

# City of Chico, CA

## Community-Wide Greenhouse Gas Emissions Inventory

### 2005 - 2012

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Prepared by the Institute for Sustainable Development at California State University, Chico  
Summer 2015



#### **ABSTRACT**

This report summarizes results of a high-level community-wide greenhouse gas emissions inventory for the years 2005 – 2012. Its results include emissions from the Transportation, Energy and Waste Sectors across the City of Chico Urban Area.

## ACKNOWLEDGEMENTS

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## SECTION I: EXECUTIVE SUMMARY

### I.I CITY OF CHICO GREENHOUSE GAS EMISSIONS TRACKING

The City of Chico has an adopted Climate Action Plan (CAP) that outlines strategies, organized within a flexible ten-year framework, for a significant reduction of greenhouse gas (GHG) emissions that are directly and indirectly generated by local activities. The CAP includes actions to reduce transportation fuel, energy and water consumption, and to reduce waste sent to the landfill. CAP implementation is intended to help the City achieve its GHG reduction goal of 25% below 2005 emission levels by the end of 2020.

A key facet of CAP implementation is evaluating progress towards meeting the GHG reduction goal. To help gauge success in achieving the City's GHG reduction goal, a community-wide GHG emission indicator has been developed that will be evaluated on an annual basis. The indicator is a combination of estimates of GHG emissions associated with activity in three Sectors – Energy, Transportation and Waste – and includes primary data from seven Sub-Sectors: community-wide sales of gasoline and diesel fuel, commercial and residential electricity use, natural gas consumption, and tonnage of waste sent to the landfill.

Emissions factors (EF) used to convert the primary inputs (i.e., gallons of fuel, kWh's of electricity, therms of natural gas, tonnage of waste) into estimates of metric tons of carbon dioxide equivalent emissions (MT CO<sub>2</sub>e – the standard metric for measuring GHG emissions) are based on established and best available data. With the exception of the EF for electricity, which is based on current utility grid mix, the factors do not change year-to-year. The methodology used in this inventory is intended to be transparent, consistent, and easily replicable. It was designed to establish a mechanism for the City to capture a high-level estimate of community-wide GHG emissions on an annual basis with limited data gathering and analysis required.

### I.II COMMUNITY-WIDE GHG EMISSIONS OVERVIEW 2005 - 2012

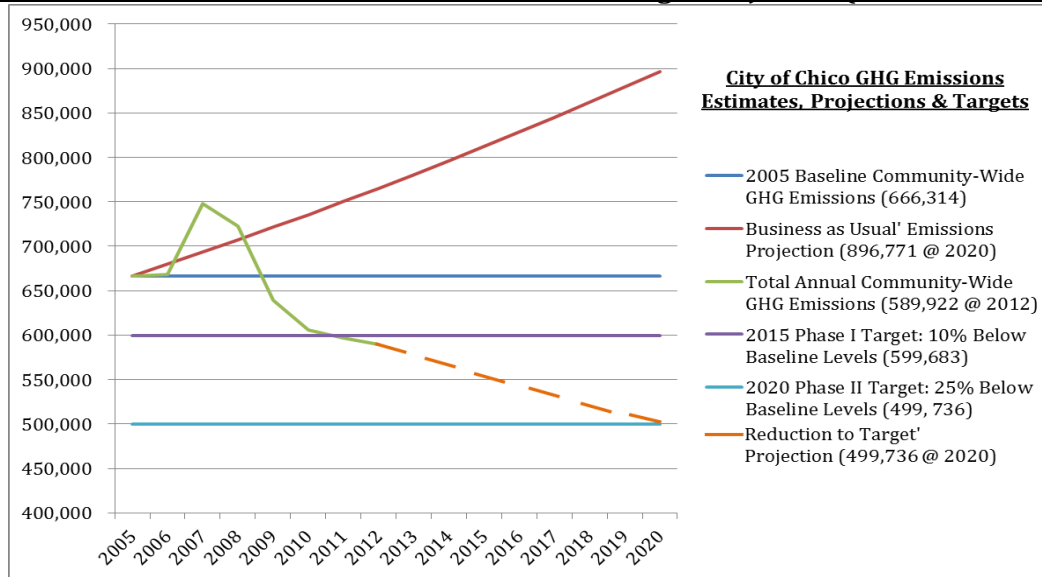
During the eight year period covered in this inventory community-wide GHG emissions decreased by 11.5% - from 666,314 MT CO<sub>2</sub>e in 2005 to 589,922 MT CO<sub>2</sub>e in 2012. Of the seven Sub-Sectors included in the inventory scope, four – gasoline, diesel fuel, commercial natural gas and waste to landfill – saw decreases in emissions while the other three – residential natural gas, residential electricity and commercial electricity – saw increases in emissions.

**Figure 1**, on the following page, illustrates this reduction in the context of a number of other key emissions estimates. These include a 'Business as Usual' emissions projection made from the 2005 base year at a 2% annual aggregate growth rate, the CAP's 2015 target emissions level of 10% below 2005 baseline levels and 2020 target of 25% below 2005 baseline levels, and a 'Reduction to Target' emissions projection made from 2012 levels to the 2020 target level. The results of this inventory show 2012 total emissions levels are slightly below the 2015 interim target level, however, a continuation of that trend is uncertain.

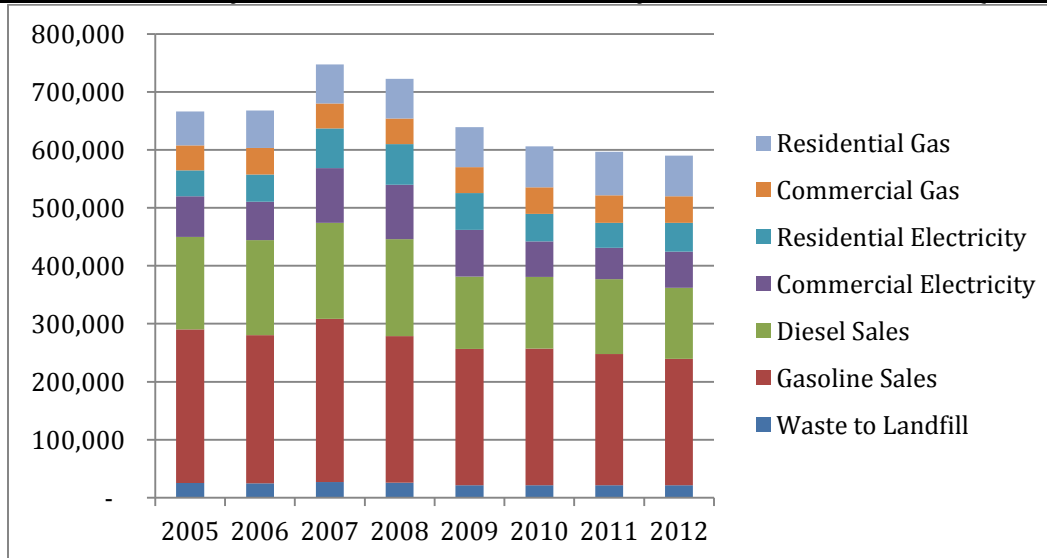
**Figure 2**, on the following page, shows annual emissions levels by contributing Sub-Sector. While total emissions decreased by 11.5% between 2005 and 2012 the relative contribution of each Sub-Sector did not change significantly and has generally trended in the same direction as net emissions from the Sub-Sector. Emissions from the Transportation Sector – both gasoline and diesel fuel – make by far the biggest contribution to aggregate emissions levels: 63.7% in 2005 and 57.7% in 2012. Emissions from the Energy Sector – commercial and residential electricity and natural gas – comprised 32.6% of the total in 2005 and 38.7% in 2012. The contribution of the Waste Sector to aggregate emissions levels remains below 4%.

**Table 1**, on the following page, shows total change in GHG emissions by Sub-Sector from 2005 – 2012.

**Figure 1 - 2005 Baseline, Business As Usual Projection, CAP Targets, Annual GHG Emissions Estimates and Reduction to Target Projection (all values MT CO<sub>2</sub>e)**



**Figure 2 - Community-Wide GHG Emissions, Totals by Sub-Sector, 2005 - 2012 (MT CO<sub>2</sub>e)**



**Table 1 - % Change in GHG Emissions Levels by Sub-Sector 2005 - 2012**

Sector	Sub-Sector	% Change in GHG Emissions 2005-'12
Transportation	Gasoline Sales	-17.7%
	Diesel Fuel Sales	-23.3%
Energy	Residential Natural Gas	+19.9%
	Commercial Natural Gas	+6.0%
	Residential Electricity	+10.2%
	Commercial Electricity	-10.6%
Waste	Waste to Landfill	-15.2%

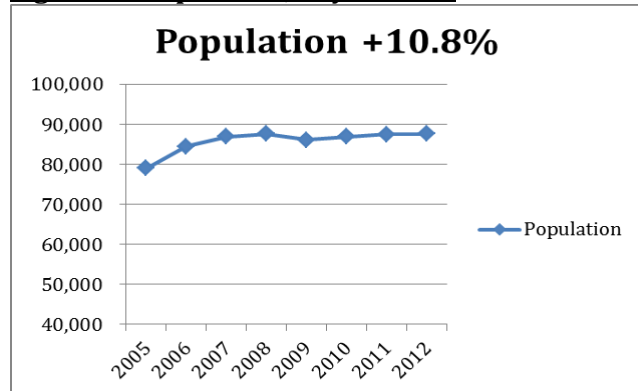
### I.III CITY OF CHICO GREENHOUSE GAS EMISSIONS IN CONTEXT

In considering community-wide GHG emissions levels and comparing them year to year it is useful to contextualize them, both in terms of population growth and economic activity. In **Table 2** and **Figures 3-6** below, population, sales tax revenue, and annual GHG emissions from the 2005 base year to 2012 are provided for additional context. Between 2005 and 2012 the population of the City of Chico increased by 10.8% - from 79,091 to 87,671 residents. Some of this increase, particularly during 2005-2007 was the result of City annexation of residential County areas. Per capita GHG emissions over that time decreased by 20.1% - from 8.42 to 6.73 MT CO<sub>2</sub>e / person. Over the same time period local sales tax revenues decreased substantially - in line with the global economic recession - but have mostly recovered. The net decrease between 2005 and 2012 was 2.2%. Emissions per dollar of sales tax revenue decreased by 9.5% over that time - from 0.0382 to 0.0346 MT CO<sub>2</sub>e / \$.

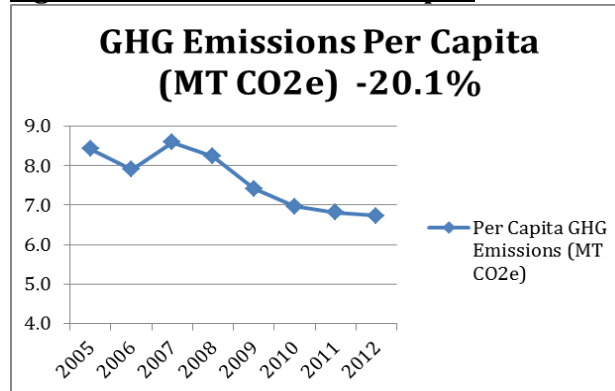
**Table 2 – Total Annual Community-Wide GHG Emissions, Population and Sales Tax Revenue 2005 - 2012**

Year	2005	2006	2007	2008	2009	2010	2011	2012	% +/- '05-'12
Total Annual Community-Wide GHG Emissions (MT CO <sub>2</sub> e)	666,314	668,113	747,630	722,321	639,134	605,795	596,731	589,922	-11.5%
Population	79,091	84,491	86,949	87,637	86,103	86,900	87,500	87,671	10.8%
GHG Emissions Per Capita	8.42	7.91	8.60	8.24	7.42	6.97	6.82	6.73	-20.1%
City Sales Tax Revenue	\$17.4 M	\$17.1 M	\$16.4 M	\$14.4 M	\$14.2 M	\$14.8 M	\$16.5 M	\$17.0 M	-2.2%
GHG Emissions Per \$ STR	0.0382	0.0390	0.0457	0.0502	0.0451	0.0409	0.0362	0.0346	-9.5%

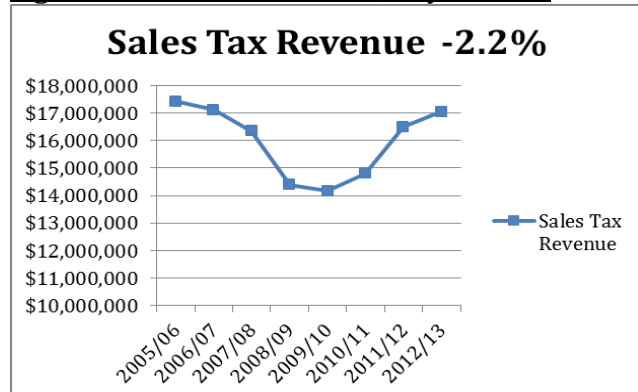
**Figure 3 – Population, City of Chico**



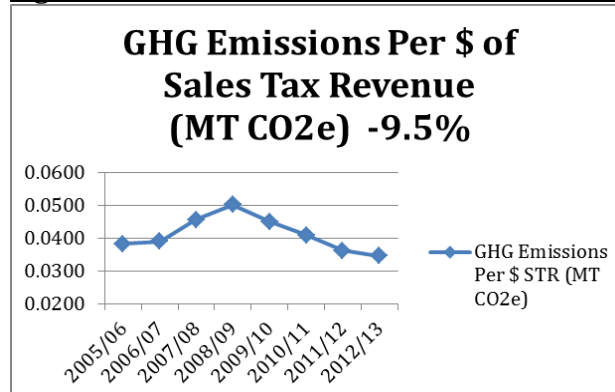
**Figure 4 – GHG Emissions Per Capita**



**Figure 5 – Sales Tax Revenue, City of Chico**



**Figure 6 – GHG Emissions Per Dollar of Sales Tax**



## SECTION II: METHODOLOGY & RESULTS

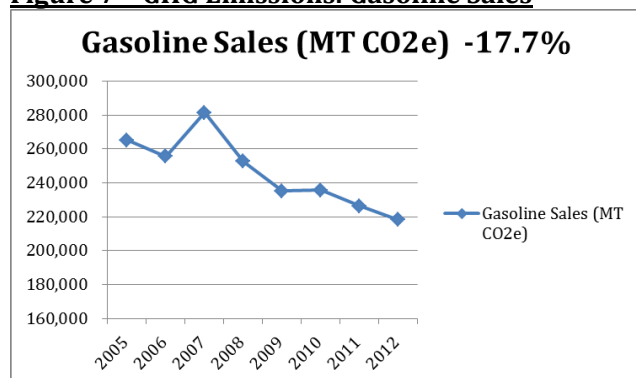
This section provides an overview of the inventory inputs and results by Sector and Sub-Sector, including data sources for primary form inputs and emissions factors used in calculations. It also includes a statement on the gross change in emissions for each Sub-Sector compared to the total net change in emissions levels and on the relative contribution of each to total emissions levels. The scope of the data collected for each Sub-Sector is the City of Chico. A full list of annual emissions estimates for each Sub-Sector in each year from 2005 – 2012 can be found in **Appendix A-3**.

### II.I TRANSPORTATION SECTOR – GASOLINE & DIESEL FUEL SALES

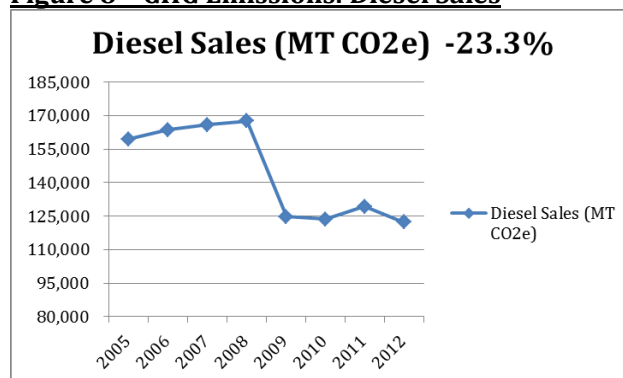
Between 2005 and 2012 annual gasoline sales by volume within the City of Chico decreased by 17.7%. This resulted in a gross decrease in GHG emissions of 37,149 MT CO<sub>2</sub>e – out of a net decrease of community-wide GHG emissions levels of 76,392 MT CO<sub>2</sub>e. This was the second largest decrease of any Sub-Sector over that time period. Gasoline consumption generated 39.8% of total community-wide GHG emissions during the base year of 2005 and 37.0% of the total in 2012. **Figure 7** below shows estimates of annual GHG emissions generated by gasoline consumption community-wide from 2005 – 2012.

Over the same time period annual diesel fuel sales by volume within the City of Chico decreased by 23.3%. This resulted in a gross decrease in GHG emissions of 46,875 MT CO<sub>2</sub>e – the single largest decrease of any Sub-Sector over that time period. Diesel fuel consumption generated 23.9% of total community-wide GHG emissions during the base year of 2005 and 20.7% of the total in 2012. **Figure 8** below shows estimates of annual GHG emissions generated by diesel fuel consumption community-wide from 2005 – 2012.

**Figure 7 – GHG Emissions: Gasoline Sales**



**Figure 8 – GHG Emissions: Diesel Sales**



Primary Input Data Source: Tax Analysis Section of the CA State Board of Equalization  
For primary input data by year see **Appendix A-1**

Emissions Factor Source: EPA's Emissions Factors for Greenhouse Gas Inventories (updated 4/2014)  
For emissions factor values see **Appendix A-2a**

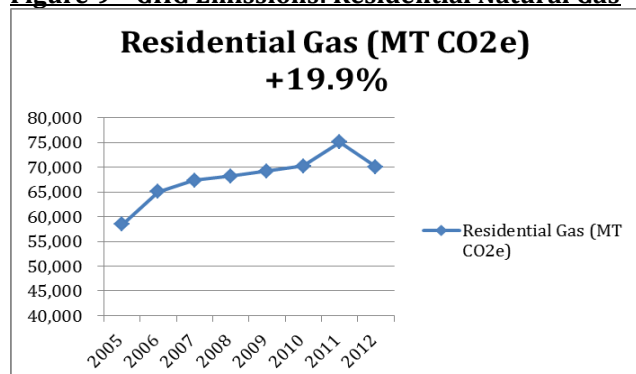


## II.II ENERGY SECTOR – RESIDENTIAL & COMMERCIAL NATURAL GAS

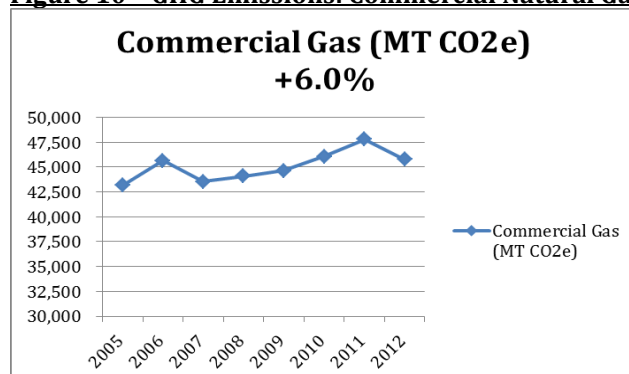
Between 2005 and 2012 annual residential natural gas consumption within the City of Chico increased by 19.9%. This resulted in a gross increase in GHG emissions of 11,652 MT CO<sub>2</sub>e – compared to a net decrease of community-wide GHG emissions levels of 76,392 MT CO<sub>2</sub>e. This was the single largest increase of any Sub-Sector over that time period. Residential natural gas consumption generated 8.8% of total community-wide GHG emissions during the base year of 2005 and 11.9% of the total in 2012. **Figure 9** below shows estimates of annual GHG emissions generated by residential natural gas consumption community-wide from 2005 – 2012.

Over the same time period annual commercial natural gas consumption within the City of Chico increased by 6.0%. This resulted in a gross increase in GHG emissions of 2,594 MT CO<sub>2</sub>e. This Sub-Sector generated 6.5% of total community-wide GHG emissions during the base year of 2005 and 7.8% of the total in 2012. **Figure 10** below shows estimates of annual GHG emissions generated by residential natural gas consumption community-wide from 2005 – 2012.

**Figure 9 – GHG Emissions: Residential Natural Gas**



**Figure 10 – GHG Emissions: Commercial Natural Gas**



Primary Input Data Source: Incorporated City of Chico PG&E Energy Overview 2005 – 2012  
For primary input data by year see **Appendix A-1**

Emissions Factor Source: PG&E's *City of Chico Community Energy Use & GHG Data*  
For emissions factor values see **Appendix A-2a**

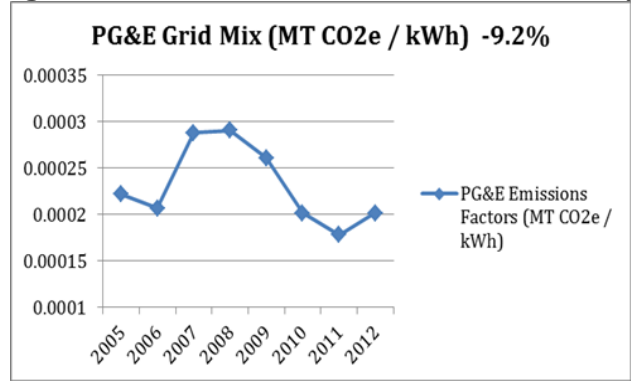


# II.III ENERGY SECTOR – UTILITY GRID MIX & ELECTRICITY EMISSIONS FACTORS

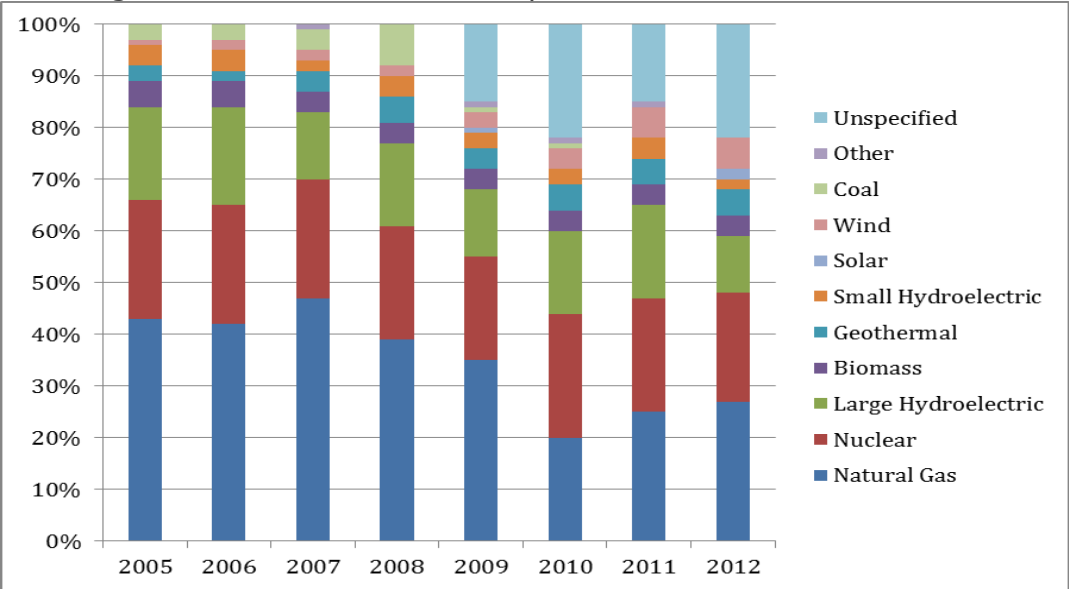
The emissions factors used for converting kilowatt hours (kWh) of electricity consumption into an estimate of MT CO<sub>2</sub>e were provided by *Pacific Gas & Electric's Community Energy Use and GHG Data Report*. These factors change year-to-year based on the makeup of PG&E's grid mix – the annual total of the different types of electricity generation that the utility uses. **Figure 11** below shows PG&E's emissions factors for electricity from 2005 – 2012. GHG emissions associated with PG&E's grid mix decreased by 9.2% over this time period.

**Figure 12** below shows the makeup of PG&E's grid mix, or 'power content label' by year from 2005 – 2012. Over that time period the largest changes to PG&E's grid mix have come in the form of decreased reliance on natural gas and increased reliance on 'unspecified' purchases – electricity generated by another party that is not traceable to specific generation sources by an auditable contract trail. Changes to the annual contribution of nuclear have been minimal; the contribution of large hydroelectric, however, PG&E's other large-scale generation source, have been decreasing and will continue to decrease in subsequent years. Contributions of biomass, geothermal, solar and wind in aggregate have increased from 12% to 19%. Contributions from coal have decreased from between 3% and 8% annually to 0%.

**Figure 11 – PG&E Emissions Factors for Electricity**



**Figure 12 – PG&E Annual Grid Mix / Power Content Label 2005 – 2012**

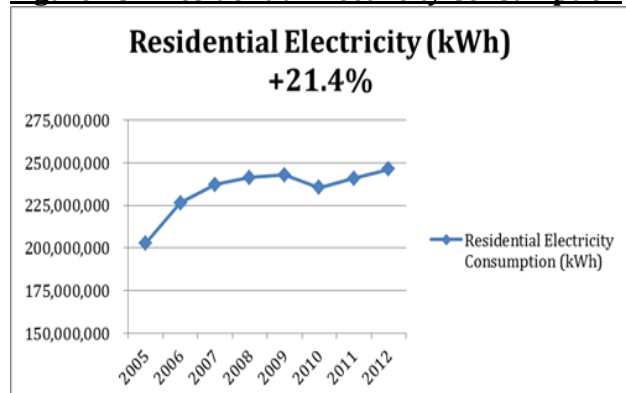


## II.IV ENERGY SECTOR – RESIDENTIAL & COMMERCIAL ELECTRICITY

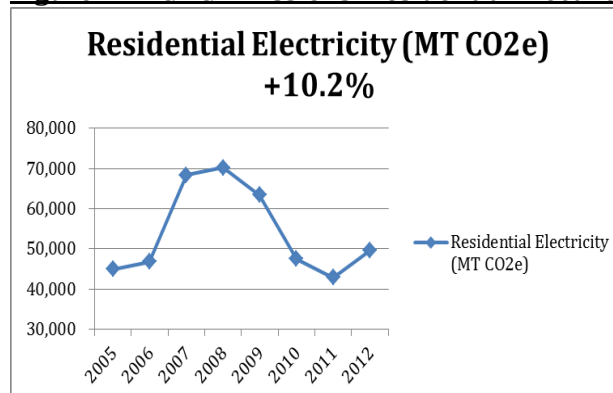
Between 2005 and 2012 annual residential electricity consumption within the City of Chico increased by 21.4%. Over this same period, however, due to changes in PG&E's grid mix, total GHG emissions associated with residential electricity usage increased by only 10.2%. This correlates to a gross increase in GHG emissions of 4,589 MT CO<sub>2</sub>e – compared to a net decrease of community-wide GHG emissions levels of 76,392 MT CO<sub>2</sub>e. This was the second largest increase of any Sub-Sector over that time period. Residential electricity consumption generated 6.8% of total community-wide GHG emissions during the base year of 2005 and 8.4% of the total in 2012. **Figure 13** below shows total annual community-wide residential electricity consumption from 2005 – 2012. **Figure 14** below shows estimates of annual GHG emissions associated with residential electricity consumption community-wide from 2005 – 2012.

Between 2005 and 2012 annual commercial electricity consumption within the City of Chico decreased by 1.5%, however, again due to changes in PG&E's grid mix, total GHG emissions associated with commercial electricity usage decreased by 10.6%. This correlates to a gross decrease in GHG emissions of 7,399 MT CO<sub>2</sub>e. This Sub-Sector generated 10.5% of total community-wide GHG emissions during the base year of 2005 and 10.6% of the total in 2012. **Figure 15** below shows total annual community-wide commercial electricity consumption from 2005 – 2012. **Figure 16** below shows estimates of annual GHG emissions associated with commercial electricity consumption community-wide from 2005 – 2012.

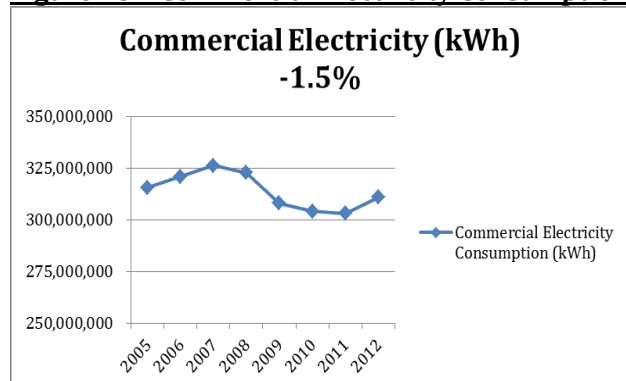
**Figure 13 – Residential Electricity Consumption**



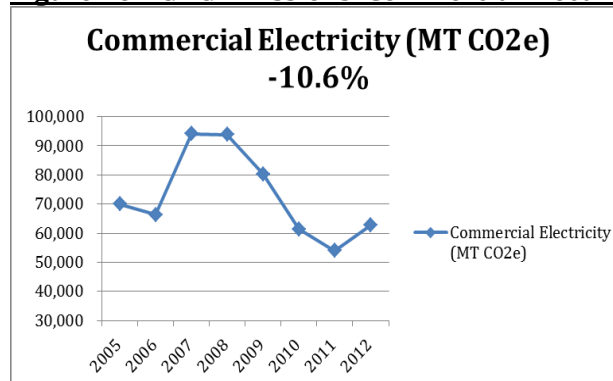
**Figure 14 – GHG Emissions: Residential Electricity**



**Figure 15 – Commercial Electricity Consumption**



**Figure 16 – GHG Emissions: Commercial Electricity**



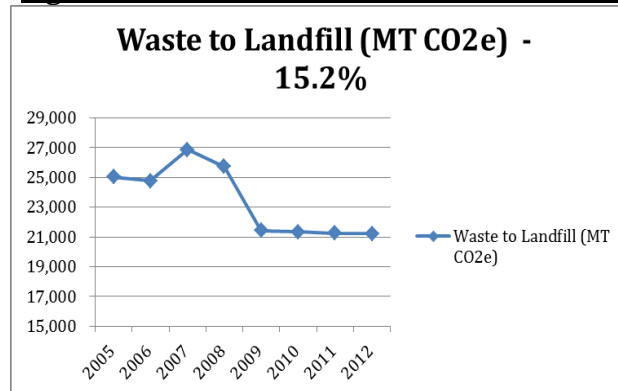
Primary Input Data Source: Incorporated City of Chico PG&E Energy Overview 2005–2012 (See **Ap. A-1**)

Emissions Factor Source: PG&E's City of Chico Community Energy Use & GHG Data (See **Ap. A-2b**)

## II.V WASTE SECTOR – WASTE TO LANDFILL

Between 2005 and 2012 annual tonnage of waste to landfill generated within the City of Chico decreased by 15.5%. This resulted in a gross decrease in GHG emissions of 3,804 MT CO<sub>2</sub>e – out of a net decrease of community-wide GHG emissions levels of 76,392 MT CO<sub>2</sub>e. This Sector generated 3.8% of total community-wide GHG emissions during the base year of 2005 and 3.6% of the total in 2012. Emissions from waste to landfill are relatively low in part because the methane emissions generated at the Neal Road Landfill are captured. The emissions factor used here takes that capture, and average system efficiencies, into account. **Figure 17** below shows estimates of annual GHG emissions generated by waste sent to the landfill community-wide from 2005 – 2012.

**Figure 17 – GHG Emissions: Waste to Landfill**



Primary Input Data Source: City of Chico Department of Public Works & Butte County Recycling  
For primary input data by year see **Appendix A-1**

Emissions Factor Source: ICLEI's Community Protocol V1-1, Appendix E – Solid Waste Emissions Activities and Sources  
For emissions factor values see **Appendix A-2a**

### SECTION III: INVENTORY RESULTS SUMMARY

Total community-wide GHG emissions decreased by 11.5% between the City's baseline year of 2005 and 2012 – the most recent year for which inventory data is available. Of the three primary Sectors included within the scope of the inventory, Transportation and Waste saw reductions, while the Energy Sector saw increases.

Gasoline sales within the City of Chico, and associated emissions, decreased by 17.7%, while diesel sales and associated emissions decreased by 23.3%. Some of this is likely attributable to increases in average vehicle fuel efficiency – called for by the State of California and taken into consideration in the City of Chico's CAP. Much of this reduction, however, is likely attributable to the global economic recession that occurred during the interim years. As the nation and the state recover from that recession, and especially considering sharp decreases in fuel costs during 2014 – 2015, some of these reductions will likely be reversed.

Energy consumed by the Commercial Sector did not change significantly – electricity consumption decreased 1.5% while natural gas consumption, and associated emissions, increased by 6.0%. Given changes in the grid mix of PG&E – again, called for by the State and considered in the City's CAP – emissions associated with electricity consumption decreased by 9.2% overall, resulting in a 10.6% reduction in emissions from commercial electricity consumption.

Energy consumed by the Residential Sector increased significantly, in contrast to the other Sectors contributing to community-wide GHG emissions. Part of this increase is likely due to population spikes resulting from City annexation of residential County areas between 2005 and 2007. Electricity consumption increased by 21.4% while natural gas consumption, and associated emissions, increased by 19.9%. Changes in PG&E's grid mix offset some of the increase in residential electricity consumption, resulting in an increase in associated emissions of 10.2%.

Waste generated in the City of Chico and sent to the landfill decreased by 15.2%, and so did associated emissions. This is a reflection of trends of expanded recycling and material reuse in both the Commercial and Residential Sectors. Looking at these results as an indicator of progress in implementing the City's CAP, a few important trends stand out:

1. Overall, GHG emissions have been decreasing community-wide as a result of utility-level actions and macro-economic conditions, but also a result of local actions taken by a range of independent actors in the community and the City itself. These decreases occurred despite population growth of 10.8% during the eight year period inventoried, and have continued despite a rebound in economic activity illustrated by City sales tax revenues. This inventory shows the City appears to be on track to meet the CAP's 2015 interim target of 10% below 2005 levels, however, data for 2013 and 2014 will help determine if the trend holds.
2. Although the Transportation Sector has seen significant decreases in fuel consumption and associated emissions, a substantial portion of these reductions is likely due to larger economic conditions and may be reversed in subsequent years. The Transportation Sector still contributes a majority of total community-wide emissions and therefore requires special priority and attention.
3. Despite decreases in emissions in other Sectors, emissions from the Residential Energy Sub-Sectors have increased significantly, and therefore it also requires special priority and attention.

## APPENDICES: INVENTORY INPUTS, EMISSIONS FACTORS & RESULTS TABLES

**A-1 Inventory Input Data - Primary Form**

Year	Population	Waste Sector	Transportation Sector		Energy Sector		
		Waste to Landfill (tons)	Gasoline Sales (gallons)	Diesel Sales (gallons)	Commercial Electricity (kWh)	Residential Electricity (kWh)	Commercial Gas (therms) Residential Gas (therms)
2005	79,091.0	88,307.0	30,167,879.0	15,604,197.0	315,745,514.0	202,942,451.0	8,133,661.0 11,007,290.0
2006	84,491.0	87,413.4	29,086,753.0	16,017,892.0	320,968,364.0	226,585,923.0	8,604,247.0 12,255,141.0
2007	86,949.0	94,758.5	32,014,382.0	16,237,030.0	326,417,568.0	237,137,075.0	8,208,145.0 12,692,043.0
2008	87,637.0	90,747.1	28,750,856.0	16,393,090.0	322,805,491.0	241,421,670.0	8,309,927.0 12,847,934.0
2009	86,103.0	75,536.6	26,776,961.0	12,213,811.0	308,010,913.0	242,887,779.0	8,411,096.0 13,040,424.0
2010	86,900.0	75,295.3	26,806,872.0	12,094,927.0	304,103,106.0	235,458,985.0	8,679,168.0 13,235,049.0
2011	87,500.0	74,983.6	25,755,939.0	12,647,934.0	303,130,440.0	240,758,000.0	9,007,071.0 14,143,971.0
2012	87,671.0	74,889.9	24,834,712.0	11,969,633.0	311,008,187.0	246,295,688.0	8,622,453.0 13,202,811.0
% +/- 05-12:	10.8%	-15.2%	-17.7%	-23.3%	-1.5%	21.4%	6.0% 19.9%

**A-2a Inventory Emissions Factors**

Inventory Sector	Unit of Measurement	Emissions Factor
WTLF	Tonnage	0.283500 MT CO <sub>2</sub> e / Wet Short Ton w/ Methane Capture
Gasoline	Gallons	0.008789 MT CO <sub>2</sub> e / Gallon
Diesel Fuel	Gallons	0.010221 MT CO <sub>2</sub> e / gallon
Electricity	Kilowatt Hours	(See Table to Right)
Natural Gas	Therms	0.005307 MT CO <sub>2</sub> e / Therm

**A-2b PG&E Electricity Emissions Factors by Year**

Year	MT CO <sub>2</sub> e / kWh	Year	MT CO <sub>2</sub> e / kWh
2005	0.0002218	2009	0.0002608
2006	0.0002068	2010	0.0002019
2007	0.0002884	2011	0.0001783
2008	0.0002908	2012	0.0002014

**A-3 Inventory Results - MT CO<sub>2</sub>e**

Year	Per Capita	Per \$ Sales Tax Revenue	Waste Sector	Transportation Sector		Energy Sector				Total
			Waste to Landfill	Gasoline Sales	Diesel Sales	Commercial Electricity	Residential Electricity	Commercial Gas	Residential Gas	
2005	8.4	0.0382	25,035.0	265,157.4	159,489.3	70,035.2	45,014.5	43,166.1	58,416.6	666,314.1
2006	7.9	0.0390	24,781.7	255,654.9	163,717.7	66,389.2	46,867.1	45,663.5	65,039.1	668,113.1
2007	8.6	0.0457	26,864.0	281,387.0	165,957.5	94,123.0	68,378.9	43,561.3	67,357.8	747,629.5
2008	8.2	0.0502	25,726.8	252,702.6	167,552.5	93,857.5	70,194.7	44,101.5	68,185.1	722,320.8
2009	7.4	0.0451	21,414.6	235,353.3	124,836.4	80,334.9	63,349.6	44,638.4	69,206.6	639,133.8
2010	7.0	0.0409	21,346.2	235,616.2	123,621.3	61,383.4	47,577.6	46,061.1	70,239.5	605,795.3
2011	6.8	0.0362	21,257.9	226,379.1	129,273.6	54,037.1	42,918.4	47,801.3	75,063.3	596,730.6
2012	6.7	0.0346	21,231.3	218,282.1	122,340.7	62,636.1	49,603.2	45,760.1	70,068.4	589,922.0
% +/- 05-12:	-20.1%	-9.5%	-15.2%	-17.7%	-23.3%	-10.6%	10.2%	6.0%	19.9%	-11.5%