiction-by-jurisdiction basis.
- GHG reductions and electricity consumption in 2045 are calculated from 2030 data using the same growth rate as GHG forecast.

Analysis Details

GHG Analysis

Utilizing electric power would offset direct GHG emissions from fuel combustion. Indirect emissions from electricity are significantly lower than direct emissions from fuel combustion. Electrifying landscaping equipment therefore results in a reduction in GHG emissions.

<u>Emissions Reductions</u>

The OFFROAD 2007 model calculates vehicle operating emissions by fuel type (e.g., diesel, gasoline) and average horsepower. Model emissions outputs by vehicle class were filtered to only include less than 120 horsepower equipment and then multiplied by the percent of landscaping equipment electrified by 2030 and 2045 (determined by the jurisdictions) to calculate GHG emission reductions from reduced fuel consumption.

Electricity consumption by equipment is calculated by Horsepower × Load Factor × Hours of Operation × 0.7457 (horsepower to kWh conversion factor) using OFFROAD2007 outputs. GHG emissions from electricity consumption were then calculated by multiplying the energy consumption by the appropriate utility emission factors.

The GHG emission reductions were calculated from the difference of reduced fuel emissions and increased electricity emissions.

Co-Benefit Analysis

The following benefits are expected from implementation of measure OffRoad-3.

Reduced Air Pollution: Utilizing electricity in place of gasoline and diesel would reduce local air pollution.

OffRoad-3: Electric Landscaping Equipment

Public Health Improvements: Fossil fuel combustion releases several toxic air contaminants known to cause adverse human health effects. Reductions in the amount of fuel combusted would result in corresponding reductions in toxic air contaminants. Additionally, reductions in ozone precursors would reduce the formation of smog, which has numerous human and environmental effects, including respiratory irritation and reduced plant productivity.

Increased Quality of Life: Electric equipment is quieter and typically easier to maneuver than diesel- and gasoline-powered equipment.

Waste-1: Waste Diversion

Measure Description

Continue to provide public education and collection services to community residents and business. Exceed the waste diversion goals recommended by Assembly Bill 939 and CALGreen by adopting citywide waste goals of at least 75% of waste diversion.

Assumptions

The following assumptions were considered for the quantification of this measure.

- The 2020 BAU waste diversion rate equals the 2016 diversion rate for each Partnership city (CALRecycle, 2010b).[8]
- The jurisdiction participating in this measure will increase their diversion rates linearly from their 2020 rate to their selected new diversion rate goal by 2050. These rates range from 50% to 100%.

Analysis Details

GHG Analysis

[8] Diversion rates for years after 2006 are not available from CALRecycle.

Diversion programs reduce the amount of waste deposited in regional landfills. Because waste generates methane emissions during decomposition, reducing the volume of waste sent to landfills directly reduces GHG emissions. In general, waste diversion rates have risen dramatically since the early 1980s. The U.S. achieved 51% diversion in fiscal year 2009 (U.S. EPA, 2011b).

BAU Emissions

The GHG Inventory projected 2020 waste volumes for each city using historic landfill data obtained from CalRecycle. The 2016 diversion rate for each jurisdiction was assumed to remain constant under 2020 BAU conditions.

Emissions Reductions

Implementation of Waste-1 would increase the BAU diversion rate for each jurisdiction by 2020 (e.g., to 75%). The amount of waste diverted by material type under BAU conditions was therefore increased by the difference between the BAU diversion rate and the new diversion rate selected by the jurisdictions. GHG emissions that would have been generated by the diverted waste if it had been deposited in regional landfills were quantified using CARB's FOD Model and new waste disposal quantities based on the new 2020 waste diversion goal for each jurisdiction.

CAPCOA recommends the use of EPA's Waste Reduction Model (WARM) to quantify emissions reductions from diverting landfill waste to composting or recycling. The WARM model calculates life-cycle emission reductions, which includes emissions and avoided emissions upstream and downstream from the point of use. This approach is not consistent with the method used in the inventory, and EPA recommends against using this life-cycle approach for inventories because of the diffuse nature of the emissions and emission reductions within a single WARM emission factor. Consequently, the WARM model was not used to calculate reductions from Waste-1. CARB's FOD Model was used to calculate reductions because it is consistent with the inventory and does not have a lifecycle component.

Co-Benefit Analysis

The following benefits are expected from implementation of Waste-1.

Reduced Air Pollution: The decomposition of landfilled waste emits methane, which can react with other species in the atmosphere to form local smog. By sending less waste to regional landfills, methane emissions would be reduced.

Resource Conservation: Waste that is diverted to recycling centers can be converted into reusable products, thereby reducing the need for raw materials.

Water-1: Require Adoption of the Voluntary CALGreen Water Efficiency Measures for New Construction

Measure Description

Require adoption of the Voluntary CALGreen water efficiency measures for new construction. CALGreen voluntary measures recommend use of certain water-efficient appliances, and plumbing and irrigation systems, as well as more aggressive water savings targets. Update building standards and codes for new buildings to require adoption of these voluntary measures, including:

- Use of low-water irrigation systems.
- Installation of rainwater and graywater systems.
- Installation of water-efficient appliances and plumbing fixtures, as well as composting toilets.
- A 30-40% reduction over BAU conditions in indoor water use, and a 55-60% reduction in outdoor potable water use (CALGreen Tier 1 or 2).

Assumptions

The following assumptions were considered for the quantification of this measure:

- The market penetration rate for new buildings (residential and commercial) achieving CALGreen Tier 1 or 2 voluntary water efficiency measures and the penetration rate for new parks performing irrigation retrofits were determined by the jurisdictions on an individual basis.
- The following voluntary CALGreen measures would be implemented by development.
    - Installation of water efficient appliances and plumbing fixtures (showerheads, faucets, toilets, urinals, and dishwashers).
    - Use of low-water irrigation systems.
- 57of total residential water use is for outdoor use / landscaping; the remaining 43% is used indoors (ConSol, 2010).
- 35% of total nonresidential water use is for outdoor use / landscaping; the remaining 65% is used indoors (Yudelson, 2010).
- Heating a gallon of hot water requires 0.0098 therms of natural gas or 0.19 kWh of electricity (ICLEI Local Governments for Sustainability 2010).
- 73% of water used in faucets and showerheads is hot water (U.S. Department of Energy, 2012).
- 10.5% homes have electric water heaters (1.3 million households out of 12.4 million households used electricity to heat water in 2005 in California) (Energy Information Administration, 2009, Table WH2).
- 40%of commercial buildings have electric heaters (2,771 million square feet out of 6,947 million square feet use electricity to heat water in 2003 in the Pacific Census Region) (Energy Information Administration, 2009, Table B32).
- Assumptions for water-efficient faucets:
    - The current California standard residential faucet flow rate is 2.2 gallons/minute @ 60 psi; the mandatory CALGreen standard flow rate is 1.62 gallons/minute @ 60 psi (California Air Pollution Control Officers Association, 2010). This equates to a savings of 0.6 gallons/minute for each faucet replaced.
    - The current California standard nonresidential bathroom faucet flow rate is 0.5 gallons/minute @ 60 psi; the voluntary CALGreen standard flow rate is 0.35 gallons/minute @ 60 psi (California Air Pollution Control Officers Association, 2010). This equates to a savings of 0.2 gallons/minute for each bathroom faucet replaced.
    - There are 40 employees per faucet (20 employees per toilet and 2 toilets per faucet) (8 CCR Section 1526(a); 29 CFR 1910.141(c)(1)(i)).
    - There are 2.1 faucets per household on average (ICLEI Local Governments for Sustainability 2010).
    - The average faucet use time (per capita or per employee) is 4.75 minutes use/day total: 0.75 minutes for bathroom faucets (three 0.25 minute uses for bathroom faucets) and 4 minutes for kitchen faucets (four one minute uses for kitchen faucets) (California Building Standards Commission 2011, p. 49)
- Assumptions for water-efficient showerheads:
    - The current California standard showerhead flow rate is 2.5 gallons/minute @ 60 psi; the mandatory CALGreen standard flow rate is 2.0 gallons/minute @ 60 psi (California Air Pollution Control Officers Association, 2010). This equates to a savings of 0.5 gallons/minute for each showerhead replaced.

  - The average shower use time is 8 minutes per day per capita (California Building Standards Commission, 2011, p. 49).
- Assumptions for water-efficient toilets/urinals:
  - The current California standard toilet water use rate is 1.6 gallons/flush; the mandatory CALGreen standard flow rate is 1.28 gallons/flush (California Air Pollution Control Officers Association, 2010). This equates to a savings of 0.32 gallons/flush for each toilet replaced. Flushes per commercial toiler per day for men is 1, and women is 3 (CalGreen Code Page 49).
  - The current California standard urinal water use rate is 1.0 gallons/flush; the voluntary CALGreen standard flow rate is 0.5 gallons/flush (California Air Pollution Control Officers Association, 2010). This equates to a savings of 0.5 gallons/flush for each toilet replaced.
  - 2 toilet flushes per person per day (residential) and 2 urinal flushes per male employee per day (nonresidential) (California Building Standards Commission, 2011, p. 49).
  - In commercial building 50% of the employees are men and 50% are women.
- Assumptions for water-efficient dishwashers:
  - The current California standard dishwasher water use rate for standard dishwashers is 6.5 gallons/cycle/cubic foot; the voluntary CALGreen standard water use rate is 5.8 gallons/cycle/cubic foot (California Air Pollution Control Officers Association, 2010). This equates to a savings of 0.7 gallons/cycle for each standard dishwasher replaced.
  - The current California standard dishwasher water use rate for compact dishwashers is 4.5 gallons/cycle/cubic foot; the ENERGY STAR water use rate is 3.5 gallons/cycle/cubic foot (California Air Pollution Control Officers Association, 2010). This equates to a savings of 1.0 gallons/cycle for each compact dishwasher replaced.
  - 0.1 average dishwasher runs per person per day (Mayer and DeOreo, 1999).
  - 100% of water used in dishwashers is hot water.
- Assumptions for low-water irrigation systems:
  - The average lawn size per home is 0.2 acre (Grounds Maintenance 2012) (except for Yucca Valley, for which it was assumed 0.1 acres/lawn per home in order to more accurately calculate outdoor residential water use for this city).
  - An acre of lawn requires 570,239 gallons to irrigate per year (Hanak and Davis, 2006)
  - 35% of total nonresidential water use is for outdoor use / landscaping; the remaining 65% is used indoors (Yudelson, 2010).
  - 25% of park/open space acreage is irrigated (estimate).
  - 26% savings in landscaping water use for homes and buildings installing low-water irrigation systems (U.S. EPA, 2007).
  - 25% of residential outdoor water use is replaced with gray water; 50% of nonresidential outdoor water use is replaced with gray water (estimate).

Analysis Details

GHG Analysis

Water use contributes to GHG emissions indirectly, via the production of the electricity that is used to pump, treat, and distribute the water. Installing low-flow or high-efficiency water fixtures in buildings reduces water demand, energy demand, and associated indirect GHG emissions.

In 2010, the California Building Standards Commission unanimously adopted Title 24 Part 11 (also known as CALGreen), the mandatory green building standards code and the first such code in the nation. CALGreen requires all new buildings in the state to be more energy efficient and environmentally responsible. Effective January 1, 2011, CALGreen requires that every new building constructed in California reduce water consumption by 20%. CALGreen voluntary measures recommend a 30–40% reduction over BAU conditions in indoor water use and 55–60% reduction over BAU outdoor potable water use.

California homes and businesses consume a significant amount of water through indoor plumbing needs and outdoor irrigation. ConSol estimates that an average three-bedroom home uses 174,000 gallons of water each year (ConSol, 2010). A large portion of water use can be attributed to inefficient fixtures (e.g., showerheads, toilets). Recognizing that water uses a great deal of electricity to pump, treat, and transport, the state adopted SB X7-7, which requires a 20% reduction in urban per capita use by December 31, 2020 (20X2020 goal). Achieving this goal would not only reduce electricity consumption, but avoid GHG emissions and conserve water.

Emissions Reductions

Water savings were calculated for the installation of six different water-efficient fixtures/systems: faucets, showerheads, toilets/urinals, dishwashers, low-water irrigation systems, and gray water systems. Methods for calculating water savings for each of these are described below.

Faucets:

- Residential water savings (gallons) = total new households in 2020,2030 and 2045 * jurisdiction-selected market penetration rate * persons/household (varies by jurisdiction) * 0.6 gallons of water saved/minute * 4.75 minutes of use/person per day * 365 days/year
- Nonresidential bathroom faucet water savings (gallons) = total number of new employees in 2020,2030 and 2045 * jurisdiction-selected market penetration rate ÷ 40 employees/faucet * 0.2 gallons of water saved/minute * 0.75 minutes of use/employee per day * 260 workdays/year
- Nonresidential kitchen faucet water savings (gallons) = total number of new employees in 2020,2030 and 2045 * jurisdiction-selected market penetration rate ÷ 40 employees/faucet * 1.4 gallons of water saved/minute * 4 minutes of use/employee per day * 260 workdays/year

Showerheads:

a) Residential water savings (gallons) = total new residents in 2020,2030 and 2045 * 100% market penetration rate * 0.5 gallons of water saved/minute * 8 minutes of shower use/person per day * 365 days/year

b) No savings for nonresidential

Toilets/urinals:

a) Residential water savings (gallons) = total new residents in 2020,2030 and 2045 * 100% market penetration rate * 0.32 gallons of water saved/flush * 2 flushes/person per day * 365 days/year

b) Nonresidential toilet water savings (gallons) = total number of new employees in 2020,2030 and 2045 * jurisdiction-selected market penetration rate * 0.48 gallons of water saved/flush * (50% men * 1 flush/male employee per day + 50% women * 3 flushed/female employee per day) * 365 days/year

c) Nonresidential urinal water savings (gallons) = total number of new employees in 2020,2030 and 2045 * city-selected market penetration rate * 0.5 gallons of water saved/flush * 50% men * 2 flushes/male employee per day * 260 workdays/year

Dishwashers:

a) Residential water savings (gallons) = total new residents in 2020,2030 and 2045 * jurisdiction-selected market penetration rate * (50% standard dishwashers * 0.7 gallons of water saved/cycle for standard dishwashers + 50% compact dishwashers * 1.0 gallons of water saved/cycle for compact dishwashers) * 0.1 dishwasher runs/person per day * 365 days/year

b) No savings for nonresidential

Low-water irrigation systems:

a) Residential water savings (gallons) = total new homes in 2020,2030 and 2045 * 0.2 acres of lawn/home average * 100% market penetration rate * 652,000 gallons used for irrigation/acre per year * 26% reduction in water use for irrigation control sensors

b) Nonresidential building water savings (gallons) = total new 2020,2030 and 2045 water use * 35% outdoor water use for office buildings on average * jurisdiction-selected market penetration rate * 26% reduction in water use for irrigation control sensors

c) Parks water savings (gallons) = total new 2020,2030 and 2045 park water use * jurisdiction-selected market penetration rate * 26% reduction in water use for irrigation control sensors

Gray water systems:

a) Residential water savings (gallons) (total new homes in 2020,2030 and 2045 * 0.2 acres of lawn/home average * 100% market penetration rate * 570,239 gallons used for irrigation/acre per year – water saved from irrigation control sensors) * jurisdiction-selected percentage of outdoor water use that is replaced with gray water

b) Nonresidential building water savings (gallons) = (total new 2020,2030 and 2045 water use * 35% outdoor water use for office buildings on average – water saved from irrigation control sensors) * jurisdiction-selected percentage of outdoor water use that is replaced with gray water

Water use savings result in energy use reductions for three different categories. Electricity savings from reduced water conveyance, treatment, distribution, and wastewater treatment were quantified by multiplying the anticipated water reductions by the appropriate energy-intensities.

Electricity savings from reduced water heating for faucets, showerheads, and dishwashers were quantified as follows:

c) Residential electricity savings (kWh) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 10.5% of homes with electric water heaters * 0.19 kWh to heat a gallon of water

d) Nonresidential electricity savings (kWh) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 40% of commercial buildings with electric water heaters * 0.19 kWh to heat a gallon of water

Natural gas savings from reduced water heating for faucets, showerheads, and dishwashers were quantified as follows:

a) Residential natural gas savings (therms) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 89.5% of homes with natural gas water heaters * 0.0098 therms to heat a gallon of water

b) Nonresidential natural gas savings (therms) = gallons of water saved * 73% hot water for faucets and showerheads OR 100% hot water for dishwashers * 40% of commercial buildings with electric water heaters * 0.19 kWh to heat a gallon of water

GHG savings from electricity and natural gas reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Water-1.

Resource Conservation: Reduced water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Likewise, water consumed during showers, dish washing, and clothes washing require electricity and natural gas to heat the water to a comfortable temperature. Consequently, reductions in water use would reduce energy consumption from pumping, treatment, transporting, and heating

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

Increased Property Values: Energy-efficient bulidings have higher property values and resale prices than less efficient buildings.

Water-2: Implement a Program to Renovate Existing Buildings to Achieve Higher Levels of Water Efficiency[9]

Measure Description

Implement a program to renovate existing buildings to achieve higher levels of water efficiency. Education and outreach programs can help educate individuals on the importance of water efficiency and how to reduce water use. Rebate programs can help promote installation of water-efficient plumbing fixtures. The program could address:

- Development plans to ensure water conservation techniques are used (e.g., rain barrels, drought tolerant landscape).
- Water efficiency upgrades as a condition of issuing permits for renovations or additions of existing buildings.
- Adopt water conservation pricing, such as tiered rate structures, to encourage efficient water use.
- Incentives for projects that demonstrate significant water conservation through use of innovative water consumption technologies.

Assumptions

The assumptions described in Water-1 were used to quantify water, energy, GHG emissions reductions associated with this measure. The following assumptions were modified:

- The market penetration rate for buildings (residential and commercial) performing water efficiency retrofits and the penetration rate for parks performing irrigation retrofits were determined by the jurisdictions on an individual basis.

Analysis Details

GHG Analysis

[9] Emissions reductions associated with reduced electricity and natural gas for hot water heating will be achieved in the building energy sector. However, these emissions reductions are reported as part of Water-2 as they are a direct result of implementation of water-efficient fixtures.

Water use contributes to GHG emissions indirectly, via the production of the electricity that is used to pump, treat, and distribute the water. Installing low-flow or high-efficiency water fixtures in buildings reduces water demand, energy demand, and associated indirect GHG emissions.

California homes and businesses consume a significant amount of water through indoor plumbing needs and outdoor irrigation. ConSol estimates that an average three-bedroom home uses 174,000 gallons of water each year (ConSol, 2010). A large portion of water use can be attributed to inefficient fixtures (e.g., showerheads, toilets).

<u>Emissions Reductions</u>

The methods described in Water-1 were used to quantify water, energy, and GHG emissions reductions associated with this measure. The following assumptions were modified.

- BAU water flow rates were based on the 1992 Energy Policy Act.[10]

Co-Benefit Analysis

The following benefits are expected from implementation of Water-2.

Resource Conservation: Efficient appliances and fixtures would reduce water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Likewise, water consumed during showers, dish washing, and clothes washing require electricity and natural gas to heat the water to a comfortable temperature. Consequently, reductions in water use would reduce energy consumption from pumping, treatment, transporting, and heating.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity) and local air pollution (from reduced burning of natural gas).

Increased Property Values: Energy-efficient buildings have higher property values and resale prices than less efficient buildings.

[10] Because this measure applies to existing developing, assuming BAU flow rates are equivalent to the 2010 building code is inappropriate. According to the City's Housing Element and the EIA, the majority of homes and commercial developments were constructed prior to 1980. Assuming the 1992 flow rate therefore represents a conservative assumption as several developments that comply with this measure will likely replace fixtures with flow rates much higher than required in 1992.

Water-3: Encourage Water-Efficient Landscaping Practices

Measure Description

Encourage Water-Efficient Landscaping Practices. Adopt a landscaping water conservation plan that exceeds the requirements in the Model Landscape Ordinance (AB 1881).

Assumptions

The following assumptions were considered for the quantification of this measure:

- The market penetration rate for buildings (residential and commercial) and parks performing water-efficient landscaping practices was determined by the jurisdiction on an individual basis.
- The average lawn size per home is 0.2 acre (Grounds Maintenance, 2012).
- An acre of lawn requires 570,239 gallons to irrigate per year (Hanak and Davis, 2006)
- Assuming an irrigation efficiency of 71%, as specified in the Model Water Efficient Landscape Ordinance, and no Special Landscape Area, the percent reduction in $MTCO_2e$ for water-efficient landscapes is (California Air Pollution Control Officers Association, 2010):
    - 0% reduction if 100% of vegetation is Moderate Example Plant Factor (PF)
    - 13% reduction if 40% of vegetation is Low PF, 40% is Moderate PF, and
    - 20% is High PF
    - 35% reduction if 50% of vegetation is Low PF and 50% is Moderate PF
    - 70% reduction if 100% of vegetation is Low PF
- The average reduction in $MTCO_2e$ is 30% (based on the percent reductions above).
- 6.1% reduction in $MTCO_2e$ for water-efficient landscape irrigation systems (California Air Pollution Control Officers Association, 2010).
- 35% of total nonresidential water use is for outdoor use/landscaping; the remaining 65% is used indoors (Yudelson, 2010).
- 25% of park/open space acreage is irrigated (estimate).

Analysis Details

GHG Analysis

Water use contributes to GHG emissions indirectly, via the production of the electricity that is used to pump, treat, and distribute the water. California homes and businesses consume a significant amount of water through outdoor water use, which includes landscape irrigation. Designing water-efficient landscapes for a project site reduces water consumption and the associated indirect GHG emissions.

Examples of measures to consider when designing landscapes are reducing lawn sizes, planting vegetation with minimal water needs such as California native species, choosing vegetation appropriate for the climate of the project site, and choosing complimentary plants with similar water needs or which can provide each other with shade and/or water. Achieving this goal would not only reduce electricity consumption, but avoid GHG emissions and conserve water.

<u>Emissions Reductions</u>

The following steps were performed to calculate water savings:

a) Residential water savings (gallons) = total homes in 2020,2030 and 2045 * 0.2 acres of lawn/home average * jurisdiction-selected market penetration rate * 570,239 gallons used for irrigation/acre per year * (30% average reduction in water use for water-efficient landscapes + 6.1% reduction in water use for water-efficient landscape irrigation systems)

b) Nonresidential building water savings (gallons) = total 2020, 2030, and 2045 water use * 22% outdoor water use for office buildings on average * jurisdiction-selected market penetration rate * (30% average reduction in water use for water-efficient landscapes + 6.1% reduction in water use for water-efficient landscape irrigation systems)

c) Parks water savings (gallons) = total 2020, 2030, and 2045 park water use * jurisdiction-selected market penetration rate * (30% average reduction in water use for water-efficient landscapes + 6.1% reduction in water use for water-efficient landscape irrigation systems)

GHG savings from electricity reductions were then calculated by multiplying the energy reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of Water-3.

Resource Conservation: Efficient irrigation systems would reduce water consumption would help conserve freshwater resources.

Reduced Energy Use: Water uses a great deal of electricity to pump, treat, and transport. Consequently, reductions in water use would reduce energy consumption from pumping, treatment, and transporting.

Reduced Air Pollution: Reduced energy use would contribute to reductions in regional air pollution (from reduced generation of electricity).

Increased Property Values: Energy-efficient buildings have higher property values and resale prices than less efficient buildings.

Agriculture-3: Methane Capture at Large Dairies

Measure Description

This measure promotes installation of methane digesters at large dairies to capture methane emissions from decomposing manure. The methane could be used on site as an alternative to natural gas in combustion, power production, or as a transportation fuel. Further, individual project proponents can sell GHG credits associated with these installations on the voluntary carbon market. This is a voluntary measure; however, in September 2016, SB 1383 was signed into law and requires reducing methane emissions from dairy manure management to 40% below 2013 levels by 2030. The regulations to reduce dairy emissions will not take effect until after January 1, 2024.

Assumptions

The following assumptions were considered for the quantification of this measure.

- Manure management emissions are 225.88 kg CH_4 per head of cattle (CARB, 2019), which is equivalent to 6.32 $MTCO_2e$ per head.
- This measure is only applicable to jurisdictions with more than 1,000 cattle (CARB, 2008), which are Chino, Ontario, and Unincorporated County.
- Percent of cows at large dairies subject to methane capture is 73% (CARB, 2008).
- New methane capture rate of installed systems is assumed to be 86% (CARB, 2008).

Analysis Details

GHG Analysis

Dairies produce large quantities of methane from enteric fermentation and manure management of dairy cows. Capturing this methane, instead of allowing it to be released into the atmosphere, would reduce GHG emissions associated with dairies. Biodigesters recover methane from animal manure through a process called anaerobic digestion. The captured methane can be flared, combusted to produce electricity, or converted to fuel such as natural gas.

Emissions Reductions

The 2030 and 2045 dairy emissions for each jurisdiction were calculated using the number of head of dairy cattle in 2016 and a countywide growth factor. Implementation of this measure would result in the capture of 86% of the methane generated from the manure of 73% of the dairy cows within Chino, Ontario, and Unincorporated County. Total emissions from dairy cows for these jurisdictions were multiplied by 73% and then by 86% to determine the quantity of methane captured within each jurisdiction.

Co-Benefit Analysis

The following benefits are expected from implementation of measure Agriculture-3.

Reduced Air Pollution: Manure management at dairies emits methane, which can react with other species in the atmosphere to form local smog. By capturing much of this methane, emissions would be reduced.

Resource Conservation: Methane can be used to generate electricity or produce other useful fuels, thereby reducing the need for energy.

Economic Development: Development of renewable energy infrastructure (e.g., anaerobic digesters) would create new jobs, taxes, and revenue for the local economy.

Wastewater-1: Methane Recovery

Measure Description

Under this measure, the participating jurisdiction will coordinate with the Inland Empire Utilities Agency (IEUA) or other local wastewater treatment providers to identify funding and cooperating agencies for establishing methane recovery systems at all wastewater treatment plants (WWTPs) that service the County residents. WWTPs in the region operated by IEUA, City of San Bernardino, and Victor Valley Waste Water Agency (VVWA) already have an approximately 62% methane capture rate. Jurisdictions serviced by these providers would only benefit from this measure if the methane capture rate could be increased. For WWTPs that currently do not have methane capture systems, plants operators would work with regional power providers, local jurisdictions, or other entities to identify funding for methane capture system installation.

Assumptions

The following assumptions were considered for the quantification of this measure.

- For WWTPs with methane recovery system, 75% of captured methane will be combusted to generate electricity.
- Standard conversion factors were used to convert methane into energy, including: 662 grams methane per cubic meter; 35.3 cubic feet per cubic meter; 1,012 btu per cubic feet of methane; 0.00009 kWh per btu energy conversion factor (CAPCOA, 2010).
- The efficiency factor for converting methane into electricity is 0.85 (CAPCOA, 2010).
- Electricity generation is 0.00009 kWh per Btu of methane combusted.
- Reductions are allocated regionally (reductions are proportionate to emissions).
- Current methane capture rate in City of Barstow, Big Bear Area Regional Wastewater Agency, and City of Redlands is 0%. Current methane capture for the rest of the cities except for Twentynine Palms and Yucca Valley is 62%, which is the average of IEUA (60%) and San Bernardino Water Reclamation Facility (64%).
- Twentynine Palms and Yucca Valley will not benefit from this measure because they are on septic systems and do not have WWTPs.

Analysis Details

GHG Analysis

Wastewater treatment plants produce large quantities of methane from wastewater processing. Capturing this methane, instead of allowing it to be released into the atmosphere, will reduce GHG emissions associated with wastewater treatment.

Emissions Reductions

The amount of electricity generated through combustion of the captured methane was calculated using the following equation:

> Electricity generated (kWh) = total methane captured (metric tons) × 1,000,000 grams per metric ton/662 grams methane per cubic meter × 75% combustion rate × 35.3 cubic feet per cubic meter × 1,012 Btus per cubic feet of methane × 0.85 efficiency factor × 0.00009 kWh generated per Btu of methane combusted

GHG emissions reductions from electricity generation were quantified by multiplying the resulting electricity production for each jurisdiction by the appropriate utility emission factors. The reduction in methane emission was multiplied by global warming potential and included as GHG emission reductions.

Co-Benefit Analysis

The following benefits are expected from implementation of measure Wastewater-1.

Wastewater-1: Methane Recovery

Reduced Air Pollution: Wastewater treatment processes emit methane, which can react with other species in the atmosphere to form local smog. By capturing much of this methane, emissions would be reduced.

Resource Conservation: Methane can be used to generate electricity or produce other useful fuels, thereby reducing the need for energy.

Economic Development: Development of renewable energy infrastructure (e.g., anaerobic digesters, methane capture systems) would create new jobs, taxes, and revenue for the local economy.

Wastewater-2: Energy Efficiency Equipment Upgrades at Wastewater Treatment Plants

Measure Description

This measure encourages the jurisdictions to work with their local wastewater treatment provider to upgrade and replace wastewater treatment and pumping equipment with more energy-efficient equipment, as financially feasible, at the existing facilities. The measure would require all pumping and treatment equipment to be 25% more energy efficient at the time of replacement and utilize best management practices for the treatment of waste. This measure could also include the following.

- Assess the feasibility of using advance treatment of recycled water with microfiltration or reverse osmosis for future potable water use. Assess associated energy/GHG tradeoffs and out of basin water supply.

Assumptions

The following assumption was considered for the quantification of this measure.

- Energy efficiency improvements were assumed to be 25% better than existing conditions, unless specified by jurisdictions or WWTPs.

Analysis Details

GHG Analysis

Some of the wastewater generated within the County is treated by the IEUA and other WWTP operators in a number of WWTPs. Collection and treatment of the wastewater generates fugitive methane emissions from organic decomposition, as well as GHGs from electricity consumption.

<u>Emissions Reductions</u>

Jurisdictions implementing this measure will reduce wastewater facility electricity consumption by 25%. GHG emission reductions were quantified by multiplying the electricity reductions by the appropriate utility emission factors.

Co-Benefit Analysis

The following benefits are expected from implementation of measure Wastewater-2.

Reduced Energy Use: The collection and treatment of wastewater requires electricity. Improving the efficiency of pumping and treatment equipment would therefore reduce electricity consumption at the IEUA WWTPs.

Reduced Air Pollution: Reduced electricity use would contribute to reductions in regional air pollution.

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