# *City of Davis*

## *Greenhouse Gas Inventory & Forecast Report*

*May 2008*
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## List of Acronyms

**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).

**CACP –** Clean Air Climate Protection; the software used by ICLEI to calculate GHG emissions.

**CAP** – criteria air pollutant, a category of air pollutants including: nitrogen oxides (NOx) sulfur oxides (SOx), carbon monoxide (CO), particulate matter (PM), and volatile organic compounds (VOC), which have adverse effects on human health.

**CARB –** California Air Resource Board

**CCP** – Cities for Climate Protection; a program developed by ICLEI – Local Governments for Sustainability to help local governments reduce greenhouse gas emissions from their operations and communities.

**CIWMB** – California Integrated Waste Management Board

**EIA –** U.S. Energy Information Administration

**EMFAC-** EMissions FACtor model designed by California Air Resource Board

**FHWA –** Federal Highway Administration

**GHGs** – greenhouse gases, primarily consisting of: carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O).

**GHG** – equivalent CO2 (eCO2); used to describe all greenhouse gas emissions in an equivalent volume of carbon dioxide.

**ICLEI** – Local Governments of Sustainability (formerly the International Council for Local Environmental Initiatives).

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

**MMBtu** – Millions of British Thermal Units.

**PMT** – Person Miles Traveled; a person mile of travel equals one person traveling one mile, by any mode, including walking, cycling, automobile, van pool, transit, etc. It is a measure of the level of personal mobility in a community.

**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.

**YSAQMD** – Yolo/Solano Air Quality Management District

# I. Background

### *1.1 Climate Change Legislation in California*

California's Assembly Bill No. 32: the Global Warming Solutions Act requires California to reduce its greenhouse gas (GHG) emissions to 1990 levels by 2020. Meeting this target will require that the state government record and report California's GHG emissions for 1990 and for future years through 2020, using periodic GHG emissions inventories. Additionally, many local governments are monitoring their own GHG emissions in order to reduce their impact on climate change.

### *1.2 City of Davis' Climate Protection Efforts*

For decades Davis has been a leader and working example of how a community can take action to improve quality of life by increasing efficiency and reducing consumption of natural resources. Davis has been an incubator for innovative community design, drawing on the considerable talents and energy of its citizens. Even as Davis has grown and evolved, these core values continue to influence community decisions. Faced with mounting evidence that climate change, mass species extinction, unsustainable energy supply/use, etc. are modern realities, Davis' environmental values are quickly becoming mainstream and influencing how communities are designed and operate.

In recent years there has been occasional commentary that Davis has lost it "cutting edge" sprit. Often this type of comment is made in reference to unique projects in another community containing the latest in environmentally beneficial features. While this may be true in the context of the latest development projects or comprehensive community sustainability policies/programs, we would still be hard pressed to find a community of Davis' size that has actually implemented the range of initiatives that the City has over the years. That said, the emerging discussion on sustainability and climate change certainly should continue to be pursued and celebrate what the community has accomplished while also acknowledging that the problems before us will warrant further aggressive efforts in the future.

**General Plan**

The Davis General Plan has provided policy direction and support for resource conservation, compact community design, energy efficiency, etc for decades. Examples of these policies areas that support action to address climate change and community sustainability include:

- Encouraging compact urban growth
- Improving energy efficiency and alternative transportation options
- Reducing consumption and waste of non-renewable natural resources
- Improving protection of ecosystems and farmlands
- Increasing access to and the quality of social, recreational, and cultural services
- Improving air and water quality

The recommended strategy and associated actions outlined in the analysis section below are consistent with and strengthen the link between existing City General Plan policies. Staff recognizes that achieving a meaningful balance between competing policies is a significant challenge that will influence the City's actions on the issues

identified in this report. Development of guiding principles that address competing policies in advance is one aspect of the recommended strategy.

**Council Goals – 2007/08**

In setting its goals for the next two years, the City Council has also provided clear direction that action on climate change and related issues is one of its priorities. Of eight goals covering the spectrum of all city services, one goal is dedicated fully to conservation and environmental protection. The Council goal and action items related to these issues include:

Goal: Conserve natural resources and protect the environment

- Develop policies and programs that promote reduction of resource consumption and waste generation, improvement of air and water quality, preservation of natural resources, and creation of a sustainable community.

Many of the remaining goals (downtown, housing, infrastructure, etc.) are related to and affected by the approach the community takes to sustainability.

**Past Resolutions on Climate Change**

Consistent with the City's long held goals of limiting resource consumption and reducing environmental impacts, the Council joined the Cities for Climate Protection Campaign in 1999. The Climate Protection Campaign outlined the emerging global warming threat and encouraged cities of all sizes to take preventative steps. That initial action was followed in 2006 by Council adoption of the US Mayor's Climate Protection Agreement. Both resolutions are a call to action for national and local governments to take specific steps to reduce global warming pollution. By virtue of its past and on-going programs, the Davis community was already implementing a majority of the recommended actions (e.g. promote compact urban design).

These two climate protection resolutions are the most direct and formal declarations by the City regarding global warming. They form the platform for the work of the Natural Resources Commission on global warming. The Commission met on March 26, 2007and unanimously passed a motion recommending that the City move forward with its efforts to assess its greenhouse gas emissions and develop a plan to reduce those emissions. The Commission clearly stated its desire to play a lead role in developing and implementing such a plan.

**Overview**

The City Council has directed staff to prepare a greenhouse gas emissions reduction plan (Plan) that addresses $CO_2e$ emissions generated by both City operations and the community as a whole. Based on this direction, the City has joined the Cities for Climate Protection (CCP) program along with hundreds of other communities across the globe to reduce greenhouse gas emissions at the local level. The program is designed to educate and empower local governments to take action on climate change. The CCP is a performance-oriented campaign that offers a framework for local governments to reduce greenhouse gas emissions and improve livability within their municipalities.

# 2. Introduction

## *2.1 Emissions Analysis*

The purpose of a GHG emissions inventory is to provide a baseline against which the City of Davis can measure progress towards the reduction of greenhouse gases. The baseline inventory expresses greenhouse gas production as the number of tons of carbon dioxide equivalent (eCO2/GHG) produced by energy use and waste generation in the community. The reduction target that City of Davis chooses is expressed as a percentage reduction from this baseline emission. For example, if a community is producing 100,000 tons of greenhouse gases in its baseline year and they commit to a 20% reduction in emissions by its target year, it is committing to produce only 80,000 tons of greenhouse gases by its target year.

The forecast section of the report helps a community to take into account any growth that it will experience between the baseline year and the forecast year. If a community continues to grow and continues to consume energy at current rates, emissions will grow beyond current levels. For example, a community with a baseline inventory of 100,000 tons of greenhouse gas emissions may grow in size and produce 120,000 tons of greenhouse gases by the forecast year if current energy consumption patterns continue (this is a called a business-as-usual scenario). In order for this community to reach its target of 80,000 tons, or a 20% decrease from baseline year emissions, the community must really offset 40,000 tons of emissions, rather than 20,000 tons. In this way, the forecast is an essential and useful tool for ensuring that targets are met in spite of growth.

City of Davis' inventory and forecast capture emissions from all areas of local government operations (i.e. municipal owned and/or operated buildings, streetlights, transit systems, vehicle fleets, wastewater treatment facilities and waste generated by government operations) and from energy and waste related community activities (i.e. residential and commercial buildings, motor vehicles, waste streams). The inventory excludes emissions from certain other sources such as agriculture, cement production, paving, air and marine traffic in accordance with the CCP protocol. This is because these sources are typically out of a local government's control and they are accounted for in state-level and national inventories.

The inventory and forecast provide a benchmark against which the towns and county can measure progress towards reducing emissions. In combination with an analysis of the impacts of existing climate mitigation activities in the community, the inventory will also enable City of Davis to identify those areas in which the local governments and the community at large have successfully reduced emissions and those areas that are auspicious for new mitigation activities. In this sense, the inventory and forecast are policy development tools.

## *2.2 Methodology*

ICLEI used the Clean Air and Climate Protection (CACP) software to develop a greenhouse gas emission inventory, forecast, target and local action plan. ICLEI also used the software to undertake an analysis of criteria air pollutants produced within the city. The CACP software applies fuel and sector-specific GHG and CAP emission factors to inputs of energy consumption in order to determine the emissions generated by the energy use.

**Electricity Emissions**

$CO_2e$ emissions from energy consumption are calculated by using emissions coefficients which specify the amount of $CO_2e$ produced per unit of energy used. The coefficients are standard for different fuel types, but vary for electricity consumption depending on the mix of fuel types used to generate electricity in the region in which the

municipality is located in any given year. The software uses the regions that are defined by the North American Electric Reliability Council (NERC) to determine regional variations in electricity emissions. These regions correspond to the grid-connected electricity-producing regions of the country. The City of Davis is located within NERC region 13 - Western Systems Coordinating Council/CN. CAP emissions are calculated using activity levels with emission factors. The
CAP emission factors used are provided in the CACP software.

The net emission of a pollutant from a given source in tons per year is expressed as the product of the emission factor by the source's activity rate:

$$E = Ef \times A$$

The emission factor *Ef* is process specific and has a unit of mass per quantity (mass or volume) of raw material processed at source, e.g., the emission factor from natural gas combustion has a unit of pounds per millions of Btu of natural gas burned. The activity rate *A* is the quantity (mass or volume) processed at the source per unit time.

**Fuel Emissions**

The CACP software uses a set of criteria air pollutant emission factors for each of the Residential, Commercial and Industrial sectors that are based on average technologies found in these sectors. These emissions factors represent the typical emissions of air pollutants associated with the burning of the fuels listed. In some cases, the emission factors vary by sector. These average emission factors can be used as defaults throughout the residential, commercial and industrial sectors for both inventory and measures analysis, and they are recommended for use in the analysis modules.

The software uses a separate common set of carbon dioxide emission factors for all sectors (municipal, residential, commercial, industrial and transportation), since carbon dioxide emissions vary only with the type and amount of fuel consumption and do not have significant technology dependence.

**Transportation Emissions**

The CACP software uses a simple equation for describing the impact of a particular measure or strategy for the transportation and vehicle fleet sectors. The following equation separates the vehicle miles traveled (VMT) component (number of trips, length of trips, number of people per vehicle) from the vehicle fuel efficiency (miles per US gallon ) and fuel (emissions/unit of fuel) components. For both greenhouse gases and air pollutants:

*Emissions = VMT X Emissions per VMT*

The two terms in this equation can be broken down further:

*VMT = (Person-Trips/Persons per Vehicle) X Trip Length (miles)*

The term in brackets represents vehicle-trips. The difference between the number of individual person-trips and the number of vehicle-trips depends on how many people there are in the vehicle. The vehicle occupancy factor (persons per vehicle) is the reason why transit and car-pooling are such effective ways of reducing emissions per passenger mile of travel.

*Emissions per VMT = Fuel Efficiency (i.e. MPG) X*
*Emissions per Unit of Fuel (emission coefficient)*

Combining these factors leads to the five-factor formula for transportation emissions:

*CO2 Emissions = (A/B) X C X D X E*

*A is the number of person trips made using the vehicle type*
*B is the number of people per vehicle (occupancy factor)*
*C is the trip length*
*D is the fuel consumption (in Gal/100miles)*
*E is the emissions per unit of fuel (i.e. the fuel type factor)*

Each one of these factors is dependent on a number of other factors (technological, behavioral, structural, etc.), and are interrelated. For example, a switch from an automobile to a diesel transit bus would change the value of *A* for cars and buses. While fuel consumption and emissions per unit (*D* and *E*) of fuel would increase due to the change in vehicle choice, the number of people per vehicle (on the transit bus) would increase substantially offsetting the increase of *D* and *E*.

Carbon dioxide emissions vary directly with the amount of fuel consumed; however, criteria air pollutant (CAP) emissions are not as directly related to the quantity of fuel consumed. Two vehicles with very different fuel efficiencies could have similar air pollution emissions per mile traveled and conversely, two vehicles with similar pollution emission profiles could have quite different fuel efficiencies. In the CACP software, average transportation emissions of greenhouse gases and air pollutants are based on actual *average* emissions of the entire on-road fleet of each vehicle type. However, $CO_2e$ emissions are calculated using fuel efficiency and CAP are calculated using vehicle miles traveled.

**Solid Waste Emissions**

Greenhouse gas emissions from waste and waste related measures depend on the type of waste and on the disposal method. The CACP software can only calculate $CO_2e$ emissions generated by solid waste (not CAP emissions). This is because there is insufficient information on waste related CAP emissions to enable the development of accurate coefficients for the software.

The combinations of waste types and disposal methods used in the CACP software are shown below. For each waste type and disposal method combination represented in the software, there is a set of five emission factors (*A, B, C, D, E*) which specify tons of $CO_2e$ emissions per ton of waste:

**Table 1.** Waste-related $CO_2e$ emission factors

| Factor | Description |
|---|---|
| A | GHG emissions of methane per ton of waste at the disposal site |
| B | GHG sequestered at the disposal site, in tons per ton of waste |
| C | GHG sequestered in the forest as the result of waste reduction and recycling measures |
| D | Upstream emissions from manufacturing energy use saved as the result of waste reduction or recycling, in tons of GHG per ton of waste |
| E | Non-energy related upstream emissions from manufacturing saved as the result of waste reduction or recycling, in tons of GHG per ton of waste |

In the GHG inventory, only emissions at the disposal site (factors *A* and *B*) are calculated. The following equation is used:

*GHG = Wt * [(1-R) A+B]*

Wt is the quantity of waste type 't", and R is the methane recovery factor which is only applied in the case of landfilled waste.

## *2.3 Community Inventory & Forecast Data Collection*

This section contains a discussion of the sources of information that were used for calculating emissions. A complete list of data sources is included in Appendix A.

**Growth Indicators**
Growth indicators include population, number of households, commercial and industrial employees and land use for the base year 1990 and the forecast year 2015. The city's population, number of households, and commercial/industrial employment in 1990 were obtained from the U.S. Census. Estimates are also based upon information from State Department of Finance, Employee Development Department and UCD Office of Information and Resource Management. Staff from the City of Davis Community Development Department estimated the projected 2015 population and number of households based on their expertise.

**Residential and Commercial/Industrial**
Residential and Commercial energy usage data for 2003 to 2006 was provided by PG&E. Average energy use per household was used to estimate 1990 to 2002 consumption. Similarly, average energy use per square foot from 2003 to 2006 was used to estimate 1990 to 2002 consumption.

**Transportation**
The transportation sector of the citywide greenhouse gas emissions inventory attempts to quantify the emissions that result from energy used for transportation within the City of Davis. Emissions from automobiles which travel from outside of the city are counted from the point where the vehicle enters the city.

The calculation of on-road vehicle emissions was based on an estimation of vehicle miles traveled (VMT). For 1990, average daily vehicle miles traveled in Davis were available through the Federal Highway Administration Highway Statistics (1994-2006). Data is broken down by city. There is an inventory of the miles of different road types within the city (principle arterial, collector, local) and its associated daily vehicle miles of travel. Average daily vehicle miles traveled were further converted into annual vehicle miles traveled. The average annual percentage change between 1994 and 2005 was used to estimate the miles traveled in 1990. For example, VMT increased on average 3% each year. See Appendix F.

2015 VMT was estimated by using Yolo Country VMT projections embedded in the EMFAC07 software. See Appendix G.

VMT for each category was entered into the CACP software. The calculation embedded in the software is:

*VMT (miles) x average fuel efficiency of vehicle category (miles per gallon) x CO2e coefficient for fuel type (pounds per gallon) = pounds of CO2e*

The average fuel efficiency of each vehicle category is based on distribution vehicles within each class based on national trends of actual vehicle use. The original source for this data was the U.S. Energy Information Administration's *Transportation Energy Databook*. EMFAC07 provides data on vehicle breakdown in Yolo County in 1990 and 2015. See Appendix H.

Unitrans is the bus transit system that serves the City of Davis and UC Davis. 1990 fuel consumption data was provided by Unitrans staff.

**Solid Waste**

The City of Davis sends its waste to the Yolo County Landfill just outside the city. Staff from the City of Davis Public Works Department provided data on total tonnage of waste sent to the landfill in 1990. Waste stream composition was determined based on a waste characterization study provided by city staff. Table 2 summarizes the waste share of each sector.

**Table 2.** Solid waste share for citywide inventory

| Waste Type | Waste Share |
|---|---|
| Paper products | 20% |
| Food waste | 12% |
| Plant debris | 6% |
| Wood/textiles | 13% |
| All other waste (non-organic) | 49% |

The CACP software calculates waste sector emissions based on a number of factors, including: the methane recovery factor at the landfills to which the city's solid waste is sent; the total amount of solid waste sent to the landfill; the composition of the waste sent to the landfill; and emissions coefficients derived from the U.S. EPA's Waste Reduction Model (WARM).

## *2.4 Municipal Operations & Forecast Data Collection*

City staff provided energy consumption and cost data for their area of municipal operations. A complete list of data sources is provided in Appendix A. In the absence of data, estimates of total energy use and/or cost were made. These cases are described in detail in those specific sections of the report.

# 3. 1990 $CO_2e$ Emissions Inventory

The inventory section of the report provides estimates of the greenhouse gas emissions within the community as a whole and emissions produced by local government operations in the baseline year 1990. In the sections below, emissions from each module (community and local government) are broken down into five different sectors to provide a detailed analysis of each module. This model of categorizing emissions into modules and sectors follows the Cities for Climate Protection (CCP) protocol which has been developed to facilitate and standardize emissions inventories that take part in the CCP program. The local government operations module is a subset of the community module.

All outputs from the CACP software used in this report are in units of metric tons of carbon dioxide equivalent ($CO_2e$). $CO_2$ equivalent is a common unit that allows emissions of greenhouse gases of different strengths to be added together and allows each greenhouse gas to be weighted according to its relative contribution to global climate change. For example, methane and nitrous oxide are much less abundant than carbon dioxide in the atmosphere, but because they have a greater potential to impact global climate change, conversion into $CO_2e$ accords them much more weight than their abundance may suggest.

## *3.1 Community Inventory*

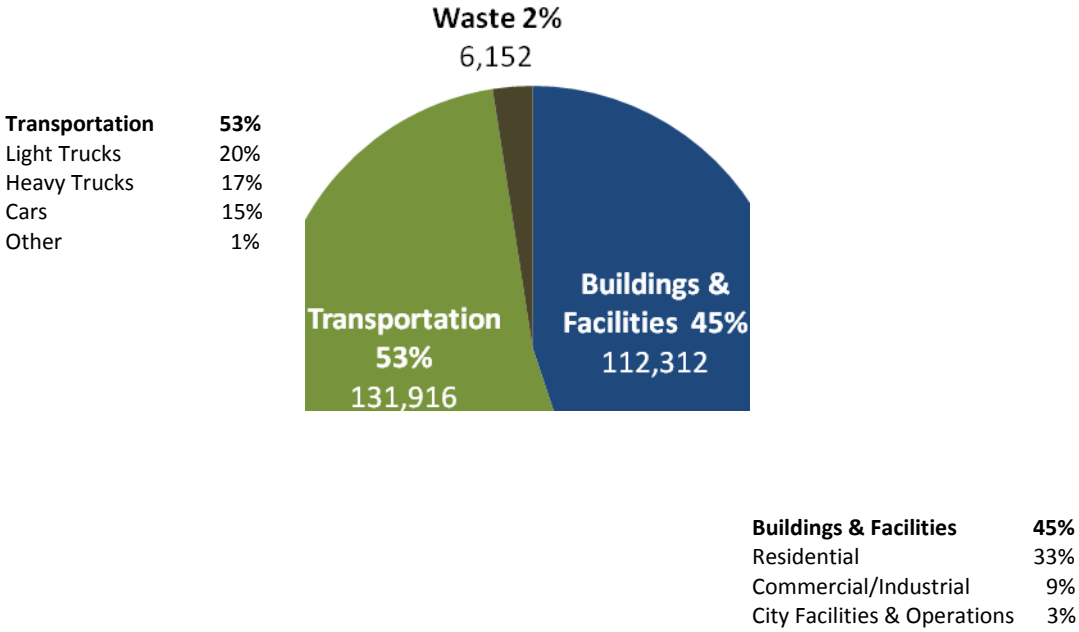
The community inventory provides an estimate of all of the greenhouse gas emissions produced within the City of Davis both by residents in their homes and by local businesses and agencies as they carry out their operations.

- Greenhouse gas emissions in Davis from civic operations and the community are primarily resulting from, natural gas and electricity use in buildings, fossil-fuel use for ground transportation and methane emissions in the landfill.
- The buildings and facilities sector represent emissions that result from electricity and natural gas used in both private and public buildings and facilities. The transportation sector includes emissions from private, commercial and fleet vehicles driven within the City's geographical boundaries as well as the emissions from transit vehicles and the city-owned fleet.
- In 1990, the City of Davis emitted approximately 250,038 tons of $CO_2e$ emissions.
- In 2005, the City of Davis emitted approximately 309,367 tons of $CO_2e$ emissions.
- The transportation sector was the largest contributor to total emissions, responsible for 53% of the greenhouse gas emissions produced within the city, followed by the residential sector (33%), the commercial/industrial sector (12%), and the waste sector (2%).

**Table 3.** 1990 community $CO_2e$ emissions by sector

| 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** |

**Figure 1.** 1990 community $CO_2e$ emissions by sector




| | |
|---|---|
| **Transportation** | **53%** |
| Light Trucks | 20% |
| Heavy Trucks | 17% |
| Cars | 15% |
| Other | 1% |

| | |
|---|---|
| **Buildings & Facilities** | **45%** |
| Residential | 33% |
| Commercial/Industrial | 9% |
| City Facilities & Operations | 3% |

**Figure 2.** 1990 greenhouse gas emissions summery by source type for Davis. Emissions are shown as metric tons of $CO_2$ equivalent, along with percent of overall inventory

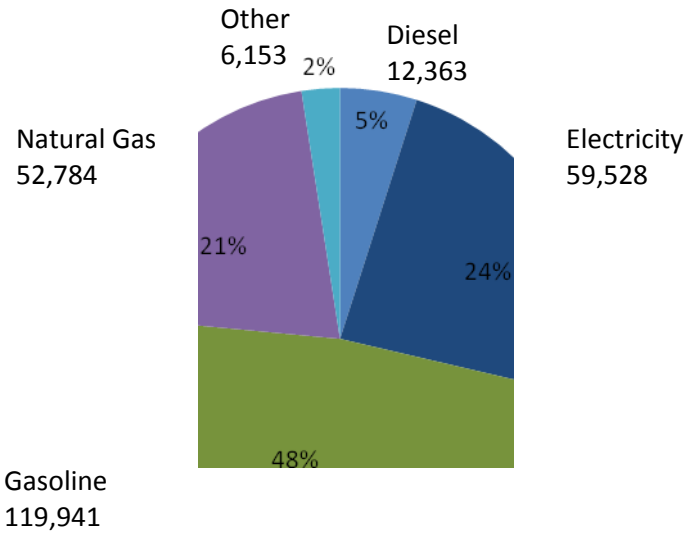


**Figure 3.** 2006 community $CO_2e$ emissions by sector

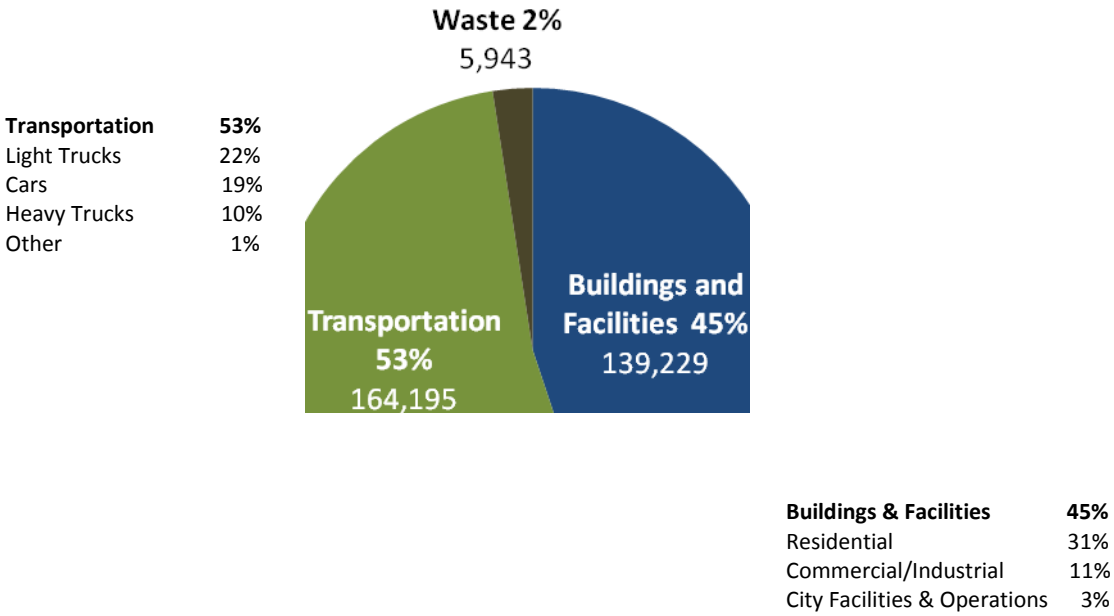
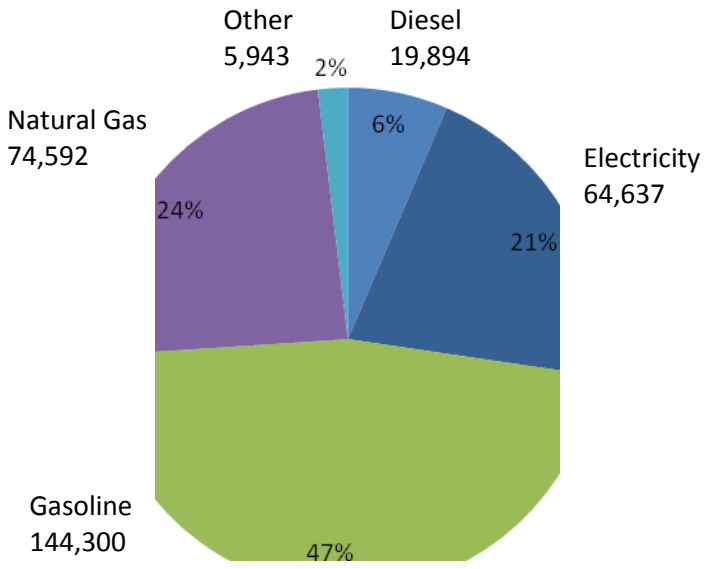



**Figure 4.** 2006 greenhouse gas emissions summery by source type for Davis. Emissions are shown as metric tons of $CO_2$ equivalent, along with percent of overall inventory

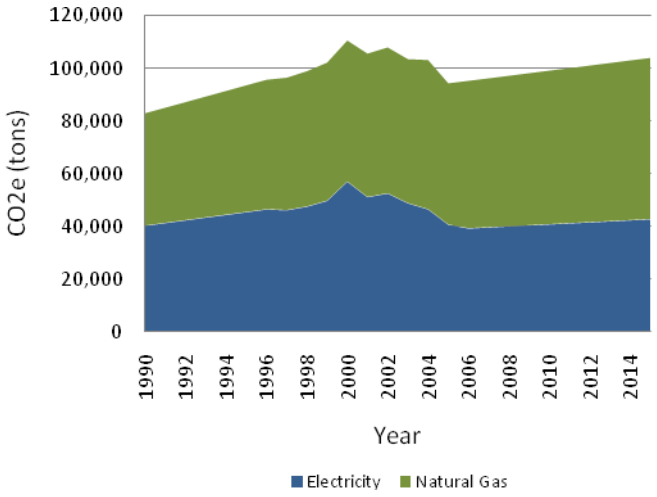


**Residential Sector:** In 1990, there were approximately 18,282 households in Davis. Within the residential sector, energy is consumed for such end-uses as space and water heating and cooling, appliances and lighting. The residential sector emitted approximately 82,835 tons of $CO_2e$ emissions and was responsible for 33% of all emissions within the City of Davis.

**Table 4**. 1990 Residential $CO_2e$ emission

| Fuel Type | $CO_2e$ (tons) | | Energy (MMBtu) |
|---|---|---|---|
| **Electricity** | 40,303 | 49% | 397,273 |
| **Natural Gas** | 42,532 | 51% | 688,413 |
| **Total** | **82,835** | | **1,085,685** |

**Figure 5.** Residential GHG Inventroy Profile, 1990-2015

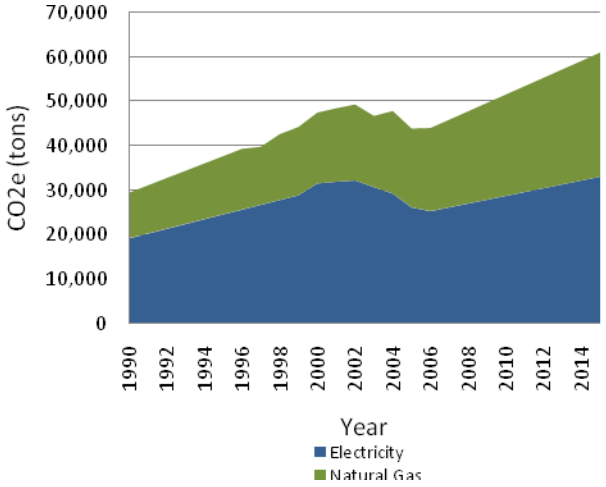



**Commercial & Industrial Sector:** The commercial/industrial sector consists of offices, retail, institutions (hospitals, schools, etc.) and government facilities. In 1990, the commercial/Industrial sector released approximately of 29,477 tons of $CO_2e$ emissions and was responsible for 12% of the City's total emissions. There were 1,003 commercial and industrial establishment and about 9,617 employees within the sector.

**Table 5.** 1990 Commercial/industrial $CO_2e$ emission

| Fuel Type | $CO_2e$ (tons) | | Energy (MMBtu) |
|---|---|---|---|
| **Electricity** | 19,225 | 65% | 189,497 |
| **Natural Gas** | 10,252 | 35% | 165,944 |
| **Total** | **29,477** | | **355,441** |

**Figure 6.** Commercial GHG Inventroy Profile, 1990-2015



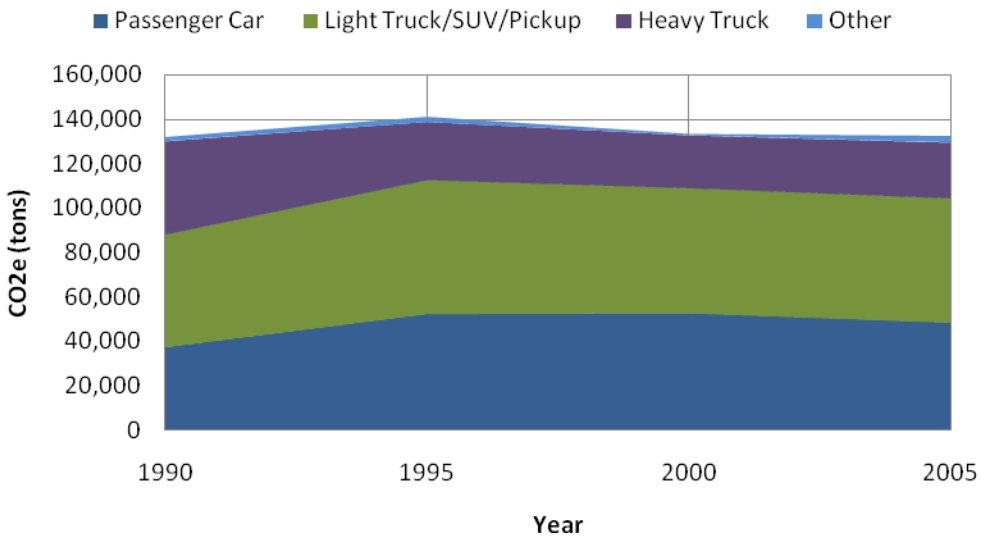
**Transportation Sector:** The transportation sector is responsible for about 53% of the City's greenhouse gas emissions.

- In 1990, motor vehicles driven within the City's boundaries emitted approximately 131,905 tons of $CO_2e$ emissions.
- Table 6 shows vehicle miles traveled (VMT) breakdown by fuel and vehicle type and associated $CO_2e$ emissions. Heavy trucks, light truck, SUVs, and pickups represent about 50% of the VMT and subsequently have the highest percentage (70%) of $CO_2e$ emissions.
- Passenger cars (compact, mid-size, and full-size) account for almost half of the VMT within Davis; yet, the same vehicle type only produces 28% of the total $CO_2e$'s emitted within the transportation sector.

**Table 6**. 1990 VMT breakdown by fuel type, vehicle type and $CO_2e$ emissions

| Vehicle Type | VMT | % | $CO_2e$ (tons) | % |
|---|---|---|---|---|
| **Car** | 68,341,350 | 48.4% | 37,435 | 28.4% |
| **Light Truck/SUV/Pickup** | 51,854,880 | 36.8% | 50,851 | 38.6% |
| **Heavy Truck** | 18,741,030 | 13.3% | 41,765 | 31.7% |
| **Motorcycle** | 1,127,280 | 0.8% | 572 | 0.4% |
| **Passenger Van** | 563,640 | 0.4% | 380 | 0.3% |
| **Transit Bus** | 439,000 | 0.3% | 913 | 0.7% |
| **Total** | **141,067,180** | | **131,905** | |

**Figure 7**. 1990-2005 transportation $CO_2e$ emissions by vehicle type



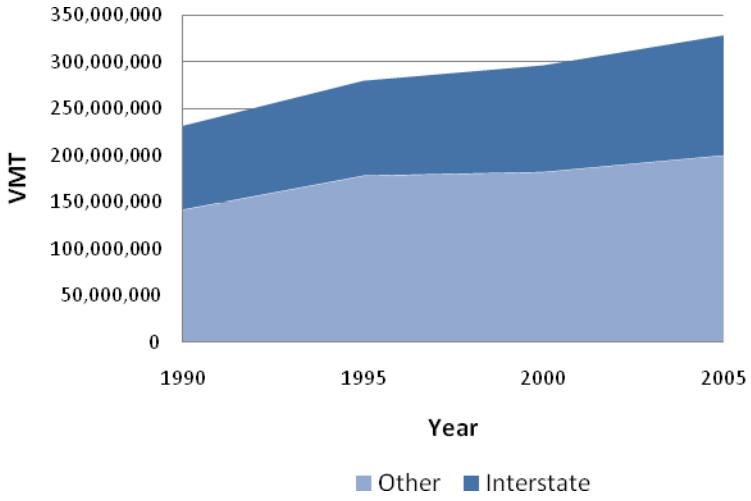

**Interstate Travel**: Interstate traffic is excluded from the inventory because the city has limited influence in reducing VMT on this vehicular corridor.

- It is thought that a high percentage of motorists driving on the interstate are simply passing by Davis on their way to other Sacramento cities and the Lake Tahoe region. For example, many Bay Area motorists pass by Davis on the way to Tahoe for the weekend. It is unclear and difficult to estimate what

percentage of the vehicles are Davis residents traveling from one side of the city to the other. ICLEI is currently collaborting with CalTrans to determine ways of measuring and mitigating GHG emisions from vehicle travel on highways. Further analysis is needed.

- The interstate accounts for about 40% of the vehicle miles traveled in the Davis boundary (see Figure 5). Other roads in Davis include: local, collector, minor arterial and other principle arterials.
- In 1990, approximately 69,638 tons of eCO2 were emitted from the interstate. In 2005, approximately 84,176 tons of $CO_2e$ were emitted or about *1.3 tons $CO_2e$ per capita*.

**Figure 8.** Annual VMT broken down by interstate and other roads




**Airline Travel**: Emissions from air transportation are largely outside the City's ability to influence and are therefore not included in Davis' inventory. The national average for miles flown is 2,700 miles/person/year or about *1.4 tons CO2e per capita*.[1]

**Solid Waste Sector:** In 1990, 35,419 tons of municipal solid waste was produced within Davis and sent to the Yolo County Landfill. As a result, 6,152 tons $CO_2e$ were produced, emitting about 2% of the total emissions.

- Emissions from the production of food and consumer goods are attributed to the jurisdiction in which they are produced, not where they are consumed.

## Comparions with Other Cties and National Data

**What are "per capita emissions"?:** When discussing greenhouse gas inventories, "total emissions" and "per capita" emissions" are commonly used terms. When making comparisons between other cities or countries, per caopita emissions are a useful metric that help to normalize what are otherqise very big numbers. For example, if two contries have the same total emissions of 20 bllion tons each, but one country has three times the population, then the per capita emissions in that country will be 1/3 that of the other. There could be many reasons for the per capita differences, including more or less development or prosperity, warmer versus colder climate, better urban planning policies, or higher nuclear versus fossil-fuel power generation.

[1] Denver Climate Action Plan

**Figure 9.** Davis' per capita greenhouse gas emissions compared to the national average, Satate of California, and to other cities within California.

| | Davis' 2006 Per Capita Greenhouse Gas Emissions (tons $CO_2e$ per person) | National State & other Cities 2005 Per Capita Greenhouse Gas Emissions ($CO_2e$ per person) |
|---|---|---|
| Direct energy use plus airline and highway travel | 7.5[2] | National: 24[3]<br>California: 14[4] |
| Direct energy use (no airline and highway travel) | 4.8 | Other California Cities: 6.3 – 17.5[5]<br>Other U.S. Cities: 11.5 – 19.5[6] |

**Comparison with National Average:** When emissions from airline and highway travel are included in Davis' greenhouse gas footprint, per capita greenhouse gas emissions for 2005 are lower than the national average. Davis' per capita emissions are also lower than the per capita emissions computed for the State of California. This consideration of both highway and airline travel allows for a more complete estimation of the city's greenhouse gas footprint. Highways and airline travel have not usually been included in other cities' inventories, making their greenhouse gas footprint apear lower than the national average.

**Comparison with surrounding cities:** Davis' per capita greenhouse gas emissions, without the inclusion of the highway and airline travel, were 4.6 tons $CO_2e$ per person for 2006. This lower than per capita emissions of other cities in the region; however, differences amoung data sets and time of data collection makes such comparisons more difficult. Comparisons with cities in other regions may not be appropriate due to climate variability significantly impacting building energy use.

[2] Air and highway travel are added: Air travel - 1.4 tons $CO_2e$ per capita. Highway travel - 1.3 tons $CO_2e$ per capita.

[3] U.S. Department of Energy: Energy Information Administration. "Emissions of Greenhouse Gases Report."

[4] California Energy Commission. "California Greenhouse Gas Emissions and Sink Summary: 1990 to 2004."

[5] Cities include Berkely (6.3), San Francisco County in year 2000 (13), Menlo Park (16), and Contra Costa County in 2006 (17.6).

[6] Cities include Portland County (Multnomah County Global Warming Porgress Report 2005), Seattle (Seattle's Community Carbon Footprint: an Update October 29, 2007), and Denver (19.5).

## *3.2. Municipal Operations Inventory*

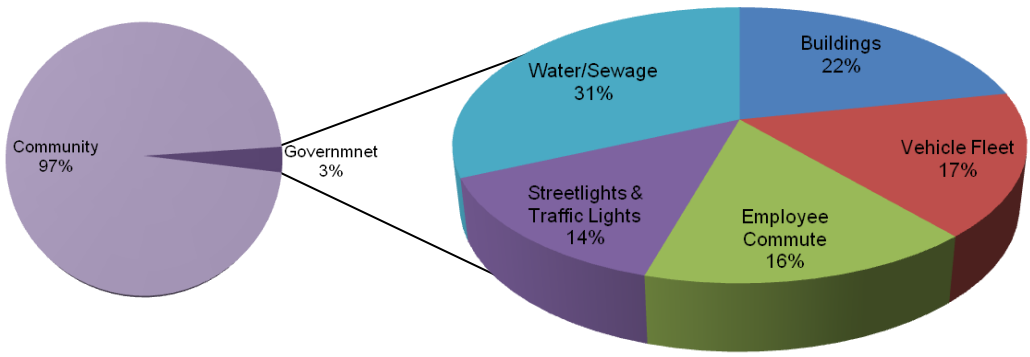
The local government module quantifies emissions from buildings, vehicle fleets, employee commute, streetlights and traffic signals, water and sewage facilities, and waste produced by municipal operations.

- The local government module is reported in more detail than the community module because local governments have direct control over their own operations and it is therefore the area in which they are most likely to be able to directly affect major emissions reductions, and can act as a leader within their own community.
- The City of Davis emitted approximately 6,804 tons of greenhouse gases in 1990.
- This accounts for approximately 3% of the emissions produced by the community as a whole, a figure that is normal for many local governments.

**Table 7**. 1990 municipal $CO_2e$ emissions

| Potential Sources | $CO_2e$ (tons) | | Energy (MMBtu) |
|---|---|---|---|
| | tons | % | |
| Buildings | 1,485 | 22% | 19,889 |
| Vehicle Fleet | 1,172 | 17% | 13,695 |
| Employee Commute | 1,085 | 16% | 12,517 |
| Streetlights & Traffic Lights | 958 | 14% | 9,440 |
| Water/Sewage | 2,159 | 32% | 21,498 |
| Waste | 51 | <1% | |
| **TOTAL** | **6,855** | **100%** | **77,039** |

**Figure 10**. 1990 municipal $CO_2e$ emissions by sector




**Buildings:** The City of Davis municipal buildings include City Offices, the Fire Department, Police Department, Senior Center, community pools, Public Works Department, and Veteran's Center.

- In 1990, municipal facilitates consumed 1,844,634 kWh of electricity and 134,493 therms of natural gas, which produced 1,485 tons of $CO_2e$ emissions.
- This accounts for 22% of all emissions from local government operations.
- There were three pools in the City of Davis in 1990: Community Pool, Manor Pool, and the Civic Center Pool. In total, they emit about 766 tons of $CO_2e$ emissions and account for about 52% of total emissions within the sector.

- To maximize the effectiveness of any investments that the city decides to make to reduce greenhouse gas emissions and energy use in the facilities, the government may want to target those facilities that are most energy and emission intensive (i.e. energy use and emissions per square foot).

**Table 8**. 1990 municipal buildings $CO_2e$ emissions

| Fuel Type | $CO_2e$ (tons) | | Energy (MMBtu) |
|---|---|---|---|
| **City Offices** | 155 | 10% | 1,791 |
| **Fire Dept.** | 119 | 8% | 1,555 |
| **Police Dept.** | 117 | 8% | 1,252 |
| **Public Works** | 66 | 4% | 841 |
| **Community Pools** | 766 | 52% | 11,293 |
| **Senior Center** | 103 | 7% | 1,247 |
| **Veteran's Center** | 160 | 11% | 1,909 |
| **Total** | **1,486** | **100%** | **19,888** |

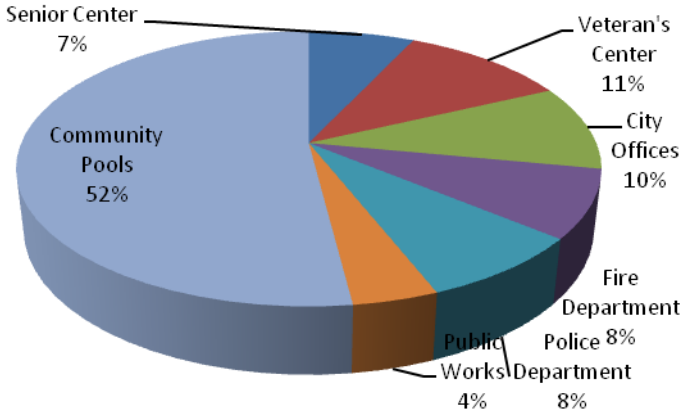



**Figure 11**. 1990 municipal buildings $CO_2e$ emissions

**Vehicle Fleet:** In the base year 1990, the City's vehicle fleet consumed approximately 148,830 gallons of gasoline and diesel and emitted approximately 1,172 tons of $CO_2e$ emissions.

- The municipal fleet includes all vehicles owned and operated by the City of Davis.
- The Police Department produced the largest amount (48%) of $CO_2e$ emissions within the municipal vehicle fleet. The Public Works and the Parks and Community Services Department each produced 22% of total emissions.

**Table 9.** 1990 vehicle fleet $CO_2e$ emissions

| Vehicle Fleet | Number of Vehicles | $CO_2e$ (tons) | | Energy (MMBtu) |
|---|---|---|---|---|
| **City Offices** | 7 | 12 | 1% | 141 |
| **Fire Dept.** | 1 | 5 | 0.4% | 57 |
| **Police Dept.** | 15 | 79 | 7% | 911 |
| **Public Works** | 48 | 259 | 22% | 3,080 |
| **Community Pools** | 47 | 558 | 48% | 6,488 |
| **Senior Center** | 85 | 259 | 22% | 3,018 |
| **Total** | **203** | **1,172** | **100%** | **13,695** |

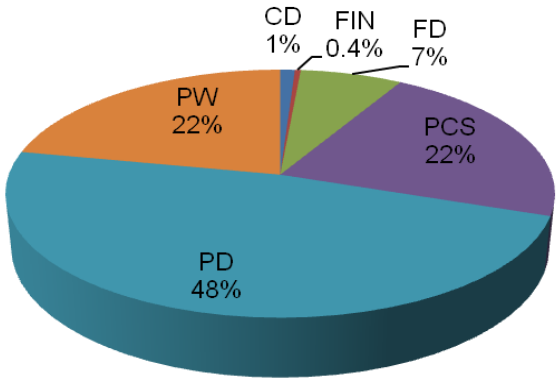



**Figure 12**. 1990 vehicle fleet $CO_2e$ emission

**Water and Sewage:** In 1990, the water and sewage sector accounted for the largest percentage (37%) of greenhouse gas emissions within municipal operations, producing 2,159 tons of $CO_2e$ emissions.

- The water and sewage sector includes all water treatment and waste water facilities, and all pumping stations and lift stations that serve the community.
- Water and wastewater are included in the government module of the inventory because water and wastewater treatment facilities often fall under the direct control of the local government. Local governments have control over the efficiency of these facilities.
- In 1990, water production used a total of 4,338,800 kWh and pumped 3,670,299,520 gallons of water. On average 846 gallons were pumped per kilowatt hour. Water production emits approximately 1,532 tons of $CO_2e$ and produces about 71% of the total $CO_2e$ emissions within the sector.

**Table 10**. 1990 water and sewage $CO_2e$ emissions

| Water/Sewage | $CO_2e$ (tons) | | Energy (MMBtu) |
|---|---|---|---|
| **Sewer Lifts & Collections** | 159 | 7% | 1,596 |
| **Waste Water Treatment Plant** | 469 | 22% | 4,620 |
| **Water Production** | 1,532 | 71% | 15,282 |
| **Total** | **2,160** | **100%** | **21,498** |

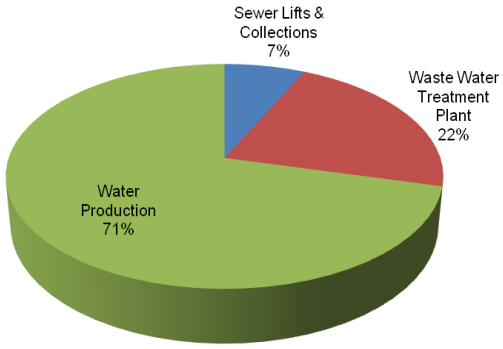



**Figure 13**. 1990 water and sewage $CO_2e$ emissions

**Streetlights and Traffic Lights:** This sector includes road lighting, park lighting, specialty or accent lighting, traffic signals, and other lights operated by the city.

- All city lights produced 958 tons of greenhouse gases. Lighting is responsible for 16% of the total emissions from municipal operations.
- Streetlights used 2,164,761 kWh and traffic lights used 601,150 kWh.

**Table 11**. 1990 streetlights and traffic lights $CO_2e$ emissions

| Streetlights | $CO_2e$ (tons) | | Energy (MMBtu) |
|---|---|---|---|
| **Streetlights** | 750 | 78% | 224,486 |
| **Traffic Lights** | 208 | 22% | 62,339 |
| **Total** | **958** | **100%** | **286,825** |

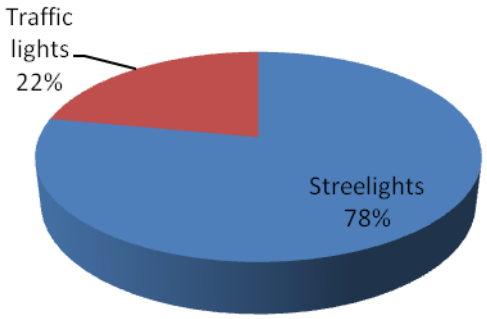



**Figure 14.** 1990 Streetlight $CO_2e$ emissions

**Solid Waste Produced by Municipal Operations:** This sector includes emissions from solid waste generated through government operations.

- This includes all employee generated waste and waste generated at municipal government facilities such as parks and recreation buildings.
- It is estimated that the City of Davis facilities and operations produce a total of 238 tons of garbage in 1990. However, because methane was captured from the landfill it is considered to have negative emissions.

**Employee Commute:** There were 366 local government employees in 1990.

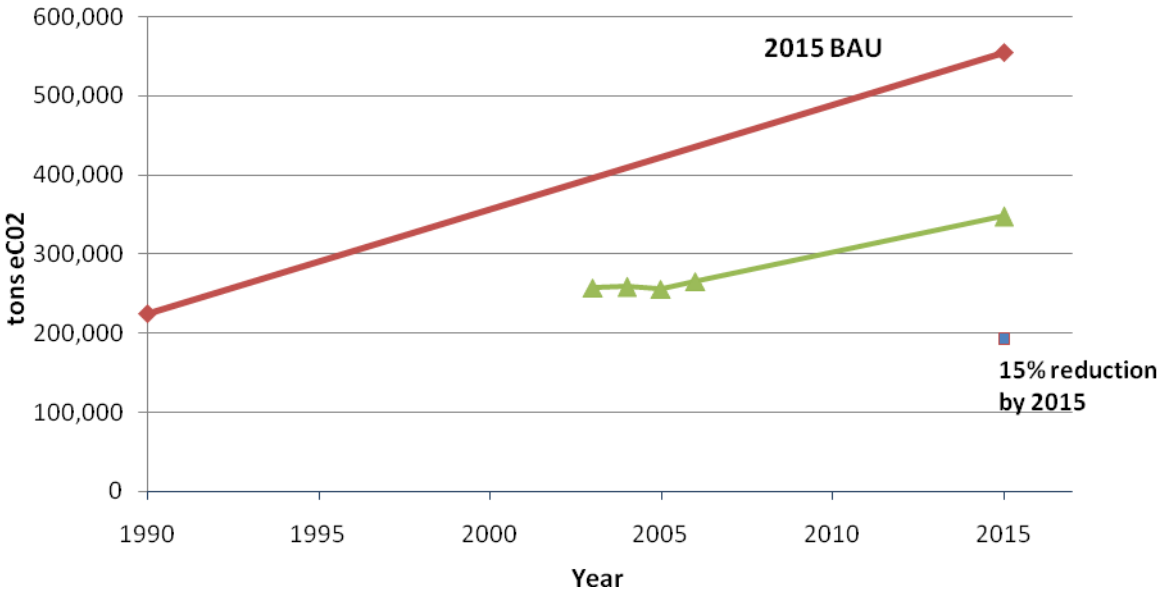
- It is estimated that they traveled an average of 14 miles one-way and total number of trips were 183,000, resulting in 2,562,000 passenger miles traveled (PMT). PMT is a person mile of travel equals one person traveling one mile, by any mode, including walking, cycling, automobile, van pool, transit, etc.
- Employee commute produced approximately 1,085 tons of $CO_2e$ emissions.

# 4. Forecast and $CO_2e$ Emissions Reduction Target

The forecast section of the report provides an estimate where emissions might be by the target year if growth continues at current rates and nothing more is done to check $CO_2e$ emissions. Both a business-as-usual (BAU) forecast and planned measures forecast were developed. The BAU forecast provides an estimate of $CO_2e$ emissions in the target year if no new measures are implemented between the baseline year and the target year.

The City of Davis has selected 2015 as the potential year by which the community will achieve an emissions reduction target. In order to determine the level of emission reductions that could be achievable given socio-economic growth in the region, emissions were forecast to 2015 using a set of growth factors. Two possible future scenarios were developed: a business-as-usual (BAU) forecast and a forecast that includes the potential emissions reductions target of 15% below 1990 levels.

**Figure 15**. Community $CO_2e$ emissions, base year & target year




## *4.1 Community Forecast*

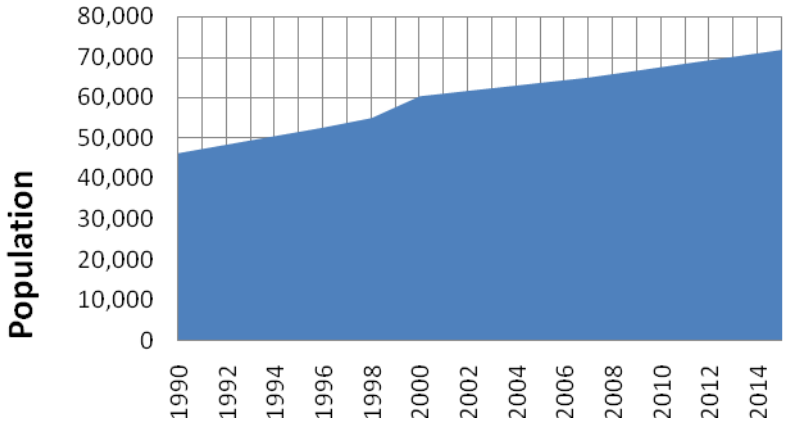
The City of Davis has selected 2015 as the year by which the community will achieve a voluntary $CO_2e$ emissions reduction target. In order to determine the level of emission reductions that could be achieved given socio-economic growth in the region, emissions were forecast to 2015 using a set of growth factors described in Table 12. The methodology used is described in more detail in section 2.

**Table 12**. Community forecast growth indicators

| Indicator | 1990 Value | 2007 Value* | Actual Annual Growth Rate | Projected Growth Rate (Max) | 2015 Projected Value | Total Growth |
|---|---|---|---|---|---|---|
| Population | 46,209[7] | 64,938[8] | 2.4% | 1%** | 71,796 | 55% |
| Households | 18,282[9] | 25,729[10] | 1.6% | 1%** | 28,429 | 56% |
| Commercial/Industrial Employees | 9,617[11] | 26,417* | 10.28% | 10.28%*** | 37,354 | 288%**** |
| Floor area | 2,370,635 | 4,633,125 | 5.6% | 5.6%*** | 6,968,220 | 194%**** |

* Estimate based upon information from State DOF, EDD and UCD Office of Information and Resource Management.
** 1% is projected at 300 units per year at approximately 2.5 persons per unit.
*** Since sufficient capacity remains to accommodate the historical growth rates through 2015 without General Plan amendments, it is assumed that these rates for Commercial/Industrial employees and floor area will remain.
**** A capacity of 9,051332 additional square feet of land area for commercial and industrial exists within the City. An assumption of build out of this land at a historical 35% FAR for commercial, office, industrial, mixed use land uses is made to yield a capacity of 3,167,966 square feet remaining undeveloped in the City.

**Figure 16**. Annual Population Growth




**Business-as-Usual Scenario:** The business-as-usual (BAU) emissions scenario provides a projection of potential emissions in 2015 if no new emission reduction measures are implemented in the City of Davis.

- Residential and commercial/industrial $CO_2e$ emissions were forecast to 2015 using socio-economic growth indicators provided by statistics from the City of Davis Planning Department, Sacramento Area Council of Governments (SACOG), and U.S. Census. For example, for the residential section of the forecast, per household emissions in 1990 were applied to the anticipated growth in the number of households in the community to forecast BAU residential emissions for 2015. The same was done for the commercial/industrial sector, using emissions per employee as the critical indicator.

- Transportation emissions were forecast using projections of VMT in 2015 that were developed by comparing the EMFAC 2015 VMT in Yolo County forecast and the average percentage of miles driven within Davis (12%). See Appendix G.

[7] SACOG as of 1/1/07.
[8] Ibid
[9] Ibid
[10] Ibid
[11] State Department of Finance, Economic Demographics Division

- Solid Waste emissions were forecast by applying 1990 per capita waste generation rates to 2015 population projections.
- In the BAU scenario, $CO_2e$ emissions would increase to approximately 334,216 tons of $CO_2e$ by 2015, which would be an increase of approximately 41% from 1990 levels. This growth would correspond with projected local economic and population growth.

**Table 13**. Community $CO_2e$ emissions growth trends by sector

| 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%** |

## *4.2 Municipal Operations Forecast*

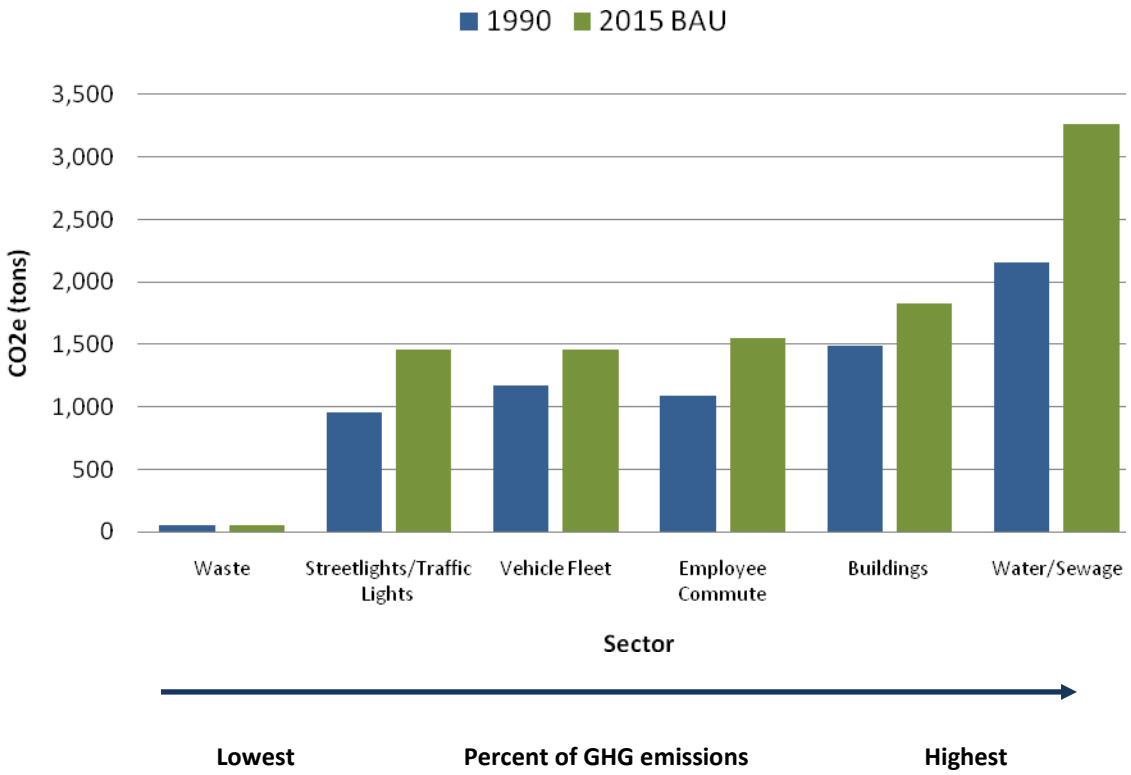
Emissions from the local government operations were projected to 2015 following a similar methodology used to develop the community forecasts. The overall increase can be attributed to population growth in the city thus the requirement of more streetlights and more sewer pumps.

Based on 1990 levels, total municipal $CO_2e$ emissions are expected to grow 40% by 2015. Table 14 shows percentage growth by sector. $CO_2e$'s emitted within the streetlights sector are expected to grow the most (52%), followed by the water and sewage sector (51%), employee commute (43%), vehicle fleet (24%) and the buildings sector (23%). Figure 12 shows growth in $CO_2e$ emissions by sector.

**Table 14**. Municipal operations $CO_2e$ emissions by sector and growth trends, 1990 and 2015 BAU

| Sector | 1990 $CO_2e$ (tons) | 2015 $CO_2e$ (tons) | Growth |
|---|---|---|---|
| Buildings | 1,485 | 1,826 | 23% |
| Vehicle Fleet | 1,172 | 1,456 | 24% |
| Employee Commute | 1,085 | 1,552 | 43% |
| Streetlights and Traffic lights | 958 | 1,454 | 52% |
| Water/Sewage | 2,159 | 3,261 | 51% |
| Waste | 51 | 51 | 0% |
| **Total** | **6,855** | **9,545** | **40%** |

**Figure 17**. Municipal operations $CO_2e$ emissions trends by sector, 1990 and 2015 BAU



# 5. Next Steps

### *5.1 Adopt GHG Emissions Reduction Target*

Upon the completion of the GHG emissions inventory for the baseline and forecast year, the municipality should next set a GHG reduction target to drive its emissions reduction efforts. To inform the selection of a GHG reduction target for the City of Davis, Table 15 illustrates targets that have been set by Ab-32 and similar cities.

**Table 15**. Existing GHG emissions reduction targets

| Municipality | GHG Reduction Target |
|---|---|
| Ab-32 | 2000 levels by 2010<br>1990 levels by 2020<br>80% below 1990 levels by 2050 |
| Berkeley | 15% below 1990 levels<br>80% below current levels |
| Oakland | 15% below 1990 levels by 2010 |
| Alameda County | 80% below current levels by 2050 |
| Marin County | 15-20% below 2000 levels by 2020 |
| San Francisco County | 20% below 1990 levels by 2012 |

To demonstrate this point, consider that adopting a reduction target o 15% below 1990 levels by 2015, would require a reduction of 3,710 metric tons of carbon dioxide equivalent from the City's annual municipal emissions inventory. For citywide emissions, this would require a reduction of 121,586 metric tons of carbon dioxide equivalent from the annual community emissions inventory. It is clear that City will not be able to achieve substantial long term citywide emissions solely by implementing measures that fall within the City's existing authority and jurisdiction.

### *5.2 Actions to Meet the Reduction Target*

When selecting potential GHG reduction measures to meet the reduction target, the following should be considered: GHG reduction potential (if available), operational feasibility, cost, payback period (if applicable), and availability of rebates and funding. As these measures are solidified, the CACP software can model potential GHG emissions reductions and cost savings resulting from the selected measure.

Table 16 illustrates different activity reduction scenarios and their associated GHG reduction potentials, as modeled by the CACP software. The extent to which any of these reduction scenarios could be achieved by implementing an assortment of the measures listed above has not yet been determined pending further analysis as a part of the development of a Local Action Plan.

**Table 16**. Citywide reduction scenarios and their GHG reduction potentials

| Emission source | Reduction Scenario | Activity reduction | Amount of $CO_2e$ (tons) |
|---|---|---|---|
| Electricity | Reduce residential electricity use by 20%* | 32,646,557 kWh | 13,559 |
| Electricity | Reduce commercial/industrial electricity use by 20%* | 1,88,535 therms | 11,662 |
| Natural Gas | Reduce residential natural gas use by 20%* | 21,082,969 kWh | 8,754 |
| Natural Gas | Reduce commercial/industrial natural gas use by 20%* | 634,242 therms | 3,918 |
| Transportation | Reduce VMT by 20%** | 41,167,830 vehicle-miles | 24,528 |

* Assumptions: Energy consumption based on 1990 figures
** Assumptions: Initial fuel is gasoline because it is the majority of all fuel consumed within Yolo County. Vehicle type is passenger vehicle (see Appendix H for definition).

### *5.3 Timeline*

The CCP campaign is a global coalition of local governments working to reduce greenhouse gases at the community level. As apart of this campaign, the City has voluntarily committed to complete the following "milestones":

1. Conduct a baseline emissions inventory and forecast.
2. Adopt an emissions reduction target for the forecast year.
3. Develop a Local Action Plan.
4. Implement policies and measures.
5. Monitor and verify results.

Appendix I shows the preliminary process schedule for completing the Davis GHG emissions reduction plan. The preliminary schedule shows meetings, key milestones, public forums, joint meetings, and general work products. Staff is estimating that with the high level of public involvement and multiple layers of advisory bodies involved in plan development and evaluation, the plan will be completed in fall 2008. Detail on the roles and responsibilities of the various advisory bodies involved in the plan development is provided in the next section of this report.

Per Council direction, staff will continue to identify, evaluate, and recommend GHG reduction measures for early implementation concurrent with the development of the long-range plan. Staff will prioritize those early actions that will fit into the long-range plan when it is complete. The preliminary process schedule is an organizational tool and is not intended to lock the Council or any advisory body into an inflexible timeline. Staff anticipates that as the CAT and the SAT begin their work, specific meeting schedules will be established that work for each body.

The preliminary process schedule also includes joint meetings to ensure that the Council and Natural Resources Commission will receive formal updates and be able to provide direction as the Plan is being developed.

### *5.4 Advisory Bodies*

The development of a long range GHG reduction plan requires engagement across all sectors of the community. The objective of forming the CAT and SAT is to develop a deeper understanding of the issues associated with climate change and to take advantage of the extraordinary talent that is unique to Davis. The following table provides a summary of the roles and responsibilities of the various groups.

Climate Action Team (CAT)

The purpose of the Ad Hoc Climate Action Team (CAT) is to assist city staff in accelerating the development of a Greenhouse Gas Reduction Plan (Plan) for the City of Davis and the community as a whole to address the issues of greenhouse gas emissions. The CAT will develop and implement with the active involvement of designated city staff a process to facilitate community input and comment designed to increase overall awareness of the efforts as well as to generate innovative approaches and comprehensive strategies to address the City's goal of significantly reducing the GHG emissions of the City and the community as a whole.

**Timeline**

This is an Ad Hoc and time limited effort. The development of a comprehensive Greenhouse Gas Reduction Plan and community engagement process will be completed by October 31, 2008. The CAT will provide quarterly written status reports to the Natural Resources Commission and the City Council beginning no later than March 2008. The Climate Action Team shall be dissolved, unless extended by the City Council, upon completion of the initial charge as identified in this document.

**Objectives**

With a primary focus on community wide GHG emissions, the CAT will, as directed by the City Council, and under the general coordination of the City Sustainability Coordinator:

1. Work on defined objectives, within the defined time frame, to produce materials that will assist in the rapid development of a Greenhouse Gas Reduction for the City.
2. Plan, organize, and conduct public workshops to solicit community input and identify potential elements of an action plan for the city, including inviting appropriate speakers or others to make presentations at these forums.
3. Identify and interview persons with specific expertise important to the development of a city action plan.
4. Identify potential public education materials to promote the city's climate change program.
5. Identify potential partners and partnerships, which the city may wish to pursue in implementing a community–wide Greenhouse Gas Reduction Plan.
6. Research programs in other cities, develop detailed descriptions of these programs, and report to city staff, including recommendations.
7. Assist in the identification and evaluation of potential community wide GHG emission reduction targets and measures for inclusion in the Plan.
8. In the interest of streamlining adoption of early GHG emission reduction measures by the City, the CAT will not have a primary role in the identification or evaluation of these early action measures.

Science Advisory Team (SAT)

The purpose of the Ad Hoc Science Advisory Team (SAT) is to ensure that the Davis Greenhouse Gas Reduction Plan (Plan) is informed by the best available expertise and green house gas (GHG) reduction strategies and measures. To meet this purpose, a group of local scientists and experts will be convened to evaluate and provide objective insight and expert opinion pertaining to GHG reduction strategies and measures for the Davis community. As necessary, the SAT will recommend GHG reduction strategies and measures that draw on emerging information and research that may not be readily available to the Climate Action Team or the Natural Resources Commission in their respective roles in developing the Davis GHG reduction plan. The overall goal of the SAT is to generate innovative approaches and comprehensive strategies to address the City's goal of significantly reducing the GHG emissions of the City and the community as a whole. The Davis City Council recognizes that the independence of the SAT is important and recognizes that its ability to provide objective insight benefits from this status. Conversely, the SAT recognizes that it plays an advisory role in the development of the Davis GHG reduction plan.

**Timeline**

This is an Ad Hoc and time limited effort. The development of a comprehensive Greenhouse Gas Reduction Plan and community engagement process will be completed by October 31, 2008. The SAT will provide quarterly

written status reports to the Natural Resources Commission and the City Council beginning no later than March 2008. The SAT shall be dissolved, unless extended by the City Council, upon completion of the initial charge as identified in this document.

**Objectives**

With a primary focus on community wide GHG emissions, the SAT will, as directed by the City Council, and under the general coordination of the City Sustainability Coordinator:

1. Work on these defined objectives, within the defined time frame, to produce materials that will assist in the rapid development of a Greenhouse Gas Reduction Plan for the City and community.
2. Evaluate and provide objective insight and expert opinion pertaining to GHG reduction strategies and measures for the Davis community. The SAT's primary task will be the review and evaluation of draft strategies and measures. For the purpose of gaining maximum value from its expertise, as necessary, the SAT may identify, evaluate, and recommend GHG reduction measures and strategies based on emerging research and/or information.
3. Serve as a technical resource to the City Council, NRC, SAT, and City staff for the purposes of informing the development of the GHG reduction plan.
4. In the interest of streamlining adoption of early GHG emission reduction measures by the City, the SAT will not have a primary role in the identification or evaluation of these early action measures although they may suggest alternatives or new measures as appropriate.

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# Appendix A – Data Providers

**Table 17**. Community data providers

| Sector | Source (Contact/Title/Department) | Organization | Data Provided |
|---|---|---|---|
| Residential, Commercial & Industrial | Rhys Rowland, Assistant Planner, Community Development Department | City of Davis | 1990 Population, household, and employment statistics. Population and household projection for 2015 |
| Residential, Commercial & Industrial | Xantha Bruso, Climate Protection Policy Specialist, Environmental Policy Department | PG&E | 2003 – 2006 Residential & Commercial energy usage data. 2003 – 2006 coefficients. |
| Transportation | Matt Jones, Senior Air Quality Planner | Solano-Yolo Air Quality Management District | Assisted in VMT calculation process |
| Transportation | Roxanne Namazi, Senior Civil Engineer | City of Davis | Verified Davis VMT data |
| Transportation | Gary Francisco, Senior Engineering Assistant | City of Davis | Provided transportation infrastructure data |
| Transportation | Tara Goddard, Bicycle/Pedestrian Coordinator | City of Davis | Assisted with bicycle data |
| Transportation | Anthony Palmere, Assistant General Manager | Unitrans | Provided VMT and fuel usage, ridership statistics |
| Transportation | Jim Allison, Principle Planner | Capitol Corridor Joint Powers Authority | Provided data on number of trips to/from Davis used to estimate VMT savings from public transit |
| Solid Waste | Richard Tsai, Senior Utility Resource Specialist, Public Works | City of Davis | Solid waste generation, Waste composition data |
| Solid Waste | Jennifer Gilbert, Conservation Coordinator, Public Works | City of Davis | Provided information on city waste reduction programs such as Apartment Move out and RISE (Recycling is Simply Elementary) |

**Table 18**. Municipal operation data providers

| Sector | Source (Contact/Title/Department) | Organization | Data Provided |
|---|---|---|---|
| Buildings, Streetlights, Water/Sewage | Butch Breault, City Electrician, Public Works | City of Davis | "Corporate Customer Revenue and Usage Report by Year for City of Davis" Total electricity and natural gas consumption in 1990 |
| Buildings, Streetlights, Water/Sewage | "PG&E Gas & Electric Info, 1995 -1999" binder provided to City of Davis. Obtained from Butch Breault, City Electrician, Public Works | PG&E | Municipal energy consumption study shows breakdown of energy consumption by sector |
| Buildings | Gloria Delgado, Administrative Analyst, Parks & Community Services | City of Davis | 1990 energy usage data for City Offices, Fire Department, Police Department, Senior Center, and Veteran's Center |
| Buildings | Rick Guidara, IS Manager | City of Davis | Inventory of Energy Star Products |
| Water/Sewage | Bob Schoech, Public Works Department | City of Davis | Annual water production energy usage data |
| Water/Sewage | Marie Graham, Utility Program Coordinator, Public Works Department | City of Davis | Annual gallons per capita per day (GPCD) average |
| Water/Sewage | John McNerney, Wildlife Resource Specialist, Public Works Department | City of Davis | Provided wetland water treatment system information |
| Vehicle Fleet | Gloria Delgado, Administrative Analyst, Parks & Community Services | City of Davis | 88-89 Budget Estimate for Equipment Rental, 1991 Fleet Inventory, 1991-2007 fuel consumption records |
| Vehicle Fleet | Don Lemmon, Asst Director/Operations, Public Works Department | City of Davis | Employee bike usage averages within Public Works Department (operations) |
| Vehicle Fleet | Ton Phan, Police Sergeant, Police Department | City of Davis | Provide bike patrol data |
| Employee Commute | Ann Waid, Human Resources Assistant, City Manager's Office | City of Davis | Employee zip codes to determine average trip length |
| Solid Waste | Jeanette More, Storekeeper | City of Davis | Provided total amount of batteries ordered in 2007 (for rechargeable battery acquisition study) |
| Solid Waste | Ken Shepard | Davis Waste Removal (DWR) | Provided information on the number of bins at city sites including parks and city facilities, disposal frequency, and a yard/toter to tons conversion |

# Appendix B – Emissions Coefficients

**Electricity Coefficients**

Specific emission factors for each grid region, as defined by the North American Electricity Reliability Council (NERC), were developed for the CACP software. Electricity emission factors specify the emissions per kilowatt-hour of the annual average kilowatt-hour produced in the electricity region specified. Default values are provided for 1990 through 2020. Essentially, these average kilowatt-hour factors have been derived by dividing emissions in each NERC region by end use electricity. Regional average emission factors for carbon dioxide, methane and nitrous oxide were determined as follows:

$CO_2$

Total emissions (in short tons) of carbon dioxide, sulfur dioxide, and nitrogen oxides associated with electricity generation were obtained directly from regional outputs of the AEO2001 reference case NEMS model run.

Total electric sales of electricity (in MWh) were obtained directly from regional outputs of the AEO2001 reference case NEMS model run.

Final emission factors for each NERC region were determined by dividing total annual emissions by total annual electric sales.

$CH_4$ and $N_2O$

Since emission inventory levels for these pollutants are not tracked in the U.S. EPA's National Air Quality and Emissions Trends Report (U.S. EPA, 2000), we used "Tier 1" fuel-specific emission factors, as recommended by the Intergovernmental Panel on Climate Change (IPCC, 1996).

Total annual average emissions for the years 2000-2020 were determined by multiplying the fuel-based emission factors from Step #1 above by primary consumption of these fuels in each of the 13 NERC regions, as projected by the AEO2001 reference case NEMS model run.

Final annual emission factors for each NERC region were determined by dividing total annual emissions in Step #2 above by total annual electric sales, as projected by the AEO2001 reference case NEMS model run.

**Table 19**. Electricity Coefficients

| Year | $CO_2$ (t/GWh) | CH4 (t/GWh) | N2O (t/GWh) |
|---|---|---|---|
| **1990*** | 334.3 | .037 | 0.439 |
| **1991*** | 334.3 | .037 | 0.439 |
| **1992*** | 334.3 | .037 | 0.439 |
| **1993*** | 334.3 | .037 | 0.439 |
| **1994*** | 334.3 | .037 | 0.439 |
| **1995*** | 334.3 | .037 | 0.439 |
| **1996*** | 334.3 | .037 | 0.439 |
| **1997*** | 334.3 | .037 | 0.439 |
| **1998*** | 334.3 | .037 | 0.439 |
| **1999*** | 334.3 | .037 | 0.439 |
| **2000*** | 352.2 | .037 | 0.439 |
| **2001*** | 344.0 | .038 | 0.425 |
| **2002**** | 335.4 | .038 | 0.417 |
| **2003**** | 310.0 | .037 | 0.421 |
| **2004**** | 283.0 | .036 | 0.440 |
| **2005**** | 244.5 | .035 | 0.443 |
| **2006**** | 229.5 | .034 | 0.453 |
| **2015**** | 229.5 | .030 | 0.456 |

* Source: CACP Software

** Source: Xantha Bruso, Climate Protection Policy Specialist, Environmental Policy Department, PG&E

**Fuel Coefficients**

These factors specify the carbon dioxide ($CO_2$) emissions from fuel use.

The main source for carbon dioxide ($CO_2$) emission coefficients was the 1605 Voluntary GHG Emissions Reporting Guidelines produced by the DOE. For fuels for which U.S. values were not readily available, the primary source was the IPCC default emission factors supplied in the 1996 Revised Reporting Guidelines on Greenhouse Gas Emissions.

**Table 20**. Fuel coefficients

| Fuel | $CO_2$ Coefficient | Unit |
|---|---|---|
| **Propane** | 20.709 | lbs/gal |
| **Diesel** | 144.642 | lbs/MMBtu |
| **CNG** | 20.968 | lbs/gal |
| **Natural Gas** | 143.248 | lbs/MMBtu |
| **LPG** | 0.126 | lbs/cubic feet |
| **Heavy Fuel Oil** | 144.642 | lbs/MMBtu |
| **Kerosene** | 27.584 | lbs/gal |
| **Light Fuel Oil** | 23.490 | lbs/gal |
| **Coal** | 23.010 | lbs/gal |
| **Propane** | 215.568 | lbs/MMBtu |

* Landfill gas, wood, sewage gas, solar, wind, hydroelectricity, and biodiesel have zero emissions.

Source: CACP Software

# Appendix C – Community Electricity and Natural Gas Usage

**Table 21**. Residential Energy Usage and $CO_2e$ Emissions

| Year | Elec Use (KWh) | Gas Use (thm) | CO2e Emissions (tons eCO2) |
|---|---|---|---|
| **1990*** | 116,400,861 | 6,884,127 | 82,835 |
| **1991*** | 119,371,687 | 7,059,826 | 84,949 |
| **1992*** | 122,342,513 | 7,235,526 | 87,063 |
| **1993*** | 125,313,339 | 7,411,225 | 89,178 |
| **1994*** | 128,284,165 | 7,586,924 | 91,292 |
| **1995*** | 131,254,992 | 7,762,623 | 93,406 |
| **1996*** | 134,225,818 | 7,938,323 | 95,520 |
| **1997*** | 133,314,417 | 8,114,022 | 96,290 |
| **1998*** | 137,329,785 | 8,289,721 | 98,766 |
| **1999*** | 143,650,396 | 8,465,420 | 102,040 |
| **2000*** | 156,360,054 | 8,641,120 | 110,383 |
| **2001*** | 143,521,293 | 8,790,719 | 105,451 |
| **2002*** | 151,168,131 | 8,940,317 | 107,773 |
| **2003**** | 151,651,833 | 9,213,824 | 103,336 |
| **2004**** | 157,728,659 | 9,550,013 | 102,991 |
| **2005**** | 158,893,596 | 9,045,053 | 94,187 |
| **2006**** | 163,232,786 | 9,437,677 | 95,106 |

* Backcasted based on energy use per household

** Xantha Bruso, Climate Protection Policy Specialist, Environmental Policy Department, PG&E

**Table 22.** Commercial Energy Usage and $CO_2e$ Emissions

| Year | Elec Use (KWh) | Gas Use (thm) | CO2e Emissions (tons eCO2) |
|---|---|---|---|
| **1990*** | 55,522,590 | 1,659,437 | 29,477 |
| **1991*** | 58,639,633 | 1,752,598 | 31,132 |
| **1992*** | 61,756,676 | 1,845,759 | 32,787 |
| **1993*** | 64,873,719 | 1,938,920 | 34,441 |
| **1994*** | 67,990,761 | 2,032,081 | 36,096 |
| **1995*** | 71,107,804 | 2,125,242 | 37,751 |
| **1996*** | 74,224,847 | 2,218,403 | 39,406 |
| **1997*** | 77,341,890 | 2,311,564 | 39,884 |
| **1998*** | 80,458,933 | 2,404,725 | 42,716 |
| **1999*** | 83,575,976 | 2,497,886 | 44,370 |
| **2000*** | 86,693,018 | 2,591,047 | 47,610 |
| **2001*** | 89,810,061 | 2,684,207 | 48,585 |
| **2002*** | 92,927,104 | 2,777,368 | 49,456 |
| **2003**** | 95,609,652 | 2,717,757 | 46,862 |
| **2004**** | 99,518,797 | 3,148,969 | 47,965 |
| **2005**** | 102,353,093 | 3,007,866 | 43,997 |
| **2006**** | 105,414,843 | 3,171,210 | 44,123 |

* Backcasted based on energy use per square foot

** Xantha Bruso, Climate Protection Policy Specialist, Environmental Policy Department, PG&E

# Appendix D – Community Transportation: 1990 VMT Estimation

Highway statistics from FHWA provide in depth data on road type and daily VMT within Davis for years 1994 to 2005. To estimate 1990 VMT, increase in VMT over the years is analyzed and a ratio is used to calculate 1990 VMT. The growth rate is estimated to be 103%.

To get annual VMT, Daily VMT (427,000 vehicle miles) is multiplied by 330 days, which accounts for lighter traffic on weekends and holidays. The CACP Software recommends this number. As a result, the 1990 annual VMT estimate is 140,250,000 vehicle-miles.

Methodology verified by Matt Jones, Senior Air Quality Planner, YSAMQD.

**Table 23**. Davis daily vehicle miles traveled

| Year | Miles | | | | | | Daily Vehicle Miles Traveled (1,000 miles) | | | | | | Annual VMT (1,000 miles) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Other Freeways and Expressways | Other Principle Arterial | Minor Arterial | Collector | Local | Total | Other Freeways and Expressways | Other Principle Arterial | Minor Arterial | Collector | Local | Total Daily VMT | |
| 1990 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 425 | 141,000 |
| 1991 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 439 | 144,760 |
| 1992 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 453 | 149,391 |
| 1993 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 467 | 154,150 |
| 1994 | 2 | 14 | 12 | 28 | 90 | 146 | 38 | 171 | 51 | 142 | 80 | 482 | 159,060 |
| 1995 | 2 | 4 | 23 | 28 | 98 | 155 | 39 | 60 | 185 | 131 | 124 | 539 | 177,870 |
| 1996 | 2 | 4 | 23 | 28 | 98 | 155 | 40 | 64 | 188 | 137 | 71 | 500 | 165,000 |
| 1997 | 2 | 4 | 23 | 28 | 98 | 155 | 36 | 58 | 177 | 120 | 114 | 505 | 166,650 |
| 1998 | 2 | 4 | 23 | 28 | 98 | 155 | 40 | 60 | 181 | 131 | 116 | 528 | 174,240 |
| 1999 | 2 | 4 | 23 | 28 | 98 | 155 | 47 | 64 | 181 | 125 | 123 | 540 | 178,200 |
| 2000 | 2 | 4 | 24 | 29 | 110 | 169 | 48 | 64 | 187 | 125 | 127 | 551 | 181,830 |
| 2001 | 2 | 4 | 24 | 29 | 110 | 169 | 61 | 64 | 187 | 125 | 120 | 557 | 183,810 |
| 2002 | 2 | 5 | 24 | 29 | 110 | 170 | 61 | 72 | 188 | 124 | 130 | 575 | 189,750 |
| 2003 | 2 | 5 | 24 | 29 | 110 | 170 | 48 | 72 | 190 | 129 | 111 | 550 | 181,500 |
| 2004 | 2 | 5 | 24 | 29 | 110 | 170 | 58 | 73 | 190 | 129 | 105 | 555 | 183,150 |
| 2005 | 3 | 5 | 25 | 35 | 111 | 179 | 88 | 69 | 224 | 132 | 92 | 605 | 199,650 |
| 2006 | 3 | 5 | 26 | 33 | 115 | 182 | 86 | 86 | 246 | 146 | 81 | 645 | 212,850 |

Source:
1. "Urbanized area summaries: Miles and Daily Vehicle-Miles of Travel", Highway Statistics 1994 – 2005, Section V: Roadway Extent, Characteristics, and Performance, Federal Highway Administration, U.S. Department of Transportation, http://www.fhwa.dot.gov/policy/ohpi/hss/hsspubs.htm.
2. Matt Jones, Senior Air Quality Planner, SYAQMD

# Appendix E – Community Transportation: 2015 VMT Estimation

EMFAC07 provides data on Yolo County daily VMT. The Federal Highway Administration provides data on daily VMT in the City of Davis. The average percentage of VMT within Davis from 1995 to 2005 (12%) is used to estimate Davis VMT in 2015.

To get annual VMT, Daily VMT (769,000 vehicle miles) is multiplied by 330 days, which accounts for lighter traffic on weekends and holidays. The CACP Software recommends this number. As a result, the 2015 annual VMT estimate is 253,770,000 vehicle-miles.

Methodology verified by Matt Jones, Senior Air Quality Planner, YSAMQD.

**Table 24**. Percentage of VMT in Davis

| Year | Yolo County VMT (1,000 vehicle-miles) | Davis VMT (1,000 vehicle-miles) | Percentage of Miles driven within Davis |
|---|---|---|---|
| **1994** | 1,292,492* | 159,060** | 12% |
| **1995** | 1,322,629* | 165,000** | 12% |
| **1996** | 1,359,993* | 151,800** | 11% |
| **1997** | 1,384,708* | 154,770** | 11% |
| **1998** | 1,427,512* | 161,040** | 11% |
| **1999** | 1,474,599* | 162,690** | 11% |
| **2000** | 1,510,401* | 165,990** | 11% |
| **2001** | 1,583,130* | 163,680** | 10% |
| **2002** | 1,688,807* | 169,620** | 10% |
| **2003** | 1,777,809* | 181,500** | 11% |
| **2004** | 1,838,458* | 164,010** | 9% |
| **2005** | 1,786,915* | 170,610** | 10% |
| **2006** | 1,753,611* | 212,850** | 12% |
| **2007** | 1,825,737* | 197,180*** | 11% |
| **2008** | 1,869,304* | 201,885*** | 11% |
| **2009** | 1,869,304* | 201,885*** | 11% |
| **2010** | 1,917,950* | 207,139*** | 11% |
| **2011** | 1,961,418* | 211,833*** | 11% |
| **2012** | 2,006,896* | 216,745*** | 11% |
| **2013** | 2,054,647* | 221,902*** | 11% |
| **2014** | 2,104,762* | 227,314*** | 11% |
| **2015** | 2,156,538* | 232,906*** | 11% |

* California Air Resource Board's emissions model, EMFAC07
** U.S. Department of Tranportation, Federal Highway Administration, Highway Statistics
*** Forecasted based on 1994 – 2006 percent of Yolo County VMT

# Appendix F – Community Transportation: Vehicle Makeup

The CACP Software provides a general VMT percentage by fuel and vehicle type. However, EMFAC data with Yolo County percentages was used to get a better estimate of vehicle makeup in Davis. EMFAC provides 1990 Yolo County vehicle makeup as well as forecasts to year 2030.

**Table 25**. Percentage breakdown of VMT by fuel and vehicle type (1990, 2015)

| Vehicle Type | 1990 | | 2015 | | |
|---|---|---|---|---|---|
| | Gasoline | Diesel | Gasoline | Diesel | Electric |
| Auto - Full Size | 6.7% | 0.0% | 6.5% | 0.0% | 0.0% |
| Auto - Mid Size | 14.8% | 0.0% | 14.4% | 0.1% | 0.4% |
| Auto - Sub-Compact/Compact | 26.2% | 0.8% | 25.4% | 0.0% | 0.0% |
| Heavy Truck | 4.8% | 8.5% | 2.8% | 8.0% | 0.0% |
| Light truck/SUV/Pickup | 35.3% | 1.5% | 40.1% | 0.6% | 0.1% |
| Motorcycle (MC) | 0.8% | 0.0% | 1.1% | 0.0% | 0.0% |
| Transit Bus | 0.0% | 0.2% | 0.0% | 0.2% | 0.0% |
| Passenger Vehicles | 0.4% | 0.0% | 0.2% | 0.0% | 0.0% |
| **Subtotal** | **89%** | **11%** | **90.6%** | **8.9%** | **0.48%** |

The CACP Software provides definitions for each of the vehicle types used in the software. Road transport vehicle (Autos, Light Trucks, SUVs and Pickup Trucks) definitions include examples.

**Auto – Subcompact/Compact**: An automobile with between 85 and 109 cubic feet of combined passenger and luggage volume. Examples include: HONDA Civic and TOYOTA Corolla.

**Auto – Mid-Size**: An automobile with between 110 and 119 cubic feet of combined passenger and luggage volume. Examples include: HONDA Accord and TOYOTA Camry.

**Auto – Full-Size**: An automobile with 120 or more cubic feet of passenger and cargo volume. Examples include: CHEVROLET Impala and DODGE Intrepid.

**Heavy Truck:** Trucks with a Gross Vehicle Weight over 8500 lbs.

**Heavy Truck – Large:** Large Heavy Trucks are trucks with a Gross Vehicle Weight over 33,000 lbs.
Example: tractor-trailer truck and public transit buses

**Heavy Truck – Medium:** Medium Heavy Trucks are trucks with a Gross Vehicle Weight between19,501 lbs and 33,000 lbs.
Example: three-axle, 10-tire delivery truck

**Heavy Truck – Small:** Small Heavy Trucks are trucks with a Gross Vehicle Weight between 8,501 lbs and 19,500 lbs. Examples: two-axle, 6-tire delivery truck

**Light Truck:** The light truck category includes Sport Utility Vehicles (SUVs), Pickup Trucks and commercial delivery vans and trucks. Light trucks have a Gross Vehicle Weight up to 8500 lbs.

**Light Truck/SUV/Pickup – Large:** Large Light Trucks/SUVs/Pickups have a Gross Vehicle Weight of between 6001 and 8500 lbs, and an Adjusted Loaded Vehicle Weight greater than 5750 lbs. Examples: Chevy Suburban and Ford Expedition/Lincoln Navigator.

**Light Truck/SUV/Pickup – Medium Large:** Medium Large Light Trucks/SUVs/Pickups have a Gross Vehicle Weight of between 6001 and 8500 lbs, and an Adjusted Loaded Vehicle Weight of 5750 lbs or less. Example: Dodge Durango.

**Light Truck/SUV/Pickup – Medium Small:** Medium Small Light Trucks/SUVs/Pickups have a Gross Vehicle Weight of 6000 lbs or less and a Loaded Vehicle Weight of between 3751 lbs and 5750 lbs.
Examples: Minivans and Ford Explorer.

**Light Truck/SUV/Pickup – Small:** Small Light Trucks/SUVs/Pickups have a Gross Vehicle Weight of 6000 lbs or less and a Loaded Vehicle Weight of 3750 lbs or less. Example: Toyota RAV4, Chevrolet Tracker

**Passenger Vehicle:** Passenger vehicles are a weighted mix of all size classes of automobile as well as Sport Utility Vehicles and Pickup Trucks. Both fuel economy (expressed in miles per gallon) and emission factors are weighted based on the following vehicle mix:

(i) Auto – Full-Size / SUVs / Pick-ups = 36.4%
(ii) Auto – Midsize = 18.8%
(iii) Auto – Compact / Sub-compact = 44.8%

**Transit Bus:** A transit bus is a 40-foot or longer single body unit or articulated bus operated in urban areas by transit authorities. Gross Vehicle Weight of these vehicles is 40,000 lbs and greater.

**Vanpool Van:** A vanpool van is a van that can normally accommodate 8 passengers. Typically, these are large light trucks (Gross Vehicle Weight of between 6001 and 8500 lbs, and an Adjusted Loaded Vehicle Weight greater than 5750 lbs). Example: Ford E150 Econoline XL Wagon.

Sources:
1. EMFAC07, California Air Resource Board (CARB) emissions model
2. CACP Software

City of Davis Greenhouse Gas Reduction Plan
Attachment I

# Draft Overall Process/Schedule

Joint meeting with Natural Resources Commission (NRC)
Joint meeting with City Council (CC)
Climate Action Team Meeting (CAT)
Science Advisory Team (SAT)
Community Workshop (CW)

**GHG Reduction Plan**
5 mile stones:
(1) GHG Inventory
(2) Establish Reduction Targets
(3) ID Actions, Adopt Plan
(4) Implement
(5) Assess

City Council Appointment of CAT/Science Advisors
1 Complete GHG Inventory
2 Targets Established
3 Actions Identified/ Adopt Plan
4 Implementation of Action
5 Assessment (On-going, 1st Report Early April)

**Phase I**
(1) Establish CAT
(2) Establish SAT

**Phase II**
(1) Evaluate and ID Criteria
(2) ID Sectors
(3) Community Workshop
(4) ID target reductions

**Phase III**
(1) Draft actