DRAFT

2016 Community Greenhouse Gas Emissions Inventory Update

A Product of the
City of San Luis Obispo Office of Sustainability
Completed in 2018
Revised in 2019

- for questions, or to provide suggested revisions contact cread@slocity.org -

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Introduction

A greenhouse gas (GHG) inventory is a comprehensive measure of GHG emissions that have occurred as the result of activity in a jurisdiction or a geographic area in a calendar year. It is common to prepare two separate GHG inventories, one for local government operations only and the other for community-wide emissions. Though inventories are custom to their jurisdiction, local government GHG inventories typically include the accounting of emissions from the buildings, facilities, and vehicles operated by a local government, while community-wide inventories typically include accounting of emissions from all businesses, residents, and transportation within the jurisdictional boundary.

This report focuses on community-wide GHG emissions. Section 1 of this report provides an overview of the community GHG emissions inventories and forecasts. Sections 2-5 provide detailed summaries of the inventoried GHG emissions sectors. Section 6 provides a detailed description of the GHG forecasts and a discussion of the City's progress toward its GHG reduction targets. Section 7 concludes the report with a description of areas for improvement.

1. Community GHG Inventory Overview

In 2012, the City of San Luis Obispo (City) adopted the City of San Luis Obispo Climate Action Plan (CAP) to achieve GHG emission reductions consistent with state law and City General Plan policy. The foundation of the CAP is the 2005 baseline GHG inventory (completed in 2009), which estimates the GHG emissions that occurred as the result of activity in the city.

The City prepared a 2016 comprehensive community-wide and local government GHG emissions inventory update compliant with all relevant protocols and guidance documents including the Local Government Operations Protocol (LGOP), the Global Protocol for Community Scale GHG Emissions (GPC), and the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories. The community-wide GHG inventory will be presented and adopted as part of the CAP update in 2019.

This report provides an overview of the community-wide sector GHG emissions that have been emitted from activities occurring in the city from 2005 to 2016. The four emission sectors that are included in this report are energy, transportation, solid waste, and off-road. This report presents a summary of the updated 2005 GHG emissions and details the 2016 community GHG inventory completed in 2018 and revised in 2019.[i]

1.1. 2005 Community GHG Inventory

In 2009, the community's total 2005 baseline GHG emissions were estimated to be 264,237 metric tons of carbon dioxide equivalent ($MTCO_2e$). The inventory included energy (residential and nonresidential), transportation, and waste sectors. Of the three sectors, transportation contributed the largest amount of GHG emissions with estimated emissions of 132,142 $MTCO_2e$ or 50 percent of the total City emissions. The second largest sector was commercial and industrial energy use with estimated emissions of 57,950 or 22 percent of the total City emissions. The

[i] *Due to lagging data availability, 2016 is the most recent year for complete GHG inventory data. Annual inventory updates will occur beginning in 2020.*

commercial and industrial energy and waste sectors made up the remaining 28 percent of the total city emissions. Table 1.1 presents the original estimated 2005 GHG emissions by sector and their percent of total emissions.

Table 1.1. San Luis Obispo Community GHG Emissions (2005)

Community Sector	$MTCO_2e$	Percent of Total
Transportation	132,142	50%
Nonresidential Energy	57,950	22%
Residential Energy	55,377	21%
Waste	18,768	7%
Total	**246,237**	**100%**

Source: City of San Luis Obispo Climate Action Plan (2009)

1.2. 2005 Updated Community GHG Inventory

To assess climate action progress, the City updated the 2005 baseline inventory for consistency with current protocols and best practices. This section provides updated GHG emissions data estimates for the baseline year of 2005 to allow for an "apples to apples" comparison to the 2016 GHG inventory. The City updated the 2005 GHG inventory to reflect an updated scientific understanding of how different greenhouse gasses contribute to global warming, to include a more accurate assessment of transportation related emissions, and to respond to changes to data privacy rules and collection methods that affect how data is provided.

Table 1.2 provides the updated 2005 baseline GHG emissions inventory with updated total GHG emissions of 374,000 $MTCO_2e$. One sector has been added to the updated 2005 inventory (off-road equipment) in order to comply with the guidance in the GHG inventory protocols. Similar to the original 2005 inventory, the largest sector contributing to the City's total GHG emissions was transportation with an estimated emissions total of 234,660 $MTCO_2e$ or 65 percent of the City's total.[ii] The commercial and industrial energy sector was the second largest sector contributing a total of 57,800 $MTCO_2e$ GHG emissions or 15 percent of the City's total. The remaining sectors of residential energy, solid waste, and off-road made up the remaining 30 percent of the City's total emissions in 2005.

[ii] *Section 3 provides an explanation for the significant increase in estimated transportation emissions in the revised 2005 baseline over the original draft.*

Table 1.2. 2005 update baseline GHG emissions.

Sector	Subsector	Subsector $MTCO_2e$	Sector $MTCO_2e$	Sector Percent of Total
Transportation	On-Road Transportation	234,660	234,660	63%
Nonresidential Energy	Commercial/Industrial electricity	35,380	57,800	15%
	Commercial/Industrial natural gas	22,420		
Residential Energy	Residential electricity	20,800	55,190	15%
	Residential natural gas	34,390		
Solid Waste	Community-wide municipal solid waste disposal tons	15,540	15,540	4%
Off-Road	Lawn and Garden Equipment	1,540	10,810	3%
	Construction Equipment	9,270		
Total			**374,000**	**100%**

1.3. 2016 Community GHG Inventory

In 2018, the City prepared a community-wide inventory of GHG emissions for the 2016 calendar year. Table 1.3 provides the 2016 GHG emissions inventory results. In 2016, San Luis Obispo's total GHG emissions were estimated to be 340,850 $MTCO_2e$. As in 2005, transportation was the largest contributor to the City's total GHG emissions with an estimated 221,750 $MTCO_2e$ or 65 percent of the City's total emissions. Commercial and Industrial energy was the second largest sector with GHG emissions of 53,410 $MTCO_2e$ or 16 percent of the City's total emissions. The sectors of residential energy, solid waste, off-road, and wastewater account for the remaining 19 percent of the City's total 2016 GHG emissions.

Table 1.3. 2016 GHG emissions.

Sector	Subsector	Subsector $MTCO_2e$	Sector $MTCO_2e$	Sector Percent of Total
Transportation	On-Road Transportation	221,750	221,750	65%
Nonresidential Energy	Commercial/Industrial electricity	31,310	53,410	16%
	Commercial/Industrial natural gas	22,100		
Residential Energy	Residential electricity	14,650	43,580	13%
	Residential natural gas	28,930		
Solid Waste	Community-wide municipal solid waste disposal tons	13,880	13,880	4%
Off-Road	Lawn and Garden Equipment	1,270	8,230	2%
	Construction Equipment	6,960		
Total			**340,850**	**100%**

1.4. Progress Toward 2020 Target

Table 1.4 provides a comparison overview of emissions from baseline year 2005 to 2016 to show the City's progress toward its target to reduce GHG emissions 15 percent below 2005 emission levels. Over the eleven-year period, emissions were estimated to have dropped by approximately 9 percent. The most significant changes occurred in the residential energy, solid waste, and off-road sectors.

- Residential energy emissions dropped by approximately 21 percent and reflects a significant change in the carbon intensity of grid consumed electricity, a substantial increase in rooftop renewable energy systems, and investment in energy efficiency.
- Solid waste emissions decreased by approximately 11 percent due to a decrease in the amount of solid waste produced by San Luis Obispo residents and businesses.
- Off-road emissions (including construction equipment) dropped by approximately 24 percent, primarily due to the decrease in new construction projects within the city. This number is expected to increase in future inventories as the result of recent increases in construction.

Section 2 provides a detailed report for each GHG emissions sector and the changes in emissions from each sector from 2005 to 2016.

Table 1.4. GHG emissions, 2005-2016 ($MTCO_2e$).

Sector	2005	2016	Percent Change
Transportation	234,660	221,750	-6%
Nonresidential Energy	57,800	53,410	-8%
Residential Energy	55,190	43,580	-21%
Solid Waste	15,540	13,880	-11%
Off-Road	10,810	8,230	-24%
Total	**374,000**	**340,850**	**-9%**

1.5. Progress to State GHG Reduction Targets

The key driver for updating the community GHG inventory is to assess progress toward the City's GHG emissions reduction target. Consistent with Assembly Bill (AB) 32, the City's target is to achieve a 15 percent reduction below baseline emissions by 2020. Since the baseline inventory was updated through this inventory process, resulting in a slightly increased baseline, a new target must be calculated.

