2012 Davis Community Wide Greenhouse Gas Inventory Update

City of Davis

Community Development & Sustainability Department

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PG&E-Sponsored Work Product

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Acronyms

AB 32 – Assembly Bill 32, the Global Warming Solution Act

BAU – business as usual: a scenario in which growth, energy use and waste production continue to follow existing patterns.

Btu – British Thermal Units; a standard unit of measure equivalent to the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit at the temperature at which water has its greatest density (approximately 39 degrees Fahrenheit).

CARB – California Air Resource Board

CAAP – City of Davis Climate Action and Adaptation Plan

EMFAC- EMissions FACtor model designed by California Air Resource Board

GWP – Global warming potential. Multiplier used to convert amount of non-CO_2 gases to CO_2 equivalents (**CO_2e**).

GHGs – greenhouse gases, primarily consisting of: carbon dioxide (**CO_2**), methane (**CH_4**), and nitrous oxide (**N_2O**), with some hydrofluorocarbons (**HFC**s).

ICLEI – Local Governments for Sustainability

kWh – kilowatt hours; a unit commonly used to measure electricity.

SACOG – Sacramento Area Council of Governments

VMT – Vehicle miles traveled; a measure of the total distance traveled within a community. This is used to estimate fuel consumption and greenhouse gas emissions.

1. Introduction

Greenhouse gases (GHGs) produced by human activities augment the GHGs produced by natural processes in the earth's atmosphere. Increasing human activities cumulatively increase GHGs in the atmosphere above naturally produced levels. In 1988 the United Nations formed the Intergovernmental Panel on Climate Change (IPCC) to provide the world with a clear scientific view on the current state of knowledge of climate change as well as its potential environmental and socio-economic impacts. This scientific body reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. To date, the IPCC has released four assessment reports analyzing the accumulation of GHGs in the atmosphere and the corresponding effect upon global climate. The general conclusion from the IPCC is that anthropogenic GHGs are facilitating changes in the Earth's climate.

In response to these findings by the IPCC, California signed into law Assembly Bill 32 (AB32), the Global Warming Solution Act, in 2006. This law requires California to reduce its greenhouse gas emissions to 1990 levels by 2020. In response to AB 32, in 2008 the City of Davis (City) prepared the Greenhouse Gas Inventory and Forecast Report (2008 Report) to ascertain both what 1990 emissions were and the state of then current (for calendar year 2006) emissions. Today, four years later, an update to the 2008 Report has been prepared to assess progress towards achieving compliance with the goals of AB 32 as well as the City's more ambitious GHG goals. For this purpose, this 2012 Community Wide Greenhouse Gas Inventory Update (2012 Report Update) evaluates data from calendar year 2010, which is the most recent year in which data is available to facilitate a useful comparison.

1.1 Community Climate Protection Efforts

The City has advanced its efforts toward reducing community-wide GHG emissions since the 2008 Report. The City created a Climate Action and Adaptation Plan (CAAP), conducted annual third-party verified municipal emissions inventories, and has participated in the Cool Davis Initiative. The Cool Davis Initiative is a collaborative network of citizens, community organizations, businesses and the City whose mission is to inspire the community to reduce GHGs, to adapt to a changing climate and to improve quality of life.

Successful City programs such as the Apartment Move-Out Waste Reduction and iBIN Recycling programs reduced waste production 24% between 2003 and 2010 despite growth in population. Other policies have promoted energy efficiency and water conservation. Together, these efforts have set goals and initiated policies that work toward reducing the community's carbon footprint, but are in their infancy in terms of implementation. As these programs mature and others are developed and implemented, more reductions in GHG emissions should be realized.

1.2 The Davis Climate Action & Adaptation Plan

The Davis CAAP was developed in 2010 using the 2008 Report findings as a guide to develop GHG reduction targets and formulate a plan to reduce emissions for the Community. The minimum levels required by AB 32 and desired reduction targets for the Community developed in the CAAP are listed are listed in Table 1 below.

TABLE 1 - DAVIS GHG REDUCTION TARGETS: COMMUNITY AND CITY OPERATIONS

Year	Target Range*		Notes
	State	Davis	
2010	2000 levels	1990 levels	Minimum: State target. Desired: Provides baseline for subsequent average annual reductions.
2012	1998 levels	7% below 1990 levels	Minimum: State does not establish target for this year; linear interpolation from 2010 target. Desired: Consistent with Kyoto – Mayors Climate Protection Agreement Pledge – City of Davis Reso. 2006.
2015	1995 levels	15% below 1990 levels	Minimum: State does not establish target for this year; linear interpolation from 2010 target. Desired: Consistent with initial ICLEI modeling conducted by the City.
2020	1990 levels	28% below 1990 levels	Minimum: State target. Desired: Average reduction encourages monitoring of progress and some flexibility in implementation.
2050	80% below 1990 levels	Carbon neutral	Minimum: State target. Reduction level adopted by the state based on climate stabilization levels of 3-5.5 degree increase in temp. Average reduction encourages monitoring of progress and some flexibility in implementation. Desired: Combination of actions at the local, regional, national, and international levels **and** carbon offsets. Similar target set by the UC system, City of Berkeley, and Norway.

* It is anticipated that Davis will achieve reductions within the range of the state targets (minimum) and local targets (desired). Table from the CAAP.

As listed in Table 1, the Community proposed a goal to be at 1990 emissions levels by the year 2010. While this goal has not been achieved, please note that the Community's population has increased from approximately 46,000 to 65,000 over the twenty year period from in 1990 to 2010[1]. Thus, in order to achieve 1990 levels, the per-capita emissions for the Community must correspondingly be decreased beyond emission levels per capita in 1990. The information provided in this report is intended to be used to audit the Community's progress to date and to facilitate progress in achieving the CAAP goals. In addition, the information within this report will help the Community to update its goals and target emissions sectors that have not yet been reduced to the necessary levels.

[1] U.S. Census Bureau

1.3 Definitions

This report attempts to maintain a sense of consistency with the prior inventory year while laying a foundation for future greenhouse gas inventory updates. To this end, the following definitions are used consistently throughout this report to facilitate readability:

"**2008 Report**" is the previously completed Community-wide Greenhouse Gas Inventory which was completed for the years 2006 and 1990.

"**2012 Report**" is this report, which updates the 2008 Report for the year 2010.

"**Activity emissions**" may be emitted either inside or outside the community boundary, but are attributed to an activity occurring within the community boundary. One example of an activity emission is electricity, which is used within the community yet is generated outside the community. Correspondingly emissions associated with its production occur outside the inventory boundaries.

"**City**" refers to the City of Davis municipal government organization.

"**Community**" refers to the entire Davis Community, as outlined by the City of Davis Boundaries (excluding the UC Davis Campus).

"**De minimis**" refers to emissions that are considered too small to have a significant impact on the Community inventory (i.e. less than 5% of the total inventory amount

"**ICLEI Protocol**" refers to the Local Governments for Sustainability U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions released Oct. 1, 2012. This protocol provides guidelines for communities to use in estimating their GHG emissions. In addition, this is the primary protocol which utilized in completing the 2008 and 2012 Reports.

"**LGO Protocol**" refers to the Local Government Operations Protocol Version 1.1 released in May 2010, which are guidelines used to supplement the ICLEI Protocol in the 2008 and 2012 Reports (when recommended for use by the ICLEI Protocol). This protocol is one of The Climate Registry's (TCR) industry-specific reporting protocols.

"**MT CO_2e**" stands for "Metric Tons Carbon Dioxide Equivalent" and is the amount used to quantify all greenhouse gases in the 2012 Report.

"**Source emissions**" occur within the City of Davis boundaries. An example of a source is CO_2 emitted due to natural gas being burned in residential heaters within the city.

"**Stationary combustion emissions**" refers to emissions that are directly emitted within the community boundary due to burning fuel in a stationary device (i.e. not a vehicle or mobile device). In most cases, stationary combustion emissions refer to natural gas combustion emissions for residential and commercial use (e.g. in natural gas heaters or gas stoves).

2. Summary of Inventory Findings

The ICLEI Protocol requires a community inventory to quantify emissions from five sources (See Section 3.1). It also provides communities with the option to include other emission sources while taking into account the applicability to the community and the data sources available. Table 2 below lists the many possible categories of emissions types as identified by ICLEI and whether or not each is included in this report. If a source or activity was utilized in this report, the emissions are listed in the rightmost column. Because so many emissions are dependent on the size of the Community, it is also important to note that the U.S. Census estimates that the Community's population was 65,622 with 24,196 households in 2010. This information provides the opportunity to estimate per capita use and identify similarly sized communities with which to compare emissions. In order to reduce total emissions as population and number of households increase, per capita use for individuals and households must decrease at a greater rate.

TABLE 2 - SUMMARY OF INCLUDED AND EXCLUDED EMISSIONS

Emissions Type[2]		Source or Activity[3]	Required by ICLEI Protocol	Included in this Inventory	Reason for Exclusion[4]	Emissions ($MTCO_2e$)
Built Environment						
Use of fuel in residential and commercial stationary combustion equipment		Source AND Activity	●	X		64,390
Industrial stationary combustion sources		Source			Emissions estimated to be de minimis[5] because there are few industrial uses in Community.	
Electricity	Power generation in the community	Source			Community power sources are assumed to be primarily solar in nature and therefore do not directly emit greenhouse gases during power generation.	
	Use of electricity by the Community	Activity	●	X		56,305
District Heating/ Cooling	District heating/cooling facilities in the Community	Source			Not believed to be applicable.	

[2] Possible "Emission Type" categories are from the 2012 ICLEI Community GHG Reporting Protocol – note that the ICLEI Protocol only requires five of the numerous categories.

[3] A "Source" emission is one that occurs within the Community boundaries. An example of a source is CO_2 emitted due to natural gas being burned in residential heaters within the Community. An "Activity" emission is one which may be emitted either inside or outside the boundary, but is attributed to an activity occurring within the community. One example of an activity emission is electricity, which is used within the Community yet is generated outside the Community and thus emissions associated with it occur outside the inventory boundaries.

[4] For more information reasons for excluding a particular emission please see Section 4.

[5] "De minimis" refers to emissions that are considered too small to have a significant impact on the Community inventory (i.e. less than 5% of the total inventory amount).

	Use of district heating/cooling by the Community	Activity			Not believed to be applicable.	
Industrial process emissions in the Community		Source			Emissions estimated to be de minimis because there are few industrial uses in Community.	
Refrigerant leakage in the Community		Source		X	Difficult to calculate with accuracy; emission is small compared to Community emissions.	
Transportation and Other Mobile Sources						
On-road Passenger Vehicles	On-road passenger vehicles operating within the Community	Source	● or		Preferred method of transportation accounting was used - data included in category below.	
	On-road passenger vehicle travel associated with community land uses	Activity	●	X		148,713
On-road Freight Vehicles	On-road freight and service vehicles operating within the community boundary	Source		x	Those emissions which were not fully captured in the category below were included here (e.g. garbage trucks).	5,356
	On-road freight and service vehicle travel associated with community land uses	Activity		X		48,815
On-road transit vehicles operating within the community boundary		Source		X		3,892
Transit Rail	Transit rail vehicles operating within the community boundary	Source			No light rail transit within the Community boundaries.	
	Use of transit rail travel by the community	Activity			Difficult to calculate; additionally, all transit rail use would occur outside of Community boundaries.	
Inter-city Passenger Rail Vehicles	Inter-city passenger rail vehicles operating within the community boundary	Source			Emissions are estimated to be 1,063 MT CO2e, however, preferred method of transportation accounting was used - data included in category below.	
	Use of Inter-city passenger rail travel by the community	Activity		X		1,468
Freight rail vehicles operating within the Community		Source			Difficult to Calculate; outside of the Community's responsibility	
Marine	Marine vessels operating within the Community	Source			No marine uses within the Community.	
	Use of ferries by the Community	Activity			No marine uses within the Community - Community use outside of Community assumed to be insignificant.	

Off-road surface vehicles and other mobile equipment operating within the Community		Source			Difficult to calculate	
Use of air travel by the Community		Activity			Difficult to calculate; no airport within Community.	
Solid Waste						
Solid Waste	Operation of solid waste disposal facilities in the Community	Source			Transport of waste assumed to be included in "On-road freight and service vehicle travel associated with Community land uses;" landfill is outside of Community, so other operational emissions (i.e. electricity use or equipment emissions) are not included.	
	Generation and disposal of solid waste by the Community	Activity	●	X		8,094
Water and Wastewater						
Potable Water - Energy Use	Operation of water delivery facilities in the Community	Source			Data included in the category below.	
	Use of energy associated with use of potable water by the Community	Activity	●	X		992
Use of energy associated with generation of wastewater by the Community		Activity	●	X		888
Centralized Wastewater Systems - Process Emissions	Process emissions from operation of wastewater treatment facilities located in the Community	Source		X		7,087
	Process emissions associated with generation of wastewater by the Community	Activity			The wastewater treatment plant is operated by the Community (and primarily serves the Community), and so emissions are encompassed by the above category.	
Use of septic systems in the Community		Source AND activity			No septic systems within the Community.	
Agriculture						
Domesticated animal production		Source			Minimal agricultural activities within Community.	
Manure decomposition and treatment		Source				
Upstream Impacts of Community-Wide Activities						
Upstream impacts of fuels used in stationary applications by the Community		Activity			Difficult to calculate; **no upstream emissions included in inventory.**	
Upstream and transmission and distribution (T&D) impacts of		Activity				

purchased electricity used by the Community					
Upstream impacts of fuels used for transportation in trips associated with the Community	Activity				
Upstream impacts of fuels used by water and wastewater facilities for water used and wastewater generated within the Community boundary	Activity				
Upstream impacts of select materials (concrete, food, paper, carpets, etc.) used by the whole Community	Activity				
Independent Consumption-Based Accounting					
Household Consumption (e.g., gas & electricity, transportation, and the purchase of all other food, goods and services by all households in the Community)	Activity		X	No lifecycle emissions were calculated; see Section 4.1 for more information. Electricity, etc. emissions included in other categories	
Government Consumption (e.g., gas & electricity, transportation, and the purchase of all other food, goods and services by all governments in the Community)	Activity		X	Government Emissions were partially calculated, including the following sources: Building Natural Gas, Electricity, and Refrigerant Use, Streetlight and Stoplight Electricity Use, Direct Facility and Special Equipment Emissions. No lifecycle emissions were calculated.	2,440
Life cycle emissions of community businesses (e.g., gas & electricity, transportation, and the purchase of all other food, goods and services by all businesses in the Community)	Activity			No lifecycle emissions were calculated. See Section 4.1 for more information.	
Total					**348,437**

1. Possible "Emission Type" categories are from the 2012 ICLEI Communitywide GHG Reporting Protocol – note that the ICLEI Protocol only requires five of the numerous categories.
2. A "Source" emission is one that occurs within the Community. An example of a source is CO_2 emitted due to natural gas being burned in residential heaters within the city. An "Activity" emission is one which may be emitted either inside or outside the boundary, but is attributed to an activity occurring within the Community. One example of an activity emission is electricity, which is used within the city yet is generated outside the Community and thus emissions associated with its production occur outside the Community.
3. For more information reasons for excluding a particular emission please see Section 4.
4. "De minimis" refers to emissions that are considered too small to have a significant impact on the community inventory (i.e. less than 5% of the total inventory amount).

3. Inventory Boundaries

3.1 Included Emissions

Generally, emissions attributed to Community and City activities which occur during the year 2010 are included in this report. Note that emissions sources and activities occurring outside

the Community, including those emission sources occurring within UC Davis boundaries, are excluded. The inventoried emissions include the five categories required in the ICLEI Protocol, which are:

1. Emissions occurring at power production facilities due to electricity being used within the Community (i.e. at residential and commercial/industrial facilities).
2. Emissions due to the use of stationary combustion equipment within the Community (e.g. Natural gas emissions from gas used at residential and commercial/industrial facilities).
3. On-road passenger and commercial motor vehicle emissions from travel attributable to Community residents, workers, and visitors which are considered within the Community's scope of responsibility.
4. Emissions produced from the disposal of solid waste created within the Community and deposited within the Yolo County Landfill (note that garbage trucks/ collector vehicles are included in the vehicle emissions category).
5. Emissions associated with energy used in the treatment and delivery of potable water and from the collection and treatment of wastewater used in the Community.

In addition to the above required sources, emissions from the following activities were also calculated for the 2012 Report:

- Process emissions from the Community wastewater treatment plant.
- Emissions due to other select municipal (City of Davis) operations: building refrigerant usage, and direct facility and special equipment emissions.
- Emissions due to bus travel operating within the city limits.
- Emissions due to community use of passenger (Amtrak) trains.
- Emissions due to heavy-duty vehicle use (non-freight) within the city limits (i.e. construction, utility, and garbage collection vehicles)

3.2 Included Gases

There are three major gases that are estimated in this report: carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). Some refrigerants (HFCs) are also included in the government consumption categories. In order to be able to compare emissions from sources which generate different gases, each gas is rated by its global warming potential. The global warming potential is defined as its ability to warm the earth's atmosphere relative to CO_2. Therefore, all gases reported in this report are measured in CO_2 equivalents (CO_2e). The Global warming potentials (GWPs, obtained from the LGO Protocol) used in this report are listed in Table 3 below. Note that the GWP for CO_2 is 1, because it is the base reference gas.

TABLE 3 - GLOBAL WARMING POTENTIALS FOR INCLUDED GASES

Gas	Global Warming Potential
Carbon Dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous Oxide (N_2O)	310
HFC 134a	1,300

4. Excluded Emissions

No community inventory can be fully comprehensive due to a variety of reasons, including lack of available data, lack of valid method, and time and budget constraints. Table 2 in Section 2 provides information on which emissions were excluded from this report. The following section provides further discussion on select sources which were purposely excluded from this report to simplify the quantification process and to ensure that those emissions which were included were both significant and accurate. By following the ICLEI Protocol, the City attempts to ensure that the following emissions goals will be accomplished:

1) All of the significant emissions are included within the inventory, and

2) All excluded sources will also remain excluded in future years for facilitating consistency in comparing future inventories.

4.1 Life Cycle Emissions

Lifecycle emissions for products consumed within the Community were excluded from this report. However, it is important to note that emissions associated with creating and transporting goods such as foodstuffs, cars, electronics, clothing, and many other items is potentially very large. "Upstream" emissions include all emissions associated with a product which occur prior to its use, such as mineral extraction, manufacturing, and transport. These upstream emissions may or may not occur within the Community or even within the reporting year. However, they are nonetheless directly tied to emissions activities within the Community and can often exceed in-boundary emissions (which are calculated in this report)[6]. Cement, for example, is a material which is often included in as an emission source due to its high potential to emit GHGs during production. Another example is food, which has a high "carbon cost" because growing or producing, packaging, and transporting all have the potential to be major components of emissions within a community.

Products that are considered "sustainable" can still have large upstream emissions costs associated with them. For example, manufacturing solar panels generally emits a significant amount of GHGs; however, in the community where they are installed, a reduction in purchased electricity may be realized on an annual basis because of the solar panels. In this Report, the exclusion of lifecycle emissions means that only the decrease in emissions due to the reduction in purchased electricity would be included in the emissions totals.

In the ICLEI Protocol, acknowledgement exists that that quantification of "consumption based" (as they are referred to in the document) emissions is a young field with no real standards[7]. As such, a best practice has not yet emerged and currently, these emissions have been excluded from a community wide inventory for this reason. The ICLEI Protocol suggests using the CoolClimate Carbon Calculator as one approach to help determine community lifecycle

[6] ICLEI Protocol Appendix I p. 8
[7] ICLEI Protocol Appendix I p. 6

emissions. The CoolClimate Carbon Calculator[8] estimates average household carbon footprint for various communities across the nation. For the Davis Community, the per-household footprint is estimated to be 40.8 metric tons CO2. This number includes the carbon intensity of both sources calculated in this report (vehicle fuel, water supply, natural gas and energy use) and of additional life cycle sources. Additional sources include the following lifecycle sources: car manufacturing, construction of the home, supply of food (meat, dairy, produce, cereal, and other), supply of goods (clothing, furniture, other), and services, all of which total to 22.3 metric tons CO2 per household9. With 24,196 households in 2010, the Community can estimate the total community footprint due to these additional lifecycle emissions to be 539,571 metric tons CO2. Please note, however, that this report includes some of the lifecycle emissions quantified by the CoolClimate estimate (i.e. energy associated with retail and services) in a manner that prevents adding the CoolClimate lifecycle emissions to the overall Community GHG estimate in this Report. This is why these values for additional lifecycle emissions have not been added to the Community estimates featured in this Report.

4.2 Airline Travel

Airline travel is also a potentially significant source of emissions that is not included in this inventory. The Community contributes to regional and global emissions when residents and visitors use air travel. However, the extent of these emissions is difficult to quantify because the Community has no airport of its own and data sources for air travel by the Community do not currently exist. Commercial air travel rates vary greatly from person to person, though a rough national estimate of 0.37 metric tons of CO_2e per year per person is one possible emission factor. This estimate comes from the 2010 National GHG Inventory (115.4 teragrams CO_2e) [10] and the 2010 national population (308.7 million)[11]. Please note that this number is significantly less than the 1.27 metric tons CO_2e cited for airline travel per year by (but not included in) the 2008 Report, and slightly less than the 0.6 metric tons CO_2 per person that can be estimated for air travel using the CoolClimate Calculator[12] for the Davis Community. This wide range of possible per-capita estimates for air travel-related emissions highlights the difficulties associated with reliably quantifying Community air travel emissions. For this reason, air travel is excluded from this report.

4.3 Agricultural Activity Emissions

While the Community has a few parcels of lands which are designated for agricultural use, there are no commercial agricultural facilities within the Community. What emissions that do arise within the Community come from agricultural activities are categorized as private sector

[8] http://coolclimate.berkeley.edu/carboncalculator
[9] http://coolclimate.berkeley.edu/carboncalculator
[10] http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2012-Chapter-3-Energy.pdf
[11] http://quickfacts.census.gov/qfd/states/00000.html
[12] http://coolclimate.berkeley.edu/carboncalculator

non-commercial gardening or home-based activities. For this reason, agricultural emissions are considered to be insignificant and are not included in this report.

4.4 Organic Carbon Sequestration

Carbon sequestered by planted (or growing) trees and vegetation is excluded by this report. The ICLEI Protocol does not include guidelines on how to quantify carbon sequestered by vegetation. The ICLEI Protocol specifies that all carbon "sinks," such as planting trees, must be inventoried separately from gross emissions. Because there is little data on potential emissions reductions from planting trees and it was not quantified in the 2008 Report, the source was excluded from this report.

4.5 Residential, Commercial, and Transportation Refrigerants

Due to the difficulties associated with estimating fugitive refrigerant emissions from private sources, no residential, commercial, or transportation refrigerant sources were included in this report. In conducting its annual City inventory, the City calculates the refrigerant usage within its buildings and facilities. This emission source was included in the inventory under the "Other Municipal Sources" category. For 2010 the City refrigerant emissions amount was estimated to be 6.3 metric tons CO_2e, or 0.002% of the total emissions for that year. Community refrigerant emissions could be significantly higher. However, data sources, even per-household estimates, are not currently available and would be difficult to assess. The ICLEI Protocol references the LGO Protocol for those communities that wish to include refrigerant emissions in their GHG reporting inventories. However, the LGO protocol is only useful for those instances where:

1) annual refrigerant loss can be physically measured, or
2) the original mass of refrigerant is known.

For a community emission source inventory such a data collection method is beyond the current resources of City staff to conduct.

5. Methodology and Sources

5.1 Community Electricity Use

5.1.1 Residential & Commercial Electricity

Community usage and electricity emissions factors were provided by PG&E. Reduced emissions due to the consumer enrollment in the PG&E ClimateSmart program were factored into the calculations.

Please note that there is a section within the Community usage data provided by PG&E called "DA kWh," which only applies to 2007 and later years. Direct access energy is energy supplied by a competitive energy service provider other than the utility, but uses a utility's transmission lines for distribution. Because so little is known about the direct access electricity's sources, the average emission factor for the state grid (CAMX, from the ICLI Protocol) was used, as recommended by PG&E.

5.1.2 City (Municipal) Electricity Use

The City electricity emissions for the years 2007 through 2010 were calculated using data and emission factors obtained from PG&E for the City's annual reports to The Climate Registry (TCR). These emissions were reported in accordance with TCR reporting protocols. Electricity from City buildings, streetlights, and traffic lights was included. Please note that electricity used for wastewater treatment, and water production and distribution were included separately in their own category per the ICLEI Protocol reporting guidelines.

5.1.3 Industrial Emissions

While Industrial emissions are not categorically excluded, they are combined with commercial emissions in all cases. The Community has relatively few traditional industrial facilities. PG&E provides data that does not separate out industrial facilities. This makes it difficult to place emissions into a specific industrial category within this report. Despite the fact that a separate "industrial emissions" category is not listed in the results, the data are captured within this report.

5.2 Community Stationary Equipment Emissions

5.2.1 Residential & Commercial Natural Gas Emissions

The stationary equipment emissions for the Community are comprised primarily of natural gas emissions. Residential and commercial natural gas use estimates were obtained from PG&E for the years 2003 to 2011. The emission factor for natural gas is the same for all inventory years at 11.70 lbs CO_2 per therm[13].

5.2.2 City Stationary Equipment Emissions

The City's stationary emissions for the years 2007 through 2010 were obtained using data obtained from PG&E for the City's annual reports to TCR. These emissions were reported in

[13] Source PG&E.

accordance with TCR reporting protocols. As is the same as for other Community stationary emissions, the emission factor for natural gas is the same for all inventory years at 11.70 lbs CO_2 per therm[14]. Note that stationary emissions for both water distribution and wastewater treatment were excluded from this category and incorporated into a separate category per the ICLEI Protocol reporting guidelines.

5.3 Transportation

5.3.1 Travel Data

For this report, information about vehicle miles travelled (VMT) which are attributable to the Community was obtained from the Sacramento Area Council of Governments (SACOG) for the year 2008. At the time of the writing of this report, estimates for 2010 were not available. Please note that data estimating miles for all trips conducted within the Community were included, while round-trip miles for trips both to and from Davis were divided by two, consistent with the ICLEI Protocol. By using this method, half of all outgoing and half of all incoming trips are attributed to the Community, while the other halves are attributed to the respective origin or destination cities. Data was obtained both for personal vehicles and commercial (2 and 3 axle) trucks.

5.3.2 Emissions Factors – Personal Vehicles & Commercial Trucks

Emission factors for personal vehicles and commercial trucks are developed and posted in the State of California by the CARB. For this report, the EMFAC 2011CARB model was used. This data because averaged per mile and per vehicle emissions are assumed to be the same the Community as they are for Yolo County. Where EMFAC data was not directly available (i.e. for nitrous oxide and methane emissions), EMFAC suggested methodology was used to calculate emission factors for these two gases[15]. See Appendix A for a list of EMFAC vehicle classifications included in the calculations for Personal Vehicles and the Commercial Trucks as well as the complete emissions factors methodology.

5.4 Solid Waste

Municipal waste generated within the Community is deposited at the Yolo County landfill. Procedures established in the ICLEI Protocol were followed for the emissions calculations. Equation SW.4.1 from the Protocol, found below, was used.

$$CH_4 \text{ Emissions} = GWP_{CH4} * (1\text{-}CE)*(1\text{-}OX)*M* \sum P_i*EF_i$$

Where:	GWP_{CH4}	= global warming potential of methane = 21
	CE	= LFG Collection Efficiency, set to the protocol default for a facility that collects landfill gas such as Yolo County Landfill = 0.75
	OX	= oxidation rate, provided by the protocol = 0.1
	M	= total mass of waste entering the landfill

[14] Source PG&E.
[15] http://www.arb.ca.gov/msei/emfac2011-faq.htm#emfac2011_web_db_qstn07

P = proportion of waste with certain characteristics
EF = emission factor for waste with certain characteristics

The amount (in tons) of waste disposed by the community was obtained from the Cal Recycle Jurisdiction Diversion/Disposal Rate Summaries[16]. The California-specific waste composition listed in the CARB Local Government Operations Protocol[17] was used for the proportion of waste containing carbon. For each waste subtype, the emission factors used came from the ICLEI protocol Table SW.5 CH_4, titled "Yield for Solid Waste Components."

5.5 Water and Wastewater Energy Emissions

The water and wastewater energy emissions for the years 2007 through 2010 were taken from the City's annual reports completed for TCR. 2009 and 2010 reports are undergoing verification and approval by TCR at this time. Inventory years 2007 and 2008 electricity emissions were modified slightly to account for the fact that the PG&E emission factor when the TCR reports were completed was not yet verified, and later changed.

5.6 Additional (Optional) Emissions Sources

5.6.1 Heavy Duty Vehicles & Buses

Emissions for heavy-duty vehicle (i.e. from construction equipment, garbage trucks, or buses) were estimated for Yolo County using emission factors from CARB EMFAC 2011. Emissions were attributed to the Community as a percent of the Yolo County population for each year (e.g. Community residents made up 32.7% of the Yolo County Population in 2010, and so 32.7% of heavy-duty vehicle emissions were attributed to the Community for that year). See Appendix A for a list of EMFAC vehicle classifications included in the Heavy Duty Vehicles calculations and a more complete methodology.

5.6.2 Wastewater Process Emissions

Wastewater process emissions from the Community wastewater treatment plant, including emissions from the lagoon, effluent discharge, and nitrification, were calculated for the years 2009 and 2010 in the City's TCR reports. Emissions for the years 2007 and 2008 were estimated using the 2009 and 2010 data and equations to maintain consistency over the 2007-2010 comparison period.

5.6.3 Additional City Sources

Additional City sources emissions include building refrigerant usage, direct facility and special equipment emissions. These emissions are all taken directly from the City's TCR reports prepared (and third-party verified) separately for the City. Complete City emission sources

16 http://www.calrecycle.ca.gov/LGCentral/reports/diversionprogram/JurisdictionDiversionPost2006.aspx

17 California Air Resources Board. Local Government Operations Protocol Version 1.1. May 2010. *Table 9.4 Default California Waste Characterization (1996-present),* citing the CIWMB Statewide Waste Characterization Study (2009).

inventories for the years 1990 and 2007-2010 can be found in Appendix B. Again, please note that 2009 and 2010 reports are undergoing verification and approval by TCR.

5.6.4 Passenger Rail Travel

Emissions due to Community use of passenger trains were calculated using information on estimated emissions per mile provided by Amtrak. This information, combined with the fact that in 2010 15% of Capitol Corridor trips originated from the Community's train station and 11% ended there[18], made possible an estimate of the regional train emissions attributable to the Community. It was assumed that that all trips were either to or from Sacramento (approx. 15 miles) or Emeryville (approx. 70 miles) because those two locations are the other two most popular stations on the Capitol Corridor line. As was consistent with this Report's passenger vehicle assumptions, only half of each trip was assumed to be the Community's responsibility. This methodology is slightly different than the methodology suggested in the ICLEI Protocol. ICLEI Protocol suggests including all rail emissions within the Community rather than all regional rail which can be attributable to the Community. The ICLEI method was NOT used in this report in order to better trace the relationship between Community passenger vehicle and passenger rail travel emissions over time.

[18] June 2010 Amtrak Passenger Survey

6. 2012 Inventory Findings

6.1 Emissions for the 2010 Base Year

For this report, the total estimated emissions for 2010 is 348,437 metric tons of carbon dioxide equivalents (MT CO_2e), as seen in Table 4 below.

TABLE 4 - COMMUNITY EMISSIONS

2010 Community Emissions (Metric Tons CO2e)			
Category	**Name**	**Emission**	**Subtotal**
Community Electricity Use	Residential Electricity	30,034	57,884
	Commercial & Ind. Electricity	20,619	
	City of Davis Electricity Use*	1,579	
	Direct Access Electricity	5,653	
Community Stationary Combustion	Residential Natural Gas	49,087	65,143
	Commercial & Ind. Natural Gas	15,303	
	City of Davis Natural Gas Use*	753	
Transpor-tation	Personal Vehicles	148,713	197,527
	Commercial Freight	48,815	
Solid Waste	Solid Waste	8,094	8,094
Water & Wastewater Energy Use	Water Distribution	992	1,880
	Wastewater Treatment	888	
Additional (Non-Required) Sources	Wastewater Treatment Process Emissions	7,087	17,909
	Other Municipal Sources	105	
	Bus Operation	3,892	
	Passenger Trains	1,468	
	Heavy-Duty Onroad (Utilities, Garbage Collection, Const.)	5,356	
Total		**348,437**	

*City of Davis emissions are municipal emissions; for the electricity category this includes emissions from both buildings and streetlights and traffic lights.

The largest emissions sector, by far, is transportation, which was responsible for 197,527 metric tons of CO_2e, or 56.7% of total emissions, in 2010. This figure constitutes both personal and commercial vehicles. Residential and commercial energy use, which is comprised of both

natural gas and electricity usage, makes up the bulk of the remaining emissions. Residential use is responsible for 79,120 MT CO_2e (or 22.7% of annual emissions) and commercial use is responsible for 35,922 MT CO_2e (or 10.3% of annual emissions). The remaining 10.3% of emissions are attributed to five relatively minor sectors: direct access electricity, solid waste disposal, water and wastewater treatment energy use, the City's energy use, and additional sources not required by ICLEI.

To help comprehend the share of each sector in total emissions, the information from Table 4 is presented graphically in Figure 1 below.

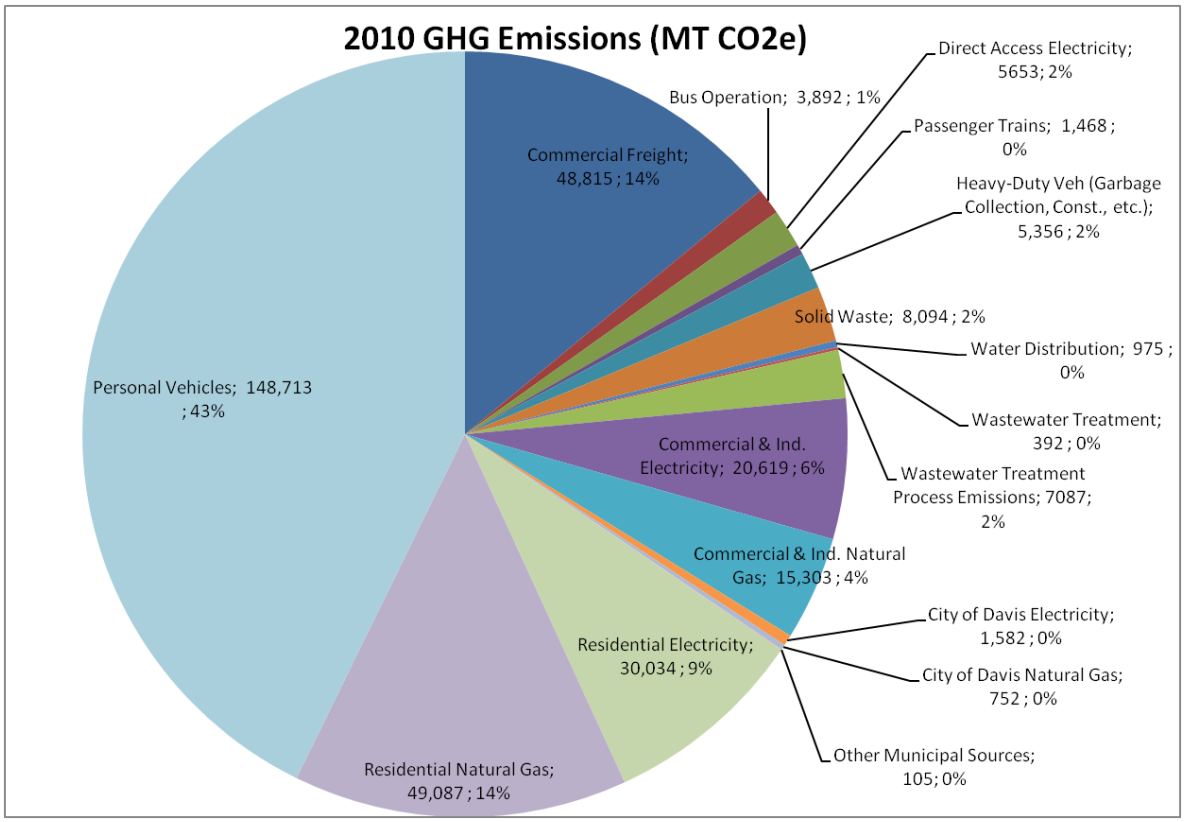

FIGURE 1 - 2010 EMISSIONS ESTIMATE BREAKDOWN BY EMISSION CATEGORY

6.2 Emissions for Other Inventory Years

Emissions for the sectors shown in Table 5 below were also calculated for the years 2007 through 2009 for comparison with 2010 sector emissions. Data was readily available for these sectors in each of these years. The comparison provides a useful snapshot for general trends developing for each sector.

TABLE 5 - SUMMARY OF 2007-2010 EMISSIONS

Year	Emissions (Metric Tons CO2e)						
	Total	Community Electricity Use	Community Stationary Combustion	Transportation	Solid Waste	Water & Wastewater Energy Use	Additional (Non-Required) Sources
2007	374,237	81,385	64,678	195,748	9,202	2,683	20,541
2008	372,690	81,272	64,872	196,772	8,510	2,840	18,426
2009	365,448	74,632	65,563	197,621	7,817	2,355	17,459
2010	348,437	57,884	65,143	197,527	8,094	1,880	17,909

As shown in Table 6 below, total emissions decreased 6.9% between 2007 and 2010. This decrease is mainly due to decreases in residential and commercial electricity emissions, which decreased 31.0%. However, combined residential and commercial electricity use decreased only 1.7% over that same period, so the emissions savings can be primarily attributed to changes in the electricity supplier's emission factors noted earlier in this report. While this represents overall progress in terms of emission reductions, it does not reveal reductions or conservations in energy consumption within the community.

Significant progress has been made, however, in the solid waste sector. While it is a small percentage of total emissions, this sector showed a reduction of emissions by 24% despite increases in population within the Community. The 2.3% decrease in heavy-vehicle (trucks, buses, commercial vehicles, etc.) emissions is also significant. However, it is not clear whether this reduction is a reflection of the economic downturn or a shift in transportation practices and behavior.

TABLE 6 - PERCENT CHANGE IN EMISSIONS FROM 2003 TO 2010 FOR COMPARABLE CATEGORIES

Percent Change in GHG Emissions 2007-2010				Change in Usage 2007-2010			
Sector		Percent Change		2007	2010	Units	% Change
Community Electricity Use	Residential Electricity	-33.7%	-28.9%	156,206	147,513	mWh	-5.6%
	Commercial & Ind. Electricity	-26.7%		96,930	101,271	mWh	4.5%
	City of Davis Electricity Use*	-30.0%		5,909	5,757	mWh	-2.6%
	Direct Access Electricity	-1.0%		19,041	18,847	mWh	-1.0%
Community Stationary Combustion	Residential Natural Gas	2.2%	0.7%	9,028,861	9,225,676	Therms	2.2%
	Commercial & Ind. Natural Gas	-4.0%		2,997,449	2,876,173	Therms	-4.0%
	City of Davis Natural Gas Use*	9.2%		129,552	141,470	Therms	9.2%
Trans-portation	Personal Vehicles	0.4%	0.9%	311,345,211	316,599,644	Vehicle Miles	1.7%
	Commercial Freight	2.4%		40,124,798	41,637,226	Vehicle Miles	3.8%
Solid Waste		-12.0%	-12.0%	42,485	37,370	Tons Waste	-12.0%
Water & Wastewater Energy Use	Water Distribution	-41.0%	-29.9%				
	Wastewater Treatment	-11.3%		2073	1768.7	Million Gallons	-14.7%
Additional (Non-Required) Sources	Wastewater Treatment Process Emissions	0.2%	-12.8%	64,128	65,622	Population Served	2.3%
	Other Municipal Sources	94.0%					
	Bus Operation	-2.0%		2,463,127	2,408,786	Attributable Vehicle Miles	-2.2%
	Passenger Trains	-15.0%		74,184	66,565	Attributable Vehicle Miles	-10.3%
	Heavy-Duty Veh. (Utilities, Garbage Collection, Const.)	-30.6%					
Total Percent Change			-6.9%				

The information from Table 6 is presented graphically in Figure 2 below.

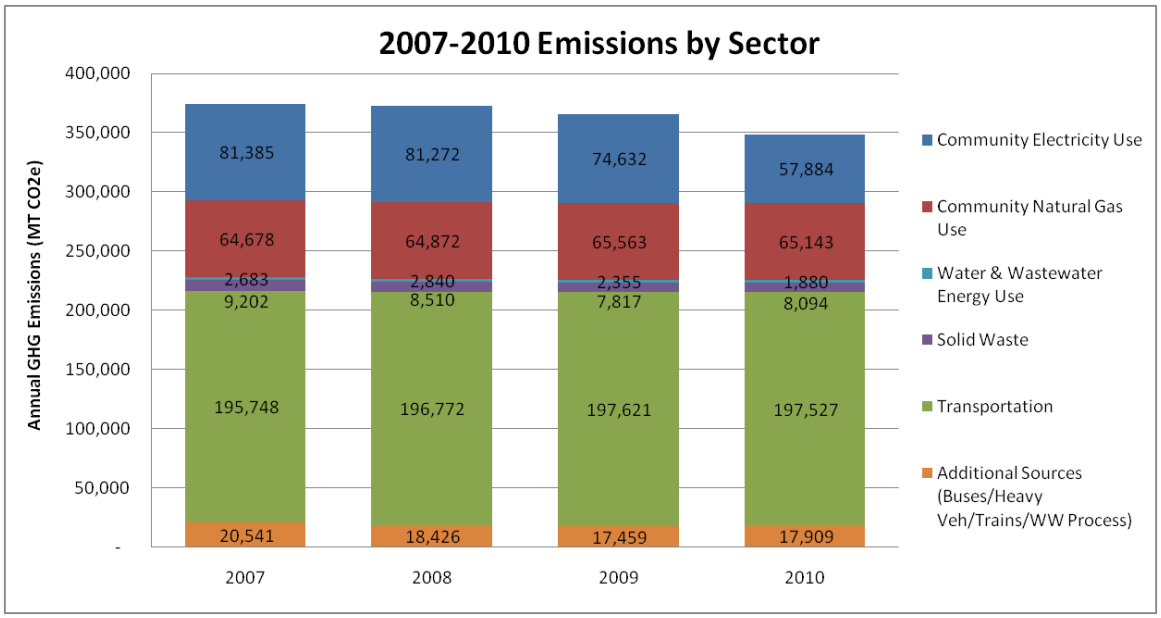

FIGURE 2 - COMMUNITY GHG EMISSIONS BY SECTOR 2007-2010

6.3 Impacts of Annual Electricity Emissions Factors

PG&E provides only the amount of CO_2, not CO_2e, emitted per kWh. To convert CO_2 to CO_2e, the CARB statewide averages for CH_4 and N_2O emissions per kWh (from LGO 2010) were multiplied by their respective Global warming potentials and added to the PG&E – specific CO_2 emission factors. While PG&E emissions factors are different than the state averages, consultations with the CARB urged the use of the utility-specific factor, as is recommended in the ICLEI protocols. This could cause the Community's "bottom-up" emissions inventory to become mismatched with the state's "top-down" emissions inventory. This was also a concern when the 2008 Report was completed.

Since the Community does not produce its own power, it is dependent upon its supplier for electricity. The Community has limited influence on the emission factor for the electricity it purchases. Therefore, the Community's emission factor for electricity may be more carbon intensive than otherwise desired. As more green energy producing sources are developed or promoted by the City within the Community, its overall emission factor would commensurately decrease. While the emission factors for PG&E energy are significantly better than state averages, changes in the factor still have an impact on the Community's emissions.

The difference between 2006 (0.4560 lbs CO_2 per kWh) and 2007 (0.6357 lbs CO_2 per kWh) is particularly significant since the factor increased by 39%.[19] A combination of reduced use and

[19] According to PG&E's GHG Fact Sheet, "PG&E's electricity emission factors vary primarily because the amount of available hydroelectricity varies from year to year. During drought years, less hydroelectricity is available. Therefore, other electric generation (usually natural gas generation) is used instead. PG&E's

lower carbon-intensive electricity production by PG&E influences the numbers for 2010 towards the goal of reduced overall emissions. As this is the intended goal of AB 32, this may be interpreted as the start of a downward trend[20]. As seen in Figure 3 below, changes in electricity-related greenhouse gas emissions closely follow electricity emissions factors trends rather that usage rates over time.

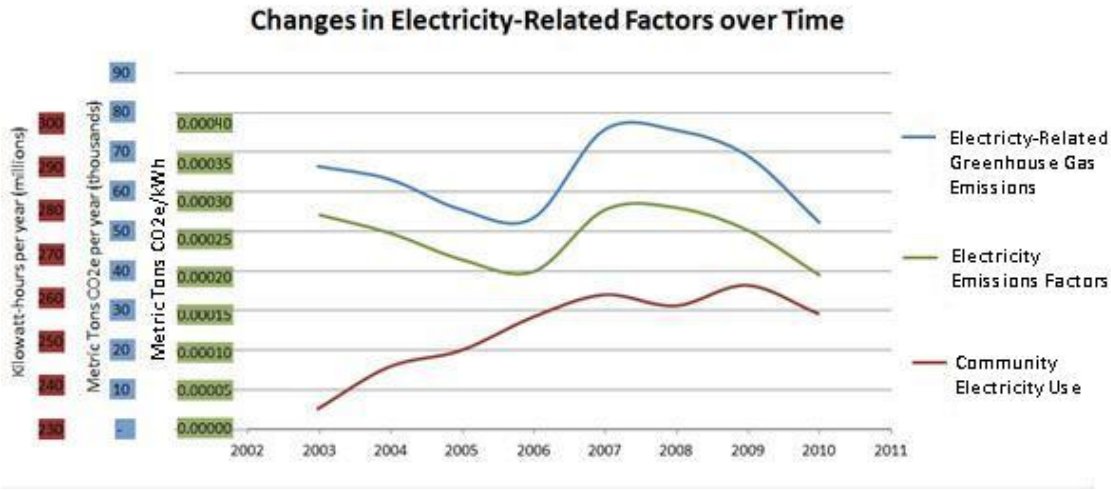

FIGURE 3 - CHANGES IN ELECTRICITY EMISSIONS, USAGE, AND GREENHOUSE GAS EMISSIONS OVER TIME
(Note that all three metrics are scaled differently)

6.4 Comparison with the 2008 Report Findings

Please note that several methodologies have changed between the 2008 Report and this report update. For example, this report includes transportation emissions which are attributable to the Community's land uses, both inside and outside the Community's boundaries. In the 2008 Report, transportation emissions generated solely within the Community's boundaries were included, while all emissions resulting from Interstate 80 and Highway 113 were excluded. In the 2012 Report method, information on trip type and length for trips either starting or ending within the Community was obtained from SACOG. All internal trips and half of all internal-external (or external-internal) trips are attributed to the Community. This was done, in part, due to the presence of Interstate 80 and HWY 113 within the Community. These two highways carry a significant amount of pass-through traffic and emissions. Though these emissions occur

electricity emissions factors will generally trend downward as PG&E increases the amount of zero-emission renewable generation in its electricity portfolio. "
http://www.pge.com/includes/docs/pdfs/shared/environment/calculator/pge_ghg_emission_factor_info_sheet.pdf

[20] In a personal communication with PG&E it was noted that they do anticipate a downward trend due to RPS compliance, however, the primary reason for year-to-year fluctuations is the use of large hydroelectric facilities which are dependent on annual rainfall.

within the Community's boundaries, they are not necessarily attributable to the Community's GHG emissions because the Community is not the only reason for the pass-through traffic.

A graphical depiction of the differences in included emissions can be seen in Figure 4 below. By including transportation emissions both inside and outside the Community which are attributable to the Community's land use choices (rather than excluding all freeway emissions as was done in the 2008 Report) the 2012 Report gives a more complete picture of the community's GHG transportation impact. However, this relationship illustrates the difficulty with accurately comparing emissions from one year to the next as emission assessment information continues to evolve.

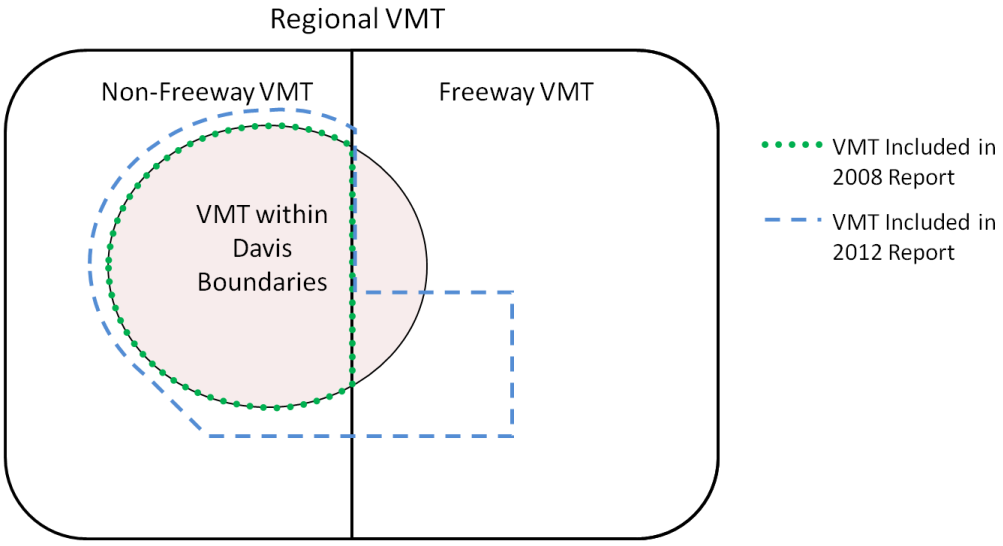

FIGURE 4 - DIFFERENCES IN INCLUDED VMT (AND EMISSIONS) BETWEEN THE 2008 AND 2012 REPORTS

Methodology in calculating solid waste emissions appears to have changed slightly as well. Most significantly, the emission factors prescribed by the ICLEI Protocol have changed. The 2008 Report used ICLEI's CACP Software in its calculations while the 2012 Report does not, and thus the exact differences between emissions factors (and possibly other changes in solid waste sector methodology) are difficult to discern.

Different sources have also been used for the electricity emissions factors for the two reports. In the 2008 Report, the California statewide grid emission factor was used, while in the 2012 Report PG&E-specific emission factors were used. See Section 6.3 for more information.

In addition, emissions due to community use of passenger trains (Amtrak) are reported for 2010 but not in 2008 Report due to lack of available data and methodology at that time.

6.4.1 Emissions for 1990

In order to determine if the Community is on track to meet the goals of AB 32, 1990 transportation emissions need to be estimated for a similar scope and methodology as utilized

for the 2012 Report. Unfortunately, there is no direct way to do this. However, Yolo County EMFAC data is available for 1990, 2006, and 2008[21] inventory years. A rough "verification estimate" can be made to help determine the accuracies of the previous years' emissions. The verification estimate assumes that the transportation emissions for which the Community is responsible remain constant over time as a percent of transportation emissions within Yolo County. The original 2008 Report estimates and the verification estimates for 1990 and 2006 can be found in Table 7 below.

TABLE 7 - COMPARISON OF 2008 REPORT AND VERIFICATION TRANSPORTATIONEMISSIONS ESTIMATES

Year	Report Transportation Emissions[1]	CO_2 for Yolo County[2]	Verification Estimate (2008 Emissions/2008 CO_2 for Yolo County x 1990 or 2006 CO_2 for Yolo County)	Percent Change Between 2008 Report Estimate and Verification Estimate
1990	119,662	696,266	121,811	1.8%
2006	164,195	1,176,395	205,809	25.3%
2008	206,391	1,179,723		

1. Note that "Report Transportation Emissions" for 2008 include both "Transportation Emissions" and "Bus Operation" and "Heavy-Duty Vehicle" emission categories presented earlier in this 2012 Report. Values for 1990 and 2006 are from the 2008 Report and are assumed to encompass the same vehicle categories as for 2008.
2. CO_2 for Yolo County Estimate from EMFAC 2011 model runs for corresponding years.

For 1990, the verification estimate is surprisingly similar to the original 1990 estimate calculated in the 2008 Report (only a 1.8% difference), and so the data from 1990 is cautiously used for comparison. A graphic of side-by-side comparisons of 1990 and 2010 emissions are presented in Figure 5 below. Please be aware that 1990 transportation data is considered a rough estimate given the lack of reliable data and the assumptions made in the estimation methodology (the 2006 estimate, for example, looks to be about 25% different from the verification check). The 2008 Report estimate for 1990, however, is the best approximation that is available currently. Complete 2008 Report GHG emissions can be found in Appendix C.

[21] 2008 is used in the verification estimate because SACOG-provided data uses 2008 as a base year and therefore 2008 is the most accurate transportation estimate in the 2012 Report.

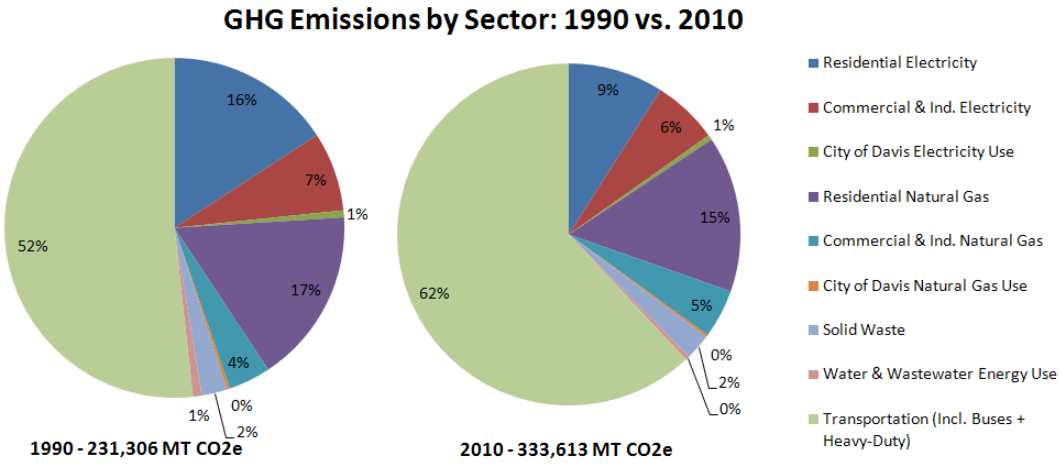

FIGURE 5 - PERCENT GHG EMISSIONS BY SECTOR 1990 & 2010

Please note that rail travel, direct access electricity, and "other municipal sources" and wastewater treatment process emissions were excluded from 2010 for comparison purposes as these categories were not part of the 1990 inventory.

Between the 1990 and 2010 GHG emission years, the percentage of contribution for the majority of the sectors remained approximately constant. Figure 5 above shows the largest change in emissions was in the transportation sector, which increased from 1990 to 2010 by 10%. Additional significant shifts can be found in the residential electricity, which decreased by 7% to make up 9% of the total emissions, and residential natural gas sectors, which decreased by 2% to make up 15% of emissions. This data reveals that within the Community, while gaining conservation in emissions from stationary sources, emissions from non-stationary sources or motor vehicles is increasing. This is despite significant technological advances in emission reductions from the auto industry.

Overall, emissions increased roughly 44% between 1990 and 2010 for common sectors. During that same period, population within the Community grew 42% to over 65,000 people. Overall, from 1990 to 2010, Community per capita emissions increased by 2 percent and, if transportation sector emissions are excluded, per capita emissions for all other sectors decreased a combined 16%. These trends in the data suggest that per capita use of motor vehicles is increasing more rapidly per capita than other sectors can makes gains in total reductions.

6.4.2 Emissions for 2006

Emissions for the year 2006 calculated in the 2008 Report do not include emissions for water treatment and distribution or wastewater treatment, nor any other City source ("Municipal" sources were only calculated for 1990 and 2015 in the 2008 Report).

Table 8 and Figure 6 show 2003 through 2010 emissions estimates as calculated by the 2012 Report alongside 1990 and 2006 values from the 2008 Report. Note that for 2006 emissions, the 2008 Report and the 2012 Report overlap. Also of significance is that in 2006 emissions in all sectors, especially transportation and solid waste, are estimated to be different. The chief reason for the difference is assumed to be due to changes in methodology.

TABLE 8 - 2012 REPORT EMISSIONS ESTIMATES FOR 2003-2010 AND 2008 REPORT ESTIMATES FOR 1990 & 2006

Year	Emissions (Metric Tons CO2e)						
	Total	Community Electricity Use	Community Stationary Combustion (Natural Gas)	Trans-portation	Solid Waste	Water & Wastewater Energy Use	Additional (Non-Required) Sources*
2003	337,056	66,431	62,355	183,310	10,657	--	14,302
2004	342,014	63,178	66,303	187,762	10,143	--	14,628
2005	337,970	55,482	62,901	193,171	10,167	--	16,249
2006	339,501	53,292	65,792	194,634	9,476	--	16,307
2007	374,237	81,385	64,678	195,748	9,202	2,683	20,541
2008	372,690	81,272	64,872	196,772	8,510	2,840	18,426
2009	365,448	74,632	65,563	197,621	7,817	2,355	17,459
2010	348,437	57,884	65,143	197,527	8,094	1,880	17,909
1990**	231,306	55,546	48,558	119,662	5,581	1,959	--
2006**	309,367	64,637	74,592	164,195	5,943	--	--

***Additional Sources include wastewater process emissions for the years 2007-2010 only.**

****Values are taken from the original 2008 Report. Methodologies have changed between 2008 and 2012 Reports, and direct comparisons should be made carefully.**

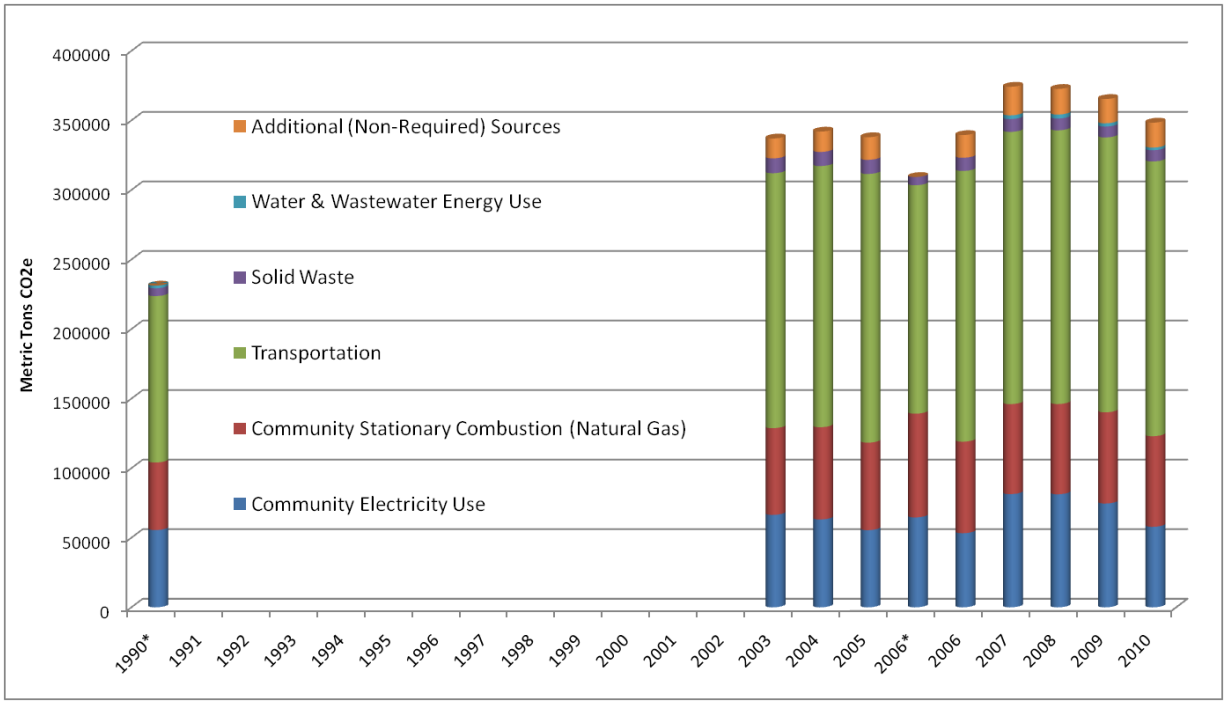

FIGURE 6 - 1990 & 2003-2010 EMISSIONS

Note that Years marked with an * were calculated in the 2008 Report rather than the current 2012 Report.

7. 2012 Inventory Projections

The 2008 Report provided projected 1990 business-as-usual (BAU) emissions for the year 2015. Projected emissions for 2015 were re-evaluated for this report with 2010 as the new BAU baseline. The re-evaluation was conducted to audit the original projection assumptions from 2008. For this report, both business-as-usual and mitigated emissions scenarios were prepared to predict whether the Community is on track to meet its goals (2015 is a key objective year in the CAAP). Emissions for the year 2020 were also projected to show how growth would impact the estimate over time.

7.1 Methodology

BAU emissions projections were calculated by averaging the per-capita or household consumption rate for the last three years of the inventory (2008, 2009, and 2010) and then multiplying these consumption rate averages by the projected population or number of households for both 2015 and 2020. City staff estimates the Community's population to be 68,565 and 74,851, and households to be 24,861 and 26,247 for 2015 and 2020, respectively. Population projections were estimated by extending the same growth rate from 2000 to 2010[22] to the target years. For electricity-related and transportation emissions the values were also multiplied by the predicted emissions factor for that year[23]. For natural gas and solid waste, the same emissions factors used elsewhere in the inventory were applied because 1) natural gas emissions factors do not vary by year and 2) the composition of the waste (rather than the overall amount) is assumed to remain relatively constant, as was assumed for past years.

Mitigated projections, which are intended to represent the BAU scenario plus the decline in emissions associated with various conservation and emissions reduction policies, were also prepared for 2015 and 2020. In the case of the Solid Waste sector, it was assumed that per-capita improvements occurring over the last eight years would continue. These projected improvements would require that new programs increasingly be implemented and successful current programs, such as the "Apartment Move-Out Waste Reduction Program," be enhanced. For all other sectors, such as the electricity and transportation sector, reduction goals from the CAAP's 2015 Objectives were utilized for the inventory projection model for the year 2015. 2020 Mitigations were assumed to maintain the reduction levels achieved by the 2015 Objectives over 2010 GHG emissions. Thus the per-capita emissions factors and metrics used to estimate 2020 emissions are higher than those per-capita emissions factors and metrics used to estimate 2015 emissions, but not high enough to increase the reduction beyond overall CAAP 2015 Objectives. Please note that if the CAAP objectives are unable to be

[22] Obtained from the U.S. Census Bureau

[23] These emission factors were obtained from the E3 GHG Calculator (Energy and Environmental Economics, Inc. (E3), GHG Calculator version 3c, worksheet tab "CO2 Allocations," cells AH35 & AH44. and AQ35 & AQ44. Also cited by the PG&E Emissions Factors White Paper.) for electricity and EMFAC 2011 model for vehicle emissions.

reached, then the actual emissions in 2015 and 2020 will be higher than those presented in the mitigated projection scenario.

7.2 Estimates

Table 9 below shows emissions are projected to decrease between the years 2015 and 2020 for the electricity and transportation sectors. This decrease is projected regardless of whether or not the Community improves its mitigation efforts. Please note that those efforts which are currently being undertaken are represented in the BAU scenario. The decrease is anticipated to be due to improvements in emissions factors that are largely beyond the community's control such as technological advances in emission controls, increasing use of clean energy sources in the electricity grid, and improved gas mileage and a greater percentage of hybrids and electric vehicles in the vehicle fleet. When new mitigation efforts are undertaken, overall emissions are expected to decrease 8.3% by 2015 and 10.9% by 2020 from the BAU scenario.

TABLE 9 - PROJECTED MITIGATED AND UNMITIGATED 2015 AND 2020 EMISSIONS

Projected Community Emissions (Metric Tons CO2e)					
Category	**Name**	**2015**		**2020**	
		BAU	**Mitigated**	**BAU**	**Mitigated**
Community Electricity Use	Residential Electricity	27,594	25,111	21,660	18,669
	Commercial & Ind. Electricity	19,073	17,242	14,859	12,817
	City of Davis Electricity	1,213	996	985	814
	Direct Access Electricity	5,901	5,335	5,308	4,579
Community Stationary Combustion	Residential Natural Gas	51,673	46,609	54,553	46,633
	Commercial & Ind. Natural Gas	16,472	14,544	17,259	14,538
	City of Davis Natural Gas	960	788	1,048	867
Trans-portation	Personal Vehicles	135,230	124,149	118,860	109,188
	Commercial Freight	49,309	49,309	49,309	49,309
Solid Waste		8,563	5,823	9,348	3,459
Water & Wastewater Energy Use		1,868	1,533	1,638	1,355
Additional (Non-Required) Sources	Other Municipal Sources	71	58	78	64
	Bus Operation	3,769	3,769	3,257	3,257
	Passenger Trains	1,758	1,758	2,066	2,066
	Heavy-Duty Onroad (Utilities, Garbage Collection, Const.)	7,517	7,517	7,929	7,929
Total		**330,971**	**304,542**	**308,157**	**275,543**

Figure 7 depicts the estimated emissions from 2007 to 2010 and projected emissions for 2015 and 2020. 2015 mitigated emissions are projected to reduce 2010 emissions by 12.6%. 2020 mitigated emissions are estimated to reduce 2010 emissions by 20.9%. In the BAU scenario, the Community can expect 5.0% and 11.6% reductions for 2015 and 2020, respectively.

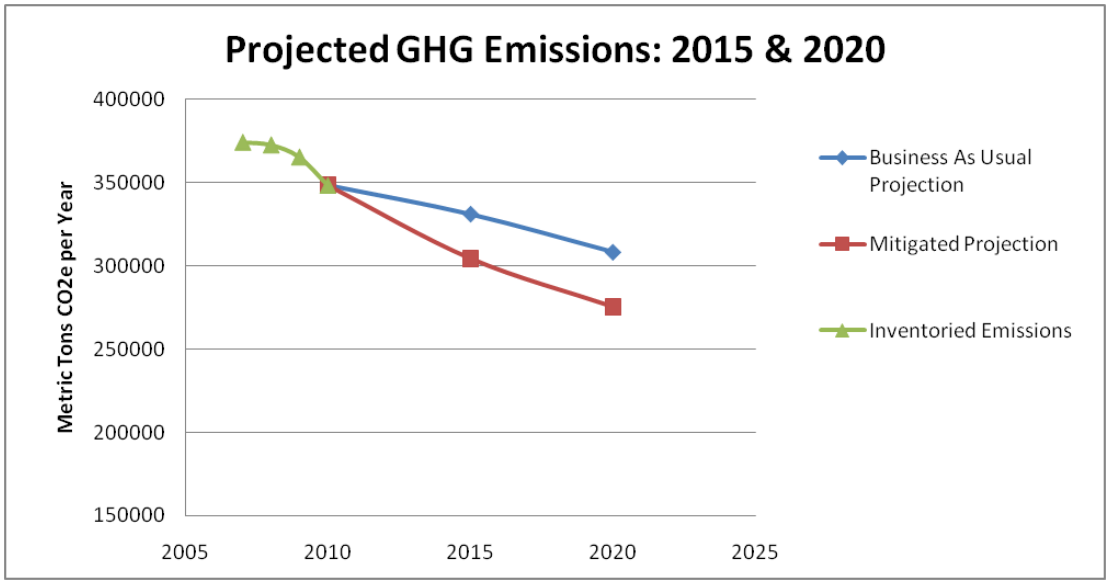

FIGURE 7 - GRAPH OF 2015 AND 2020 PROJECTED EMISSIONS

7.3 Comparison with the 2008 Report Projections

The 2008 Report projected 2015 emissions if the Community were to continue the BAU trends of the 1990 base year. Figure 8 below illustrates the 2008 Report 2015 projection trend. The figure also provides estimated emissions for the years 2007 through 2010 as well as the 2015 and 2020 projections from the 2012 Report. While 2007 through 2010 show a downward trend, it is still significantly above the previously projected BAU line, though both the mitigated and unmitigated current projections reach the 1990 BAU line by 2015. The 2008 Report BAU line, which factors in population increases, is still significantly above the goals of AB 32, which are based on 1990 overall emissions.

Please note that a significant portion of the 1990 BAU trend line is devoted to transportation emissions, which, as discussed previously, has an unknown margin of error. In addition, the 2008 Report is believed to have underestimated 2006 emissions by nearly 25% due to changes in methodologies for estimating GHG emissions (see Section 6.3.1). Projections to further dates (i.e. 2015) also have an unknown margin of error, and thus the 1990 BAU line could be an underestimate of true business-as-usual conditions.

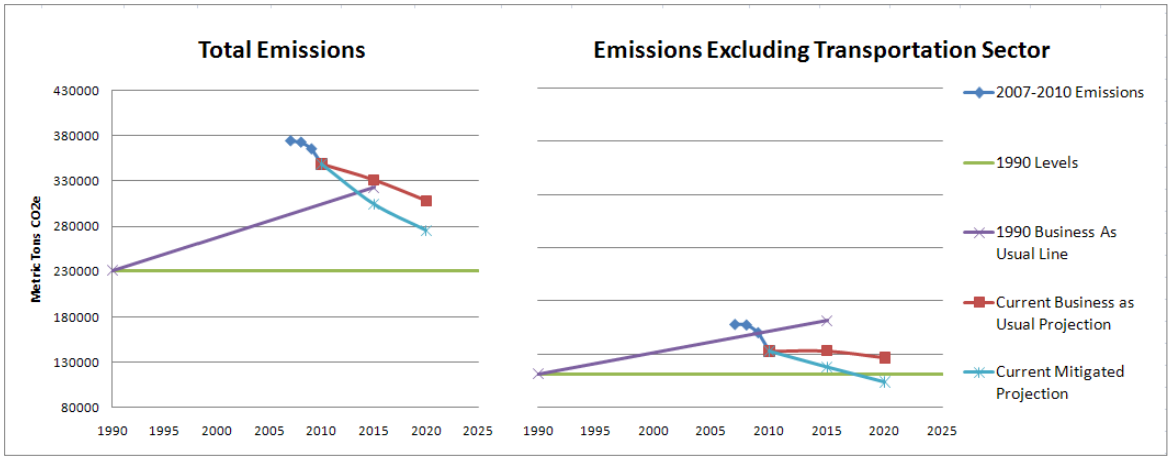

FIGURE 8 - 1990 EMISSIONS FOR 2003-2011 AND THE 1990 BUSINESS AS USUAL (BAU) PROJECTION

The current mitigated projections are still far from the CAAP goal of reaching 1990 level emissions by 2010 and the AB32 goal of reaching 1990 levels by 2020. However, if transportation sector emissions (including buses, trains, heavy-duty vehicles, and commercial travel as well as personal vehicles) are excluded from the data, emissions for 2009 and 2010 are below the 2008 Report projected 1990 BAU line (as shown to the right in Figure 8 above). If the mitigated projection holds true, then the 1990 level target goal for non-transportation sectors should be achievable by 2015. Again, the 1990 emissions totals should only be used in rough comparison with 2007-2010 estimated GHG emissions. However, it does appear that the Community is making significant improvements in non-transportation sectors and will be well below 1990 levels by 2020 for those sectors.

A strong conclusion that arises from this analysis is that the transportation sector is growing more rapidly than reductions in emissions can be realized. If the transportation sector continues in the BAU trend, then achieving the overall goals of AB 32 and the CAAP may not be feasible. There are two methods to reducing transportation emissions: improving technology and changing behavior. Significant advances in emissions technologies and fuel type usage will likely be necessary to achieve the goals of AB 32. However, technological advances exist largely outside the Community's control. Consequently, to reach the goals of the CAAP and AB 32 more vigorous and potentially difficult mitigation measures pertaining to transportation behavior will likely be necessary to consider.

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Appendix A. EMFAC 2011 Vehicle Emissions Factors

EMFAC 2011 was used to obtain the emissions factors for the Yolo County vehicle fleet for each year. Averaged per mile and per vehicle emissions are assumed to be the same for the Community as they are for the county. In order to estimate the number of Community vehicles for all categories, the number of Yolo County vehicles was scaled by the Community population divided by the Yolo County population for each emission year. Emissions for the years 2003-2011, 2015, and 2020 were all calculated individually.

Personal Vehicles

Vehicle classifications from EMFAC 2011 results included in the average annual emissions factors for personal vehicles include:

EMFAC 2011 Classification	Vehicle Description
LDA - DSL	Passenger Cars
LDA - GAS	Passenger Cars
LDT1 - DSL	Light-Duty Trucks (0-3750 lbs)
LDT1 - GAS	Light-Duty Trucks (0-3750 lbs)
LDT2 - DSL	Light-Duty Trucks (3751-5750 lbs)
LDT2 - GAS	Light-Duty Trucks (3751-5750 lbs)
LHD1 - DSL	Light-Heavy-Duty Trucks (8501-10000 lbs)
LHD1 - GAS	Light-Heavy-Duty Trucks (8501-10000 lbs)
LHD2 - DSL	Light-Heavy-Duty Trucks (10001-14000 lbs)
LHD2 - GAS	Light-Heavy-Duty Trucks (10001-14000 lbs)
MCY - GAS	Motorcycles
MDV - DSL	Medium-Duty Trucks (5751-8500 lbs)
MDV - GAS	Medium-Duty Trucks (5751-8500 lbs)
MH - DSL	Motor Homes
MH - GAS	Motor Homes

CO_2 emissions were taken on an average per-mile and per-vehicle basis directly from the EMFAC results (note that Pavley I+LCFS reductions are assumed). For CH_4 emissions, a separate calculation utilizing EMFAC2011-LDV and the results were divided by the Yolo County total number of miles and vehicles to calculate averages per-mile and per-vehicle basis. N_2O emissions were calculated following the California Air Resources Board's suggested methodology (at least as it applies to EMFAC[25]). The calculation was made by using the assumption that N_2O was equivalent to 4.16% of NO_X for all gasoline vehicles, which is the same assumption as for the emissions inventory for the Advanced Clean Cars rule. For diesel

[25] http://www.arb.ca.gov/msei/emfac2011-faq.htm#emfac2011_web_db_qstn07

vehicles, the metric of 0.3316 g/gallon fuel was used to calculate N_2O, using the gallons of diesel from the EMFAC model.

Commercial Trucks

Vehicle classifications from EMFAC 2011 results included in the average annual emissions factors for commercial trucks include:

EMFAC 2011 Classification	Vehicle Description
T6 CAIRP heavy	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR>26,000 lbs
T6 CAIRP small	Medium-Heavy Duty Diesel CA International Registration Plan Truck with GVWR<=26,000 lbs
T6 instate heavy	Medium-Heavy Duty Diesel instate Truck with GVWR>26,000 lbs
T6 instate small	Medium-Heavy Duty Diesel instate Truck with GVWR<=26,000 lbs
T6 OOS heavy	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR>26,000 lbs
T6 OOS small	Medium-Heavy Duty Diesel Out-of-state Truck with GVWR<=26,000 lbs

Per-mile and per-vehicle CO_2 and N_2O emissions were calculated using the same methodology as for personal vehicles. CH_4 was calculated using the equation $CH_4 = 0.0408*TOG$ for all Heavy-Duty vehicles, per EMFAC's suggested methodology.[26]

Heavy-Duty Vehicles

Heavy-duty vehicle emissions (i.e. from delivery trucks or construction equipment) were estimated for Yolo County using EMFAC 2011 and scaled down to the Community using populations for each respective area for each year. Not all of EMFAC's Heavy-Duty vehicle classifications were included in these calculations; agricultural equipment was excluded due to the no existence of farm land in the Community compared to Yolo County (see Section 4.3 Agricultural Activity Emissions). Public vehicles were excluded to prevent double counting with City Operations sector sources. Freeway/interstate trucks were excluded due to the large amount of pass-through traffic on Interstate 80 and Highway 113. Delivery trucks specific to the Community are assumed to be accounted for in the above commercial truck categories, Buses are accounted for separately as well (although they follow the same methodology as for the other Heavy-Duty Vehicles). Those included vehicle classifications are provided in the table below.

Miscellaneous Heavy-Duty Vehicles	
EMFAC 2011 Classification	Vehicle Description
PTO	Power Take Off
T6 instate construction heavy	Medium-Heavy Duty Diesel instate construction Truck with GVWR>26000 lbs

[26] http://www.arb.ca.gov/msei/emfac2011-faq.htm#emfac2011_web_db_qstn07

T6 instate construction small	Medium-Heavy Duty Diesel instate construction Truck with GVWR<=26000 lbs
T6 utility	Medium-Heavy Duty Diesel Utility Fleet Truck
T7 CAIRP construction	Heavy-Heavy Duty Diesel CA International Registration Plan Construction Truck
T7 single construction	Heavy-Heavy Duty Diesel Single Unit Construction Truck
T7 SWCV	Heavy-Heavy Duty Diesel Solid Waste Collection Truck
T7 tractor construction	Heavy-Heavy Duty Diesel Tractor Construction Truck
T7 utility	Heavy-Heavy Duty Diesel Utility Fleet Truck

Buses	
EMFAC 2011 Classification	Vehicle Description
SBUS - DSL	School Buses
SBUS - GAS	School Buses
UBUS - DSL	Urban Buses
UBUS - GAS	Urban Buses
OBUS - GAS	Other Buses
All Other Buses - DSL	All Other Buses

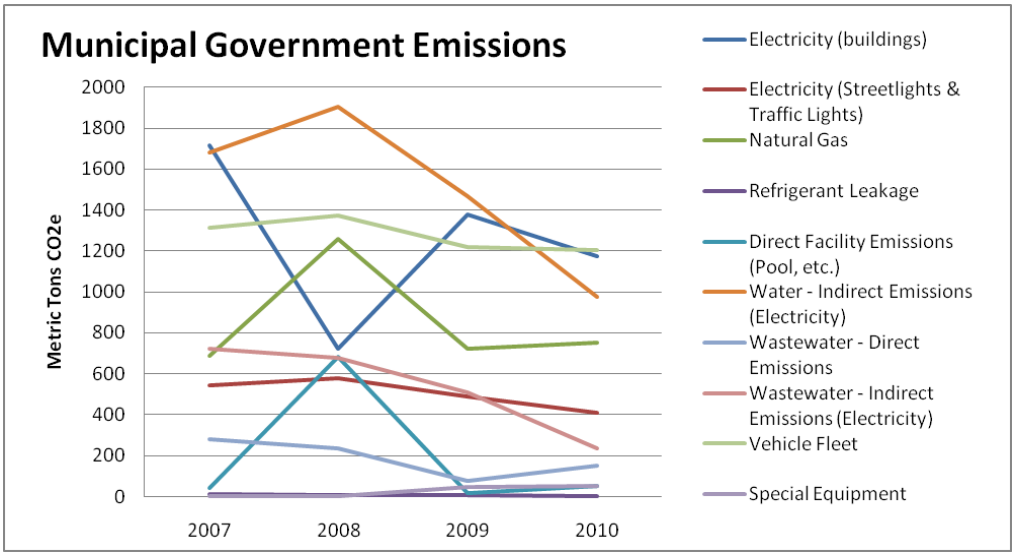
CO_2 emissions were calculated directly from EMFAC for the Heavy-Duty Vehicles. Methane was calculated as CH_4 = 0.0408*TOG. Nitrous oxide for gas-powered vehicles was calculated using the equation N_2O =.0416*NO_X. Diesel vehicles it was assumed to be 0.3316 grams per gallon of diesel fuel consumed.

Appendix B. Detailed Municipal Emissions

City emissions, excluding those for 1990, were calculated in the City's annual TCR third party-verified reports. Electricity-related emissions for the years 2007-2010 have been updated to reflect the most recent PG&E electricity emissions factors for those years.

Emissions (Metric Tons CO2e)					
Category	2007	2008	2009	2010	1990*
Electricity (Streetlights & Traffic Lights)	542.20	578.48	490.85	410.12	869.08
Electricity (buildings)	1713.82	724.69	1376.60	1172.03	
Natural Gas	689.31	1258.01	724.35	752.34	
Refrigerant Leakage	11.06	6.81	6.67	4.29	1347.17
Direct Facility Emissions	43.00	684.20	14.66	49.74	--
Water - Direct Emissions	--	20.87	9.00	0.37	
Water - Indirect Emissions (Electricity)	1682.36	1906.04	1466.69	974.34	
Wastewater - Direct Emissions	280.81	236.63	74.10	148.98	
Wastewater - Indirect Emissions (Electricity)	719.82	676.10	507.00	233.83	1958.61
Vehicle Fleet	1315.83	1371.83	1221.03	1205.42	
Special Equipment	0.05	1.48	47.33	50.31	1063.22
Waste (City Operations Only)	--	--	--	--	46.27
Employee Commute	--	--	--	--	984.30
Total	6998.25	7465.14	5938.29	5001.79	5238.08

*1990 Emissions were calculated in the 2008 Inventory Report.



Appendix C. 2008 Report Emissions

Calculated emissions for both 1990 and 2005/06 and projected emissions to 2015 from the 2008 Report used different methodologies for the transportation and, possibly, waste sectors than the methodologies used in this report. As such, any comparisons between the 2008 Report calculated emissions and 2012 Report calculated emissions should be made with an understanding of the possible margin for error and evolving methodologies for estimating emissions.

Community Inventory: 1990 and 2006 (2008 Inventory Table 3)

Potential Sources	**1990 CO_2e (tons)**	**Energy (MMBtu)**	**2006 CO_2e (tons)**	**Energy (MMBtu)**
Residential	82,853	1,085,685	95,106	1,500,876
Commercial/Industrial	29,477	355,441	44,123	676,899
Transportation	131,905	1,545,525	164,195	1,922,268
Waste	6,152		5,943	
TOTAL	**250,380**	**2,986,690**	**309,367**	**4,100,043**

Community Inventory Projections: 2015 (2008 Inventory Table 13)

Sector	**Year**		**Growth**
	1990	**2015**	
Residential	82,853	103,802	**25%**
Commercial/ Industrial	29,477	61,174	**108%**
Transportation	131,905	176,137	**34%**
Waste	6,152	6,500	**6%**
TOTAL	**250,380**	**347,613**	**39%**

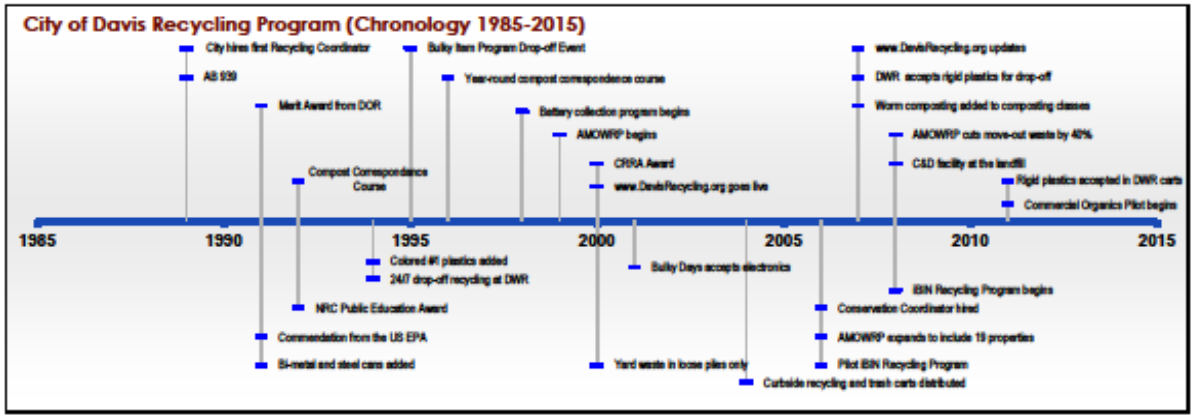
City Operations: 1990 and 2015 (2008 Inventory Table 14)

Sector	**1990 CO_2e (tons)**	**2015 CO_2e (tons)**
Buildings	1,485	1,826
Vehicle Fleet	1,172	1,456
Employee Commute	1,085	1,552
Streetlights and Traffic lights	958	1,454
Water/Sewage	2,159	3,261
Waste	51	51
TOTAL	**6,855**	**9,545**

1990 Data applied to Current Inventory tables:

1990 Community Emissions (Metric Tons CO2e)			
Category	**Name**	**Emission**	**Subtotal**
Community Electricity Use	Residential Electricity	36,562	55,546
	Commercial & Ind. Electricity	17,441	
	City of Davis Electricity Use*	1,543	
Community Stationary Combustion	Residential Natural Gas	38,584	48,558
	Commercial & Ind. Natural Gas	9,300	
	City of Davis Natural Gas Use*	674	
Transportation	Personal Vehicles	--	119,662
	Commercial Vehicles	--	
Solid Waste		5,581	5,581
Water & Wastewater Energy Use		1,959	1,959
Additional (Non-Required) Sources	Bus Operation	--	Encompassed in the Transportation total
	Heavy-Duty Onroad (Utilities, Garbage Collection, Const.)	--	
Total			231,306

Appendix D. Waste Reduction Programs



City of Davis Public Works Department
2011 Solid Waste Division Goals and Projections

Recycling Program Chronology

1970: Recycling drop-off for newspaper
1974: DWR begins collecting newspapers, bottles and cans
1986: Davis Recycling Program voted "Best Curbside Program in the Country" by the National Recycling Coalition
1989: City hires first Recycling Coordinator/ AB 939
1991: Merit Award from the CA DOC Division of Recycling/ Commendation from the US EPA/ Bi-metal & steel cans added
1992: National Recycling Coalition Public Education Award/ Clear and opaque plastics #1 & #2 added
1994: 24/7 drop-off recycling at DWR/ Colored #1 plastics added
1995: Bulky Item Program is restructured to a drop-off event, allowing multiple-family dwellings to participate
1996: City of Davis offers year-round compost correspondence course
1998: Jurisdictions in Yolo County begin battery collection program.
1999: Apartment Move-out Waste Reduction Program begins
2000: California Resource Recovery Association Recycling Award, honoring the City's recycling program for emphasizing 4Rs/ The City's Recycling Program website (davisrecycling.org) came online/ Yard waste collection changes from bags to loose piles
2001: Bulky Items Drop-off Days accepts electronics/ Electronic waste accepted at YCCL for a fee (Yolo County Program)
2004: Curbside split 64 gal recycling carts and 96 gal garbage carts distributed
2005: Electronic waste accepted at YCCL for free (Yolo County Program)
2006: Conservation Coordinator hired/ Apartment Move-out Waste Reduction Program expands to 19 properties/ Pilot iBIN Recycling Program begins with 750 apartment units
2007: DWR begins accepting rigid plastics (#3, #5, #6, & #7) for drop-off recycling/ Worm composting is added to free backyard composting classes/ Permanent HHW facility at YCCL (Yolo County Program)/ www.DavisRecycling.org updated
2008: iBIN Recycling Program begins/ AMOWRP cuts move-out waste by 40%/ C&D facility at the landfill (Yolo County Program)
2010: Weekly (every Friday and Saturday) free Household Hazardous Waste Drop-off events at landfill (Yolo County Program)
2011: Commercial Organics Pilot begins/ Rigid plastics and plastics #1-#7 accepted in DWR carts, residential and commercial

AB 939-Integrated Waste Management Act required all California jurisdictions to divert 25% of their waste by 1995 and 50% by 2000. This measurement system was changed in 2007; the State no longer calculates diversion, they measure per capita disposal only—pounds of waste generated per person per day (PPD). CalRecycle has determined Davis' per capita target to be 3.8 PPD per resident and 16.6 PPD per employee. Statewide per capita residential disposal was 4.5 PPD in 2009.

Edited February 2011