As noted in Table 1.5 and Figure 1.1, a 15 percent reduction in baseline emissions is 317,900 $MTCO_2e$ from the updated baseline year emissions of 374,000 $MTCO_2e$. The 2016 emissions estimate of 340,850 $MTCO_2e$ represents a 9 percent reduction in GHG emissions, notable progress toward the 2020 target.

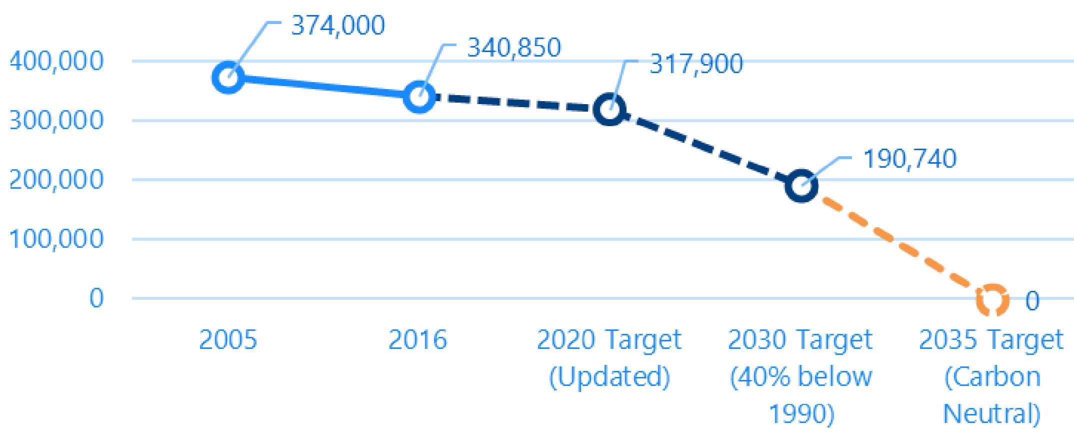
Since adoption of the City's CAP in 2012, the state adopted a 2030 target through Senate Bill (SB) 32. If the City adopts a 2030 goal that matches the state target of reducing GHG emissions

40 percent below the 2020 target levels, the target for San Luis Obispo would be 190,740 $MTCO_2e$. In September of 2018, Council directed staff to develop a climate action plan with a reduction target of carbon neutrality by 2035.

Table 1.5. Progress to AB32 and SB 32 target ($MTCO_2e$).

Year	Emissions
2005 (Updated)	374,000
2016	340,850
2020 Target (Updated)	317,900
2030 Target (40% below 1990)	190,740
2035 Target (Carbon Neutral)	0

Figure 1.1. Progress to AB32, SB 32, and Carbon Neutrality target.



2. Community Energy

2.1. Community Energy Sector Overview

This section presents the GHG emissions for the energy sector, specifically emissions generated from residential and non-residential energy use that has occurred within City limits. This section presents the updated 2005 GHG emissions along with updated emissions for 2016.

2.2. Updated Inventory Data and Methods

The update to the 2005 inventory for the energy sector incorporates changes in scientific understanding of how different greenhouse gasses contribute to global warming and changes to data privacy rules that affect how energy data is retained and provided. This section provides updated electricity and natural gas activity data and emissions estimates for the baseline year of 2005, as well as electricity and natural gas activity data and GHG emissions estimates for years 2005 through 2016.

2.2.1. Electricity

Pacific Gas & Electric (PG&E) Company provides electric service to the community and offers community electricity data to local agencies through the PG&E Green Community Portal. The electricity data (presented in kilowatt-hours, or kWh) in Table 2.1 is separated between residential and non-residential uses, which is the finest resolution possible to prevent data from being removed for privacy purposes. Nonresidential electricity use includes commercial, governmental, agricultural, and industrial usage. From 2005 to 2016, residential electricity usage decreased by 18 percent and non-residential electricity consumption increased approximately 3 percent. Between 2005 and 2016, electricity use decreased by 5 percent.

Table 2.1. Community electricity activity data, 2005-2016 (kWh).

Year	Residential	Nonresidential	Total
2005	93,045,220	158,267,695	251,312,915
2006	94,844,802	165,562,683	260,407,485
2007	92,479,221	170,259,426	262,738,647
2008	91,007,229	176,783,866	267,791,095
2009	89,252,248	183,654,370	272,906,618
2010	87,910,124	218,185,988	306,096,112
2011	86,239,267	172,742,643	258,981,910
2012	85,773,964	172,045,211	257,819,175
2013	84,492,752	171,842,797	256,335,549
2014	78,932,662	171,846,749	250,779,411
2015	78,069,529	170,606,678	248,676,207
2016	76,376,280	163,204,691	239,580,971
Total	**1,038,423,298**	**2,095,002,797**	**3,133,426,095**

The 18 percent decrease in residential electricity usage may be due to low residential growth, a significant increase in residential renewable energy installations, increases in energy efficiency investments, and overall trends toward conservation. Additional assessment investigating reductions from existing actions will be completed in support of the CAP update.

To calculate GHG emissions, an emissions factor is applied to the activity data. Table 2.2 shows the electricity emissions factors for the three major greenhouse gasses occurring as the result of electricity use in the city. PG&E staff provided CO_2 emissions factors via the Green Community Portal data request in 2018. In addition to carbon dioxide (CO_2), small amounts of methane (CH_4) and nitrous oxide (N_2O) are released in the electricity generation process. CH_4 and N_2O emissions factors are provided by PG&E's third-party-verified GHG inventory. Variability of the emissions factors occur primarily due to two factors: 1) fluctuations in hydro power production as the result of precipitation variability, and 2) increasing renewable energy sources in PG&E's power portfolio.

CO_2 is the most commonly referenced GHG, however, numerous gasses have greenhouse characteristics. Methane and nitrous oxide are commonly accounted for in GHG inventories. These gasses have a greater global warming potential; CH_4 traps approximately 28 times as much heat as CO_2 over a 100-year period and N_2O traps approximately 265 times as much heat. To account for these differences, a factor is applied to the gasses emissions to calculate aCO_2 equivalence.

Table 2.2 provides the emissions factors for 2005 through 2016. Due to changes in PG&E's energy portfolio (and particularly an increase in renewable energy supplies), the 2016 emissions factor is approximately 14 percent lower than the 2005 factor. Figure 2.1 illustrates the changes in MTCO_2e/kWh factors from 2005 to 2016.

Table 2.2. Electricity conversion factor (MTCO_2e/kWh).

Year	kWh/MTCO_2e
2005	0.000224
2006	0.000208
2007	0.000290
2008	0.000292
2009	0.000262
2010	0.000203
2011	0.000179
2012	0.000203
2013	0.000195
2014	0.000198
2015	0.000185
2016	0.000192

Figure 2.1. Electricity emissions factor ($MTCO_2e/kWh$).

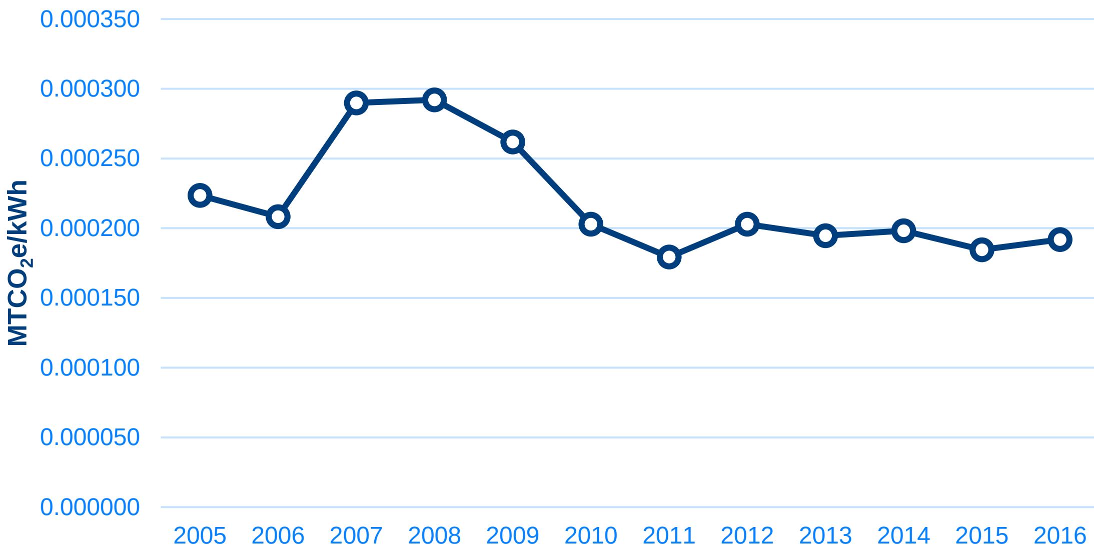


Table 2.3 provides the GHG emissions from electricity use in the city by residential and nonresidential subsectors from 2005 to 2016. During this time, electricity related residential GHG emissions decreased by approximately 30 percent, while nonresidential electricity emissions decreased by approximately 12 percent. Overall emissions decreased approximately 18 percent over the same period.

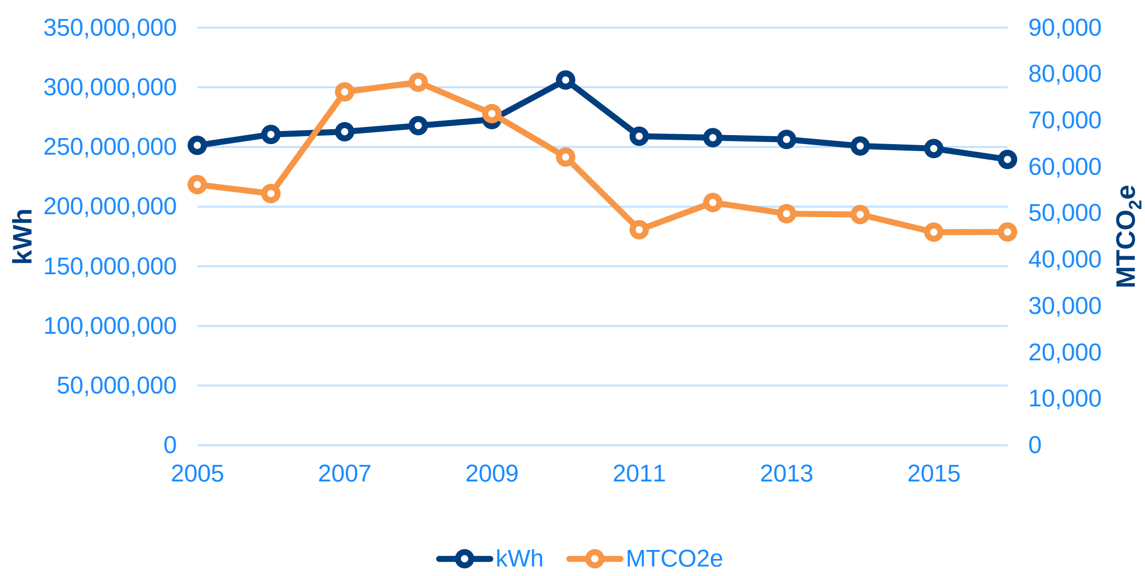
Table 2.3. Community electricity GHG estimates, 2006-2015 ($MTCO_2e$).

Year	Residential	Nonresidential	Total
2005	20,800	35,380	56,180
2006	19,760	34,490	54,250
2007	26,810	49,360	76,170
2008	26,580	51,640	78,220
2009	23,380	48,100	71,480
2010	17,840	44,280	62,120
2011	15,470	30,980	46,450
2012	17,410	34,910	52,320
2013	16,450	33,450	49,900
2014	15,650	34,060	49,710
2015	14,410	31,500	45,910
2016	14,650	31,310	45,960

Figure 2.2 illustrates GHG and kWh activity data trends between 2005 and 2016 on the same chart. It is important to note that while overall electricity use has been steadily decreasing, GHG

emissions have been more variable due to changes in PG&E's power portfolio and the related carbon intensity of the electricity it supplies.

Figure 2.2. Total community electricity activity data and GHG estimates, 2006-2016.



2.2.2. Natural Gas

Southern California Gas Company (SoCalGas) provides natural gas utility services in the city. Table 2.4 provides the natural gas activity data in therms from 2005-2016 separated by residential and nonresidential uses. Non-residential use combines commercial and industrial use.

Table 2.4. Community natural gas activity data, 2005-2016 (Therms).

Year	Residential	Nonresidential	Total
2005	6,460,870	4,211,790	10,672,660
2006	6,643,410	4,501,180	11,144,590
2007	6,702,810	4,532,760	11,235,570
2008	--	--	--
2009	--	--	--
2010	--	--	--
2011	--	--	--
2012	--	--	--
2013	--	--	--
2014	5,275,340	3,987,264	9,262,604
2015	5,068,160	3,952,562	9,020,722
2016	5,435,586	4,151,275	9,586,861

As a company policy, SoCalGas only retains community natural gas data back to 2014, which means the data in the original 2005 baseline inventory must be used in conjunction with the data provided via an Energy Data Request Portal request submitted by City staff in 2017. Since SoCalGas cannot confirm the 2005 inventory data, the comparison in natural gas consumption in the baseline year and years 2014-2017 should be observed with caution. The natural gas data provided in Table 2.4 shows an 18 percent decrease in residential therms and a 29 percent increase in non-residential usage between 2005 and 2016. Combined, the natural gas sector has a net decrease of 3 percent.

Just as with electricity, GHG emissions are estimated from activity data by applying an emission coefficient. Table 2.5 shows the emission coefficient for converting therms of natural gas to $MTCO_2e$. Unlike electricity, the inventory assumes no changes in the carbon intensity of combusting natural gas in any given year, as the composition of natural gas does not vary from year to year.

Table 2.5. Local Government Operations Protocol (LGOP) natural gas carbon dioxide equivalent.

Greenhouse Gas	$MTCO_2e$/Therm
CO_2[1]	0.005310
CH_4[1]	0.000011
N_2O[1]	0.000003
CO_2e[2]	0.005320

Table 2.6 provides GHG emissions estimates in $MTCO_2e$ for natural gas consumption in the city from 2005-2016. As noted in the natural gas activity data, there was a decrease in $MTCO_2e$ for residential and an increase for non-residential sectors with a total decrease natural gas-related emissions of 3 percent.

Table 2.6. Community Natural Gas GHG estimates, 2005-2016 ($MTCO_2e$).

Year	Residential	Nonresidential	Total
2005	34,390	22,420	56,810
2006	35,360	23,960	59,320
2007	35,680	24,130	59,810
2008	--	--	--
2009	--	--	--
2010	--	--	--
2011	--	--	--
2012	--	--	--
2013	--	--	--
2014	28,080	21,220	49,300
2015	26,980	21,040	48,020
2016	28,930	22,100	51,030

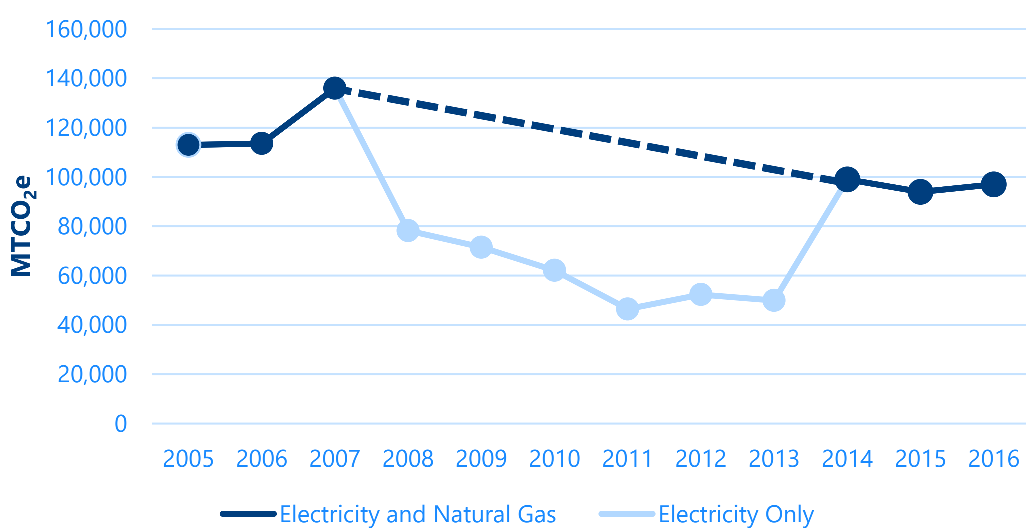
2.3. Total Energy GHG Emissions

Table 2.7 and Figure 2.3 show the total energy-related GHG emissions separated by energy type and subsector. The residential energy subsector saw a 22 percent decrease in emissions between 2005 and 2016. The nonresidential subsector emissions increased by 2 percent. Overall, energy GHG emissions dropped by 11 percent over the 11-year period. Note that Figure 2.3 provides total energy sector emissions with a dark blue line; the dashed line indicates a total emissions estimate necessitated by SoCalGas's inability to provide historical data.

Table 2.7. Energy GHG emissions, 2005-2016 ($MTCO_2e$).

Year	Residential		Nonresidential		Total		
	Electricity	Natural Gas	Electricity	Natural Gas	Res.	Nonres.	Total
2005	20,800	34,390	35,380	22,420	55,190	57,800	**112,990**
2006	19,760	35,360	34,490	23,960	59,320	58,450	**117,770**
2007	26,810	35,680	49,360	24,130	59,810	73,490	**133,300**
2008	26,580	--	51,640	--	--	--	
2009	23,380	--	48,100	--	--	--	
2010	17,840	--	44,280	--	--	--	
2011	15,470	--	30,980	--	--	--	
2012	17,410	--	34,910	--	--	--	
2013	16,450	--	33,450	--	--	--	
2014	15,650	28,080	34,060	21,220	43,730	55,280	**99,010**
2015	14,410	26,980	31,500	21,040	41,390	52,540	**93,930**
2016	14,650	28,930	31,310	22,100	43,580	53,410	**96,990**

Figure 2.3. Energy GHG emissions, 2005-2016.



3. Transportation

3.1. Transportation Sector Overview

This section presents the GHG emissions for the transportation sector, specifically emissions from all on-road trips (including cars, trucks, buses, etc.) that have occurred within City limits. This section presents the updated 2005 GHG emissions along with updated emissions for 2016.

3.2. Updated Inventory Data and Methods

This section provides updated activity data and emissions estimates for baseline year 2005 and activity data and emissions estimates for 2016. Since the 2005 baseline inventory was completed in 2009, the state has updated emissions factors and legislation on fuel economy standards. Additionally, the City has adopted a transportation model that more accurately models the vehicle miles travelled in, to, and from city boundaries.

The original 2005 inventory used the "geographic system boundary" method which considers transportation activity occurring solely within city boundaries, regardless of where a trip's destination begins or ends. This method included emissions from vehicles that were travelling through city boundaries but did not account for any of "outside of city boundary" miles that occurred from trips that originated or ended in the city.

In 2019, the City was able to use its own "origin-destination" transportation model to estimate the vehicle miles for trips that began and ended in the city, trips that began outside the city and ended in the city, trips that began in the city and ended outside the city, and trips that passed through the city without stopping. Consistent with the preferred GPC accounting method, the updated inventory includes 100 percent of internal trip miles, 50 percent of the miles for trips that start or end in the city, and zero percent of the miles that are from vehicles passing through the city.

The updated transportation model currently only estimates vehicle miles travelled for calendar year 2016. To estimate baseline 2005 emissions, the City replicated the 2005 "geographic system boundary" model with 2016 data and found a 3 percent increase in vehicles miles travelled. Assuming the two methods would capture the same scale and direction of change between 2005 and 2016, 2005 VMT was estimated by reducing the 2016 VMT by 3 percent. Table 3.1 reports the 2005 and 2016 VMT estimates.

Table 3.1. 2005 and 2016 VMT estimates.

Measure	2005	2016
Annual VMT	480,469,285	495,236,295

Source: City of San Luis Obispo, Public Works Department,

The origin destination model is preferred to the geographic model because it allows the City to understand where trips are occurring. The new method identifies a key finding: over 80 percent of community VMT occurred as the result of regional trips (e.g., trips to the city from outside the city or trips from the city to areas outside the city).

Vehicle miles traveled estimates for both years were converted to GHG emissions using the 2014 Emissions Factor (EMFAC) model. EMFAC represents the state's current understanding of motor vehicle travel activities and their associated emission levels. EMFAC 2014 is the latest U.S. Environmental Protection Agency (EPA) approved motor vehicle emission model that assesses emissions from on-road vehicles including cars, trucks, and buses in California. The City used EMFAC 2014 to estimate emissions factors for this updated report.

Table 3.2 provides the VMT and associated GHG emissions for each vehicle class in San Luis Obispo County for 2005 and 2016. GHG emissions were estimated using the California Air Resources Board (CARB) EMFAC 2014 tool. Using VMT as inputs, EMFAC 2014 generated VMT and CO_2 emission results for both 2005 and 2016 for each type of vehicle common in San Luis Obispo County. The City used this information to generate a CO_2/VMT emissions factor specific to San Luis Obispo County, reflecting the unique balance of different vehicle types, vehicle ages, and vehicle fuels used county-wide.

EMFAC 2014 does not model CH_4 and N_2O emissions, so a standard practice is to multiply CO_2 emissions factors by 100/95 (approximately 1.05) to convert CO_2 emissions to CO_2e. As the emissions factor generated by EMFAC is in tons of CO_2/VMT, the City also converted the units of this factor to metric tons. The City then applied this converted emissions factor to the total City VMT given in Table 3.1. This resulted in the total annual greenhouse gas emissions.

3.3. Total Transportation GHG Emissions

Table 3.2 shows that as VMT was modelled to increase from 2005 to 2016 by 3 percent, the total GHG emissions from on-road transportation decreased by approximately 6 percent. The decrease in GHG emissions is attributed to state and federal fuel efficiency standards, low carbon fuel standards, and an increasingly efficient overall fleet of vehicles (including an increased uptake of electric, hybrid, and high efficiency vehicles) within the city that is resulting in the emissions decline, despite an increase in miles driven. Appendix A includes more detailed information about VMT and emissions factors for individual vehicle types.

Table 3.2. Total annual VMT emissions.

	2005			2016		
	Total VMT	**$MTCO_2e$/ VMT**	**Total Emissions**	**Total VMT**	**$MTCO_2e$/ VMT**	**Total Emissions**
All vehicles	480,469,285	0.000488	234,660	495,236,295	0.000447	221,750

4. Solid Waste

4.1. Solid Waste Sector Overview

This section presents the GHG emissions for the solid waste sector, specifically emissions from the disposal of solid waste produced within City limits into a landfill. This section presents the updated 2005 GHG emissions along with updated emissions for 2016.

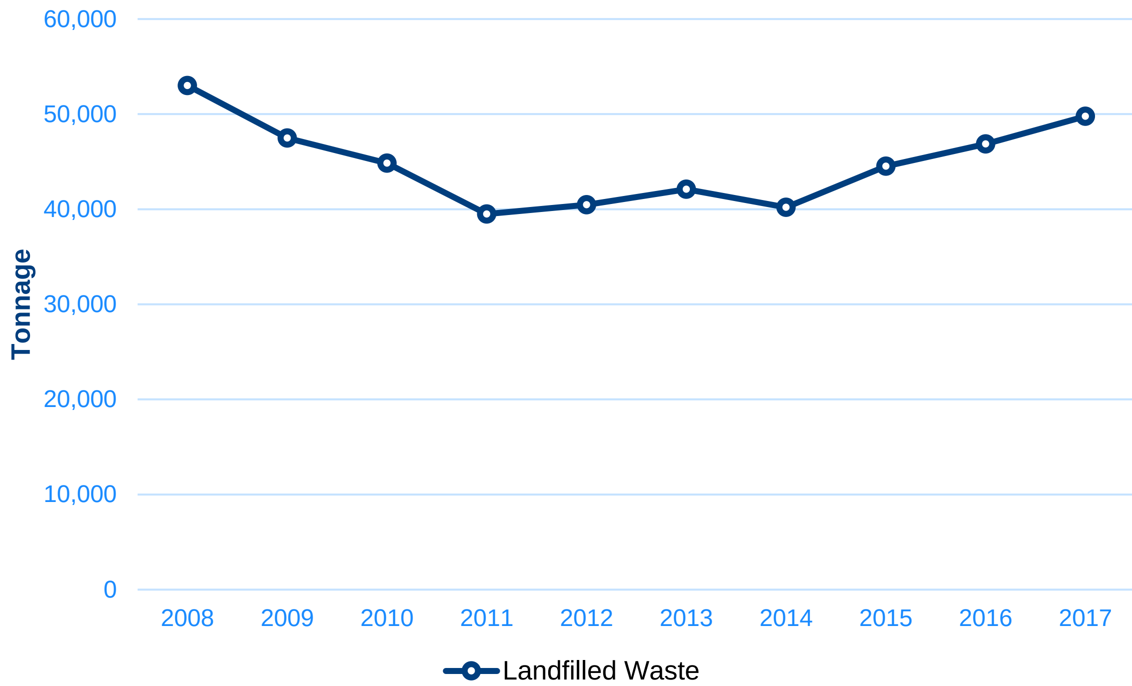
4.2. Updated Inventory Data and Methods

This section provides updated solid waste activity data for the baseline year of 2005, as well as activity emissions estimates for years 2005 through 2016 to estimate the City's total greenhouse gas emissions. The City of San Luis Obispo deposits all waste generated within city limits into the Cold Canyon Landfill. Cold Canyon Landfill provided solid waste disposal data. Table 4.1 and Figure 4.1 provide the City's solid waste disposal tonnage for 2005 to 2016. Data for 2005 to 2007 was not able to be collected; therefore 2008 data was used as a proxy.

Table 4.1. City solid waste activity data, 2008-2016 (Disposal Ton).

Year	Total Waste (Disposal Ton)
2008	53,011
2009	47,483
2010	44,836
2011	39,497
2012	40,469
2013	42,094
2014	40,200
2015	44,530
2016	46,857

Figure 4.1. Total City solid waste (Disposal Ton).



4.2.1. Green Waste

Greenwaste data was provided by the City of San Luis Obispo Utilities Department for years 2006 through 2016. Greenwaste is a part of the diverted waste stream to the Cold Canyon Landfill, which means that it is not buried at the plant and hauled to locations outside of city limits. Because the diverted waste is hauled outside of city limits, the emissions associated with greenwaste are considered to be within a different scope and boundary than what this GHG inventory is considering. For consistency with the scope and boundary of this GHG inventory, emissions from out-of-boundary waste disposal are not included in the 2005 and 2016 inventories.

4.2.2. Municipal Solid Waste GHG Emissions Conversion Factor

This inventory follows the "methane commitment method" to account for the future emissions produced from annually deposited solid waste. This method requires the following steps:

1. Estimate the percent of degradable organic materials in landfilled waste.
2. Identify the conversion factor to translate tons of carbon dioxide to metric tons of methane.
3. Estimate the amount of methane per ton of landfilled waste that will enter the atmosphere.
4. Convert the estimate of methane to carbon dioxide equivalence.

<u>1. Estimate the percent of degradable organic materials in landfilled waste.</u>

The CARB Municipal Solid Waste Characterization Landfill Tool v. 1.3 provides landfill waste characterization estimates for the amount of waste by type sent to California landfills. The waste types identified in the waste characterization studies are listed in Table 4.2. For each of these waste types, the tool includes California average estimates of the fraction of waste-in-place

(WIPFRAC), total degradable organic carbon (TDOC), and the decomposable anaerobic fraction (DANF) of the waste type. There are two relevant waste characterization studies for this inventory: one from 2003 to 2006 and the other from 2007 to the present. Table 4.2 provides information about waste characterization estimates used in this inventory, as well as the degradable organic content (DOC) percent per ton of solid waste, which is calculated by multiplying WIPFRAC, TDOC, and DANF for each waste type.

Table 4.2. Total percent of waste degradable based on waste type.

	2003-2006				2007-Present			
Waste Type	**WIPFRAC**	**TDOC**	**DANF**	**DOC**	**WIPFRAC**	**TDOC**	**DANF**	**DOC**
Newspaper	2.20%	47.09%	15.05%	0.16%	1.65%	47.09%	15.05%	0.12%
Office Paper	1.95%	38.54%	87.03%	0.65%	1.84%	38.54%	87.03%	0.62%
Corrugated Boxes	5.75%	44.84%	44.25%	1.14%	4.80%	44.84%	44.25%	0.95%
Coated Paper	11.09%	33.03%	24.31%	0.89%	8.98%	33.03%	24.31%	0.72%
Food	14.55%	14.83%	86.52%	1.87%	15.50%	14.83%	86.52%	1.99%
Grass	2.81%	13.30%	47.36%	0.18%	1.90%	13.30%	47.36%	0.12%
Leaves	1.41%	29.13%	7.30%	0.03%	3.24%	29.13%	7.30%	0.07%
Branches	2.59%	44.24%	23.14%	0.26%	1.95%	44.24%	23.14%	0.20%
Lumber	9.65%	43.00%	23.26%	0.96%	14.51%	43.00%	23.26%	1.45%
Textiles	4.44%	24.00%	50.00%	0.53%	5.47%	24.00%	50.00%	0.66%
Diapers	4.36%	24.00%	50.00%	0.52%	4.33%	24.00%	50.00%	0.52%
Construction/ Demolition	12.06%	4.00%	50.00%	0.24%	5.48%	4.00%	50.00%	0.11%
Medical Waste	0.04%	15.00%	50.00%	0.00%	0.00%	15.00%	50.00%	0.00%
Sludge/Manure	0.09%	5.00%	50.00%	0.00%	0.05%	5.00%	50.00%	0.00%

Source: CARB Municipal Solid Waste Characterization Landfill Tool v. 1.3

2. Identify the conversion factor to translate tons of carbon dioxide to metric tons of methane.

The next step in calculating the emissions factor is estimating the metric tons of methane to be generated from the organic content in the landfilled waste. Solid waste activity data is reported in tons, while the standard unit for GHG reporting is metric tons. Table 4.3 presents the conversion factors to metric tons. As the decomposing organic content in landfilled solid waste transitions from carbon to methane, the atomic mass changes as well. Since the CO_2e in this inventory is presented as mass (metric tons), this change in mass is accounted for with the stoichiometric ratio between CH_4 and carbon.

Finally, of the total landfill gas generated from decomposing waste, approximately half is methane so a methane gas fraction is applied to remove other gasses from the total. The remainder is biogenic CO_2 from vegetation from natural areas, crops, and urban vegetation and *de minimus* amounts of N_2O. The GPC advises against accounting for either of these gases in a community inventory.

Table 4.3. Conversion to metric tons of methane.

lbs/ton[1]	MT/lbs[1]	Stoichiometric ratio between CH_4 and carbon[2]	Fraction of CH_4 Gas in Landfill Gas[3]	Metric Tons of Methane
2000	0.000454	1.333333	0.5	0.604796

[1] Standard conversion factor.
[2] 16/12, provided by the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.
[3] IPCC Good Practices Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000) default range.

3. Estimate the amount of methane per ton of landfilled waste that will enter the atmosphere.

The next factor in the solid waste emissions coefficient is the amount of landfill gas that is collected by landfill gas capture systems. The San Luis Obispo County Air Pollution Control District (APCD) provides landfill capture rates for Cold Canyon Landfill, as provided in Table 4.4 for the years 2008 – 2013. The landfill capture rate for 2006 is sourced from the County of San Luis Obispo EnergyWise Plan Appendix A. Given the lack of data availability for several years, including 2005, 2007, 2014, 2015, and 2016 and the significant variability across years, this inventory relied on the EPA's standard landfill methane capture rate of 75 percent.

Table 4.4. Recorded methane capture rates from Cold Canyon Landfill.

Year	Cold Canyon
2005	Not Available
2006	60%
2007	Not Available
2008	70%
2009	99%
2010	85%
2011	85%
2012	85%
2013	75%

The next phase of the equation considers the amount of methane that is oxidized in the soil. As reported in Table 4.5, only 25 percent of landfill gas enters the atmosphere. Of that 25 percent, 10 percent is oxidized on site in the soil of the land fill cover. Of the 75 percent of the methane that is captured, approximately 99 percent enters the atmosphere as CO_2 due to the methane being combusted as part of the flaring process. Approximately 23 percent of the total methane emitted enters the atmosphere. Table 4.5 shows the factors used in this calculation.

Table 4.5. Percent of emissions reaching the atmosphere.

Fraction of methane recovered (f_{rec}) [1]	Oxidation factor (OX) [2]	Methane correction factor (MCF) [3]	Percent of Emissions Reaching Atmosphere
75%	10%	99%	23.3%

[1] Landfill gas capture rate, as provided by the Environmental Protection Agency
[2] IPCC Good Practices Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000) well-managed landfills factor.
[3] IPCC Good Practices Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000) managed landfill factor.

4. Convert the estimate of methane to carbon dioxide equivalence.

The solid waste CO_2e conversion factor was calculated by multiplying the total degradable content of each weight type (DOC), metric ton conversion factor, methane generation, and the IPCC Fifth Assessment Report methane global warming potential (Table 4.6). The factors for each waste type are then weighted by the waste composition data to obtain a single emissions factor for a ton of mixed waste. In 2005 to 2006, each ton of solid waste deposited in a landfill is estimated to produce approximately 0.293 $MTCO_2$e per ton as it degrades over time. For 2007 to 2016, the conversion factor is 0.296 $MTCO_2$e per ton of solid waste.

Table 4.6. Disposed solid waste conversion factor with Fifth Assessment Report global warming potential ($MTCO_2$e/Disposal Ton).

Waste Type	2003-2006 DOC[1]	2007-Present DOC[1]	Metric Ton (MT)	CH_4 emissions	CH_4 GWP[2]	2003-2006 $MTCO_2$e/ Ton	2007-Present $MTCO_2$e/ Ton
Newspaper	0.16%	0.12%	0.604796033	0.2325	28	0.006151	0.004606
Office Paper	0.65%	0.62%	0.604796033	0.2325	28	0.025770	0.024312
Corrugated Boxes	1.14%	0.95%	0.604796033	0.2325	28	0.044892	0.037482
Coated Paper	0.89%	0.72%	0.604796033	0.2325	28	0.035062	0.028387
Food	1.87%	1.99%	0.604796033	0.2325	28	0.073522	0.078335
Grass	0.18%	0.12%	0.604796033	0.2325	28	0.006969	0.004722
Leaves	0.03%	0.07%	0.604796033	0.2325	28	0.001176	0.002709
Branches	0.26%	0.20%	0.604796033	0.2325	28	0.010418	0.007865
Lumber	0.96%	1.45%	0.604796033	0.2325	28	0.037980	0.057146
Textiles	0.53%	0.66%	0.604796033	0.2325	28	0.020980	0.025837
Diapers	0.52%	0.52%	0.604796033	0.2325	28	0.020582	0.020455
Construction/ Demolition	0.24%	0.11%	0.604796033	0.2325	28	0.009494	0.004312
Medical Waste	0.00%	0.00%	0.604796033	0.2325	28	0.000113	0.000000
Sludge/Manure	0.00%	0.00%	0.604796033	0.2325	28	0.000089	0.000050
Total	--	--	--	--	--	**0.293**	**0.296**

Note: Values are rounded causing final values to be inconsistent with calculations.
[1] Source: CARB Municipal Solid Waste Characterization Landfill Tool v. 1.3.
[2] IPCC Fifth Assessment Report

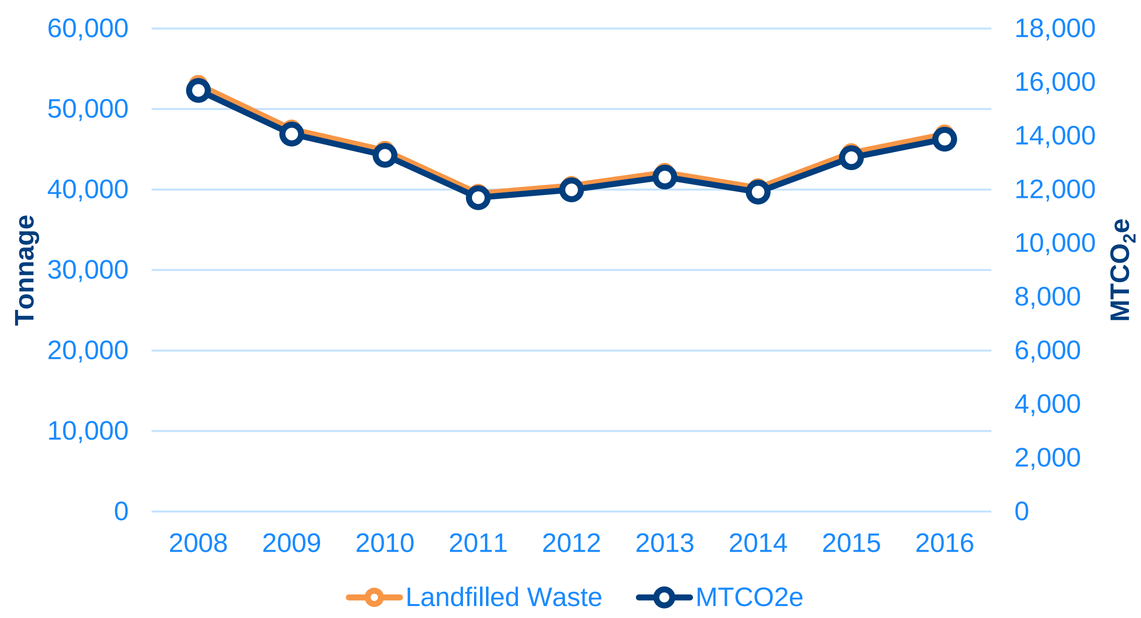
4.3. Total Solid Waste GHG Emissions

To estimate the solid waste GHG emissions, the carbon dioxide equivalency conversion factor was multiplied by the disposal ton activity data. Once these were applied, the annual solid waste disposal ton emissions were calculated. As shown in Table 4.7 and Figure 4.2, from 2005 to 2016, solid waste disposed experienced a decrease in emissions by 11 percent.

Table 4.7. Total solid waste disposed emissions ($MTCO_2e$).

Year	Total Waste (Disposal Ton)	$MTCO_2e$ Conversion Factor	Solid Waste Disposed $MTCO_2e$
2005	53,011	0.293	**15,540**
2006	53,011	0.293	**15,540**
2007	53,011	0.296	**15,700**
2008	53,011	0.296	**15,700**
2009	47,483	0.296	**14,070**
2010	44,836	0.296	**13,280**
2011	39,497	0.296	**11,700**
2012	40,469	0.296	**11,990**
2013	42,094	0.296	**12,470**
2014	40,200	0.296	**11,910**
2015	44,530	0.296	**13,190**
2016	46,857	0.296	**13,880**

Figure 4.2. Total disposed solid waste and GHG emissions ($MTCO_2e$).



5. Off-Road

5.1. Off-Road Sector Overview

This section presents the GHG emissions for off-road activity, specifically emissions from construction and lawn and garden equipment use within City limits. In this section, methods are discussed to calculate a baseline emissions inventory for 2005 along with an updated inventory year of 2016. This section concludes with the sector's total GHG emissions.

5.2. Inventory Data and Methods

To estimate emissions from off-road equipment, this sector considers emissions generated from construction and lawn and garden equipment.

Off-road emissions data for the county was gathered from the CARB OFFROAD2007 modeling tool. Table 1 provides an overview of the equipment modeled in the CARB tool. Since the CARB tool models emissions for the entire county, city specific emissions data was proportioned out using demographic housing information. Table 5.1 provides the aggregated emissions data collected and the total GHG emissions in proportion to the rest of the county.

Table 5.1. Off Road equipment.

Construction	Lawn and Garden
Tampers/Rammers, Plate Compactors, Asphalt Pavers, Rollers, Paving Equipment, Surfacing Equipment, Signal Boards, Trenchers, Bore/Drill Rigs, Concrete/Industrial Saws, Cement and Mortar Mixers, Cranes, Graders, Off-Highway Trucks, Crushing Equipment, Rough Terrain Forklifts, Rubber Tired Loaders, Rubber Tired Dozers, Tractors, Loaders, Backhoes, Crawlers, Skid Steer Loaders, Off-Highway Tractors, and Dumpers	Lawn Mowers, Chainsaws, Trimmers, Leaf Blowers, Shredders, Commercial Turf Equipment, Tillers, Rear Engine Riding Mowers, Front Mowers, Shredders, Lawn & Garden Tractors, Wood Splitters, Chippers/Stump Grinders, Commercial, Turf Equipment, Other Lawn & Garden Equipment

Source: CARB OFFROAD2007 modeling tool

Data from the OFFROAD2007 modeling tool was compiled and summed according to emission type and is presented in Table 5.2. The emissions presented in Table 5.2 are then converted to carbon dioxide equivalent by applying the most recently available global warming potential values.

Table 5.2. County off-road GHG emissions.

	2005		2016	
	Construction	Lawn and Garden	Construction	Lawn and Garden
t CO_2/day[1] (row 1)	169.033	16.805	199.982	18.189
t CH4/day[1] (row 2)	0.001	0.013	0.018	0.027
t N_2O/day[1] (row 3)	0.031	0.032	0.001	0.012
t CO_2e/day[2] (row 4)	177.315	25.871	200.781	22.093

t CO_2e/year (row 5)	64,716.466	9,442.729	73,285.229	8,064.056
$MTCO_2$e/year[3] (row 6)	58,710.393	8,566.387	66,483.924	7,315.663

[1] CARB OFFROAD2007 modeling tool
[2] Sum of rows 1-3, with row 2 multiplied by the CH_4 GWP value of 28 and row 3 multiplied by the GWP value of 265 (IPCC Fifth Assessment Report)
[3] Conversion from tons to metric tons

To estimate the emissions occurring in the city an adjustment factor was applied to the final $MTCO_2$e estimates in Table 5.3. The adjustment factor used for construction equipment was 15.79 percent for 2005 and 10.47 percent for 2016. The adjustment factor use for lawn and garden equipment was 18.02 percent for 2005 and 17.41 percent for 2016. These adjustment factors represent the proportion of new households in the city relative to the county as a whole. Table 5.3 provides the adjustment factor applied to the total yearly $MTCO_2$e of the county.

Table 5.3. City off-road GHG emissions.

	2005			2016		
	$MTCO_2$e	**% of City[1]**	**Total $MTCO_2$e**	**$MTCO_2$e[1]**	**% of Unincorporated County[1]**	**Total $MTCO_2$e[3,5]**
Construction	58,710	15.79%	9,270	66,484	10.47%	6,960
Lawn and Garden	8,566	18.02%	1,540	7,316	17.41%	1,270
Total	**--**	**--**	**10,810**	**--**	**--**	**8,230**

[1] Proportion of unincorporated county households to number of total county households

5.3. Total Off-Road GHG Emissions

From 2005 to 2016, the City of San Luis Obispo experienced a 24 percent decrease in emissions from lawn and garden and construction equipment (Table 5.4). This significant decrease in emissions from 2005 and 2016 is likely due to the lack of building construction activity that took place during this time period. As new construction projects decreased, there were less greenhouse gases emitted from off-road equipment use.

Table 5.4. Total GHG estimates from off-road use.

	2005	**2016**
Construction and Mining Equipment	9,270	6,960
Lawn and Garden Equipment	1,540	1,270
Total	**10,810**	**8,230**

6. Forecast

The GHG emissions forecast estimates how San Luis Obispo's emissions would change over time if no action were taken to reduce emissions. The forecast is based on changes to the number of people who live and work in San Luis Obispo. As the population grows and more people work in the community, there will be an increase (absent state or local action) in the amount of energy used, vehicle miles traveled, trash thrown away, and other activities that generate GHG emissions. In keeping with best practice, the draft forecast assumes that the per-capita GHGs remain constant at 2016 levels, so the change in emissions is driven by demographic changes.

The demographic projections used in the forecast come from the Land Use and Circulation Element of the City's General Plan, which guides long-term growth and development in the community. These projections assume that the development anticipated in the Land Use and Circulation is fully implemented by 2035. It is assumed that jobs in San Luis Obispo County increase at a rate of 1.1 percent, as forecasted in the Land Use and Circulation Element, starting from the number of jobs in the community in 2015 as reported by the US Census. Table 6.1 shows the demographic changes assumed in the forecast and their applicable subsectors.

Table 6.1. Demographic projections (2005-2035).

Demographic Indicator	Applicable Subsectors	2005	2016	2020	2030	2035
Population	None	44,519	46,117	48,826	53,934	56,686
Housing units	Residential electricity, residential natural gas, lawn and garden equipment	20,391	21,155	22,190	24,512	25,762
Jobs [1]	Commercial/industrial electricity, commercial/industrial natural gas	43,847	50,985	53,153	59,723	63,199
Service population [2]	On-road transportation, community-wide MSW disposal	66,779	71,610	74,253	83,430	88,286

[1] Future job numbers assume a 1.1 percent increase in the number of jobs relative to 2015 levels.
[2] Per the method used by the San Luis Obispo Community Development Department, service population is equal to the residential population plus ½ the number of jobs.
Sources: City of San Luis Obispo Land Use and Circulation Element, City of San Luis Obispo Community Development Department, Economics & Planning Systems, US Census Bureau.

This forecast holds emissions from construction equipment constant at 2016 levels. This approach helps eliminate uncertainty in future emissions, since the specific timing of construction activities depends on a number of difficult-to-predict factors, including local and larger-scale economic conditions. Keeping construction emissions constant is consistent with the expectation that San Luis Obispo will continue to grow at a steady and managed rate.

Based on the results of the forecast, emissions are expected to rise from 340,850 $MTCO_2e$ in 2016 to 372,980 $MTCO_2e$ in 2020, 412,320 $MTCO_2e$ in 2030, and 436,380 $MTCO_2e$ in 2035. Table 6.2 shows the forecasted emission levels for each sector for future years.

Table 6.2. Forecasted GHG emissions, 2005-2035 ($MTCO_2e$).

Sector	2005	2016	2020	2030	2035	Percent Change (2005-2035)
Transportation	234,660	221,750	229,940	258,350	273,390	16.4%
Nonresidential Energy	57,800	53,410	55,680	62,560	66,200	14.5%
Residential Energy	55,190	43,580	45,710	50,500	53,070	-3.8%
Solid Waste	15,540	13,880	14,390	16,170	17,110	10.1%
Off-Road	10,810	8,230	27,260	24,740	26,600	146.1%
Total	374,000	340,850	372,980	412,320	436,380	16.7%
Change from 2005	**-**	**-10.2%**	**0.27%**	**10.3%**	**16.7%**	**-**

The forecast acts as a "worst case" set of projections, forecasting what San Luis Obispo's GHG emissions would be like if there were no programs in place to reduce emissions. Since there are already such programs in place, it should not be thought of as a realistic projection of future emissions. By showing this "worst case", the City can better show the effect of existing and planned actions, including policies adopted by the State of California.

There are three major policies that the State has adopted to reduce GHG emissions at the local level:

- Renewables Portfolio Standard (RPS) and Community Choice Energy (CCE) participation: This law requires that electrical providers supply an increased amount of their electricity from eligible renewable sources. At time of writing, a bill to revise the RPS (SB 100), has been passed by the California Legislature and signed by Governor Brown requiring that 33% of the electricity sold by a provider by 2020 be renewable, that 60% of electricity be renewable by 2030, and that 100% of all electricity must be carbon-free (although not necessarily renewable) by 2045. This analysis assumes that SB 100 fully implemented. Additionally, in December of 2018, the City of San Luis Obispo joined Monterey Bay Community Power (MBCP), a community choice energy program. Beginning in January of 2020, MBCP will be providing carbon free electricity to the community. This forecast assumes that 2.7 percent of residential and nonresidential load will opt to remain with PG&E.
- Title 24: This set of standards governs how new buildings must be constructed, including specifying minimum energy efficiency requirements. The standards are updated every three years to be more stringent. California's zero net energy (ZNE) standards are included in Title 24.
- Clean Car Standards: These standards require that cars sold in California meet minimum fuel efficiency requirements, and that vehicle and equipment fuel sold in the state emit less GHGs during production and use.

The City has calculated the effect of these three policies on San Luis Obispo's emissions. Table 6.3 provides the anticipated reductions in future years from these three polices.

Table 6.3. GHG reductions from state policies ($MTCO_2e$)

State Policy	2020	2030	2035
RPS (including SB 100) and CCE	-46,760	-52,490	-55,430
Title 24	-80	-1,620	-3,010
Clean Car Standards (on-road vehicles)	-26,010	-92,880	-112,230
Total reductions	-72,850	-146,990	-170,670

With these three policies in place, San Luis Obispo's future GHG emissions are expected to be substantially lower than the previously forecasted emissions. Emissions in 2020 are projected to be 300,140 $MTCO_2e$ (19.7 percent below 2005 levels), and in 2030 are expected to be at 265,330 $MTCO_2e$ (29.1 percent below 2005 levels). In 2035, emissions with state policies in place are expected to be at 265,700 $MTCO_2e$, or 29.0 percent below 2005 levels.

Table 6.4 shows future GHG emissions with state reduction policies in place.

Table 6.4 Forecasted GHG emissions with state reductions, 2005-2050 ($MTCO_2e$).

Sector	2005	2016	2020	2030	2035	Percent Change (2005-2035)
Transportation	234,660	221,750	203,930	165,470	161,160	-31.3%
Nonresidential Energy	57,800	53,410	23,880	26,420	27,700	-52.1%
Residential Energy	55,190	43,580	30,680	32,530	33,130	-40.0%
Solid Waste	15,540	13,880	14,390	16,170	17,110	10.1%
Off-Road	10,810	8,230	27,260	24,740	26,600	146.1%
Total	**374,000**	**340,850**	**300,140**	**265,330**	**265,700**	**-29.0%**
Change from 2005	-	-8.9%	-19.7%	-29.1%	-29.0%	-

7. Areas for Improvement

A greenhouse gas emissions inventory is only a partial snapshot of the total emissions occurring in a community. The report as presented includes emissions sectors and categories as required by global accounting protocol and represent those sectors that have defensible and transparent methods and data. As the City continues its path of climate action toward carbon neutrality, the following areas for improvement will be closely monitored:

- Energy in Water – The inventory presented in this report includes the energy required to move and treat water in the city. However, it does not estimate emissions from the conveyance of water from outside city limits to the city. Future inventories should identify a defensible method to account for these emissions.

- Green Waste – All of the organic waste that is collected in the city is processed by an anerobic digester that yields clean electricity and compost. Previously, the community's green waste was trucked to a wind row composting facility in Santa Maria, CA or landfilled at Cold Canyon Landfill. The new approach is certainly reducing community emissions. However, there are no available defensible methods for estimating emissions from wind row composting, and therefore, no way to establish a baseline emissions level. The City will continue to monitor GPC work on composting methods and will include as a sector when available.

- Wastewater - The GPC requires local governments to account for direct process emissions that occur from the treatment of wastewater. It is known that the treatment of wastewater can release Nitrous Oxide and Methane, both of which are powerful greenhouse gases. Although the GPC provides accounting methods for estimating the direct release of emissions, an accounting protocol does not exist for the specific treatment type that occurs at the San Luis Obispo Water Resource Recovery Facility (nitrification, but no denitrification). Using an unvetted method, the City estimates these direct emissions to be approximately 200 MTCO2e per year. Given the small size, this sector is not critical for planning purposes, but will be included when future updates to the GPC provide a defensible accounting method.

- Carbon Stocks and Sequestration – Greenhouse gas inventories do not need to evaluate existing carbon stocks or potential for sequestration, but these analysis can help the CIty understand how to better account for the existing value of these stocks and credit actions in the future that either preserve or enhance the amount of sequestered carbon. Sequestration, if included at all, is typically included in greenhouse gas inventories as an Given the amount of land area in the General Plan Conservation/Open Space, estimating the forestry and carbon stocks will be a meaningful part of a future inventory. As with the wastewater issue mentioned above, the City will monitor GPC updates for defensible accounting methods. Beyond that, the City is working with the cities of Vancouver B.C., San Francisco, and Boulder, CO to develop a tool for estimating emissions from carbon stocks and sequestration potential.

- Fugitive Methane – From the well head to the appliance, methane leaks directly into the atmosphere as the result of natural gas development and transmission. Some estimates of total system leakage are high enough to make natural gas consumption as bad a climate polluter as coal. A common protocol for amending the natural gas emissions coefficient to account for this leakage is not available. The City will consider updating the coefficient in future years when such information is vetted and available.

- Consumption - The inventory does not include the emissions that result from community consumption (e.g., consumption of food, clothing, packaging, etc). Given the City's intent to work closely with the community in developing and implementing the climate action plan, it is important to recognize the greenhouse gas impacts created by the purchase and disposal of products and materials. Global climate action leadership cities are working on developing a standard protocol for inventorying consumption-based emissions. As with the other items in this section, the City will seek to include the sector when such a protocol is available. It should be noted that emissions from consumption may be significant, some cities estimate that consumption emissions increase their total inventoried emissions by more than 40 percent.

List of Abbreviations

AB: Assembly Bill

ADT: Average daily trips

APCD: Air Pollution Control District

Caltrans: California Department of Transportation

CAP: Climate Action Plan

CARB: California Air Resources Board

CH_4: Methane

CO_2: Carbon dioxide

CO_2e: Carbon dioxide equivalent

DANF: Decomposable anaerobic fraction

DOC: Degradable organic content

EPA: US Environmental Protection Agency

GHG: Greenhouse gas

IPCC: Intergovernmental Panel on Climate Change

kW: Kilowatt

kWh: Kilowatt-hour

LGOP: Local Government Operations Protocol

MSW: Municipal solid waste

$MTCO_2e$: Metric tons of carbon dioxide equivalent

N_2O: Nitrous oxide

PG&E: Pacific Gas & Electric Company

RPS: Renewables Portfolio Standard

SB: Senate Bill

TDOC: Total degradable organic carbon

VMT: Vehicle miles traveled

WIPFRAC: Fraction of waste in place

WRRF: Water Resource Recovery Facility

ZNE: Zero net energy

Appendix A

As described in the main body of this report, the City used the California Air Resources Board's EMFAC 2014 model to determine county-wide VMT and CO_2 emissions for 2005 and 2016. Table A.1 shows the county-wide numbers from the EMFAC 2014 model.

Table A.1: County of San Luis Obispo 2005 and 2016 EMFAC aggregated data.

	2005			2016		
Vehicle Class	**County VMT**	**% VMT of County**	**CO_2 (Ton)**	**VMT**	**% VMT of County**	**CO_2 (Ton)**
All Other Buses	5,796	0.07%	8	7,987	0.10%	11
LDA	4,029,232	46.73%	1,431	4,293,311	51.58%	1,404
LDT1	377,679	4.38%	157	331,725	3.99%	128
LDT2	1,789,539	20.75%	880	1,664,158	19.99%	751
LHD1	543,694	6.31%	435	353,435	4.25%	274
LHD2	84,062	0.97%	70	80,207	0.96%	65
MCY	53,994	0.63%	9	53,227	0.64%	9
MDV	1,417,007	16.43%	865	1,219,021	14.64%	714
MH	31,041	0.36%	44	19,918	0.24%	28
Motorcoach	2,759	0.03%	5	2,870	0.03%	6
OBUS	6,438	0.07%	9	10,023	0.12%	14
PTO	4,602	0.05%	12	4,295	0.05%	11
SBUS	6,889	0.08%	8	7,079	0.09%	9
T6	117,434	1.36%	159	114,479	1.38%	155
T7	141,272	1.64%	290	150,263	1.81%	295
UBUS	11,346	0.13%	28	11,961	0.14%	29
Total	**8,622,783**	**100.00%**	**4,410**	**8,323,959**	**100.00%**	**3,903**

The City applied the percent of VMT by vehicle type for the County to the City's VMT, resulting in estimated VMT for the City of San Luis Obispo by vehicle type. Table A.2 shows these numbers.

Table A.2. Annual City VMT estimates.

	2005		2016	
Vehicle Class	**% VMT of County**	**Total VMT**	**% VMT of County**	**Total VMT**
All Other Buses	0.07%	322,934	0.10%	475,202
LDA	46.73%	224,512,443	51.58%	255,431,744
LDT1	4.38%	21,044,625	3.99%	19,736,094
LDT2	20.75%	99,714,752	19.99%	99,009,564
LHD1	6.31%	30,295,101	4.25%	21,027,726
LHD2	0.97%	4,684,022	0.96%	4,771,928
MCY	0.63%	3,008,597	0.64%	3,166,766
MDV	16.43%	78,956,887	14.64%	72,526,011
MH	0.36%	1,729,653	0.24%	1,185,035
Motorcoach	0.03%	153,751	0.03%	170,739
OBUS	0.07%	358,717	0.12%	596,298
PTO	0.05%	256,446	0.05%	255,527
SBUS	0.08%	383,843	0.09%	421,161
T6	1.36%	6,543,538	1.38%	6,810,943
T7	1.64%	7,871,781	1.81%	8,939,945
UBUS	0.13%	632,194	0.14%	711,612
Total	100.00%	**480,469,285**	100.00%	**495,236,295**

The City used the results of the EMFAC model to determine the tons of CO_2/VMT for each vehicle type, and combined these individual emissions factors to prepare a weighted average CO_2/VMT emissions factor that reflects the specific mix of vehicles in San Luis Obispo County. The City next converted the tons of CO_2/VMT to metric tons of CO_2e/VMT, using industry-standard figures, and applied this emissions factor to the total City VMT to calculate total emissions. Table A.3 shows San Luis Obispo's VMT, emissions factors, and total emissions by individual vehicle type.

Table A.3. Total annual VMT emissions.

	2005			2016		
Vehicle Class	Total VMT	$MTCO_2e$/ VMT	Total Emissions	Total VMT	$MTCO_2e$/ VMT	Total Emissions
All Other Buses	322,934	0.001275	410	475,202	0.001312	620
LDA	224,512,443	0.000339	76,120	255,431,744	0.000312	79,780
LDT1	21,044,625	0.000396	8,340	19,736,094	0.000369	7,290
LDT2	99,714,752	0.000470	46,840	99,009,564	0.000431	42,660
LHD1	30,295,101	0.000765	23,170	21,027,726	0.000741	15,590
LHD2	4,684,022	0.000799	3,740	4,771,928	0.000774	3,690
MCY	3,008,597	0.000154	460	3,166,766	0.000167	530
MDV	78,956,887	0.000583	46,010	72,526,011	0.000559	40,550
MH	1,729,653	0.001349	2,330	1,185,035	0.001322	1,570
Motorcoach	153,751	0.001890	290	170,739	0.001888	320
OBUS	358,717	0.001382	500	596,298	0.001373	820
PTO	256,446	0.002420	620	255,527	0.002398	610
SBUS	383,843	0.001136	440	421,161	0.001162	490
T6	6,543,538	0.001291	8,450	6,810,943	0.001295	8,820
T7	7,871,781	0.001962	15,440	8,939,945	0.001876	16,780
UBUS	632,194	0.002365	1,500	711,612	0.002291	1,630
Total	480,469,285	--	**234,660**	495,236,295	--	**221,750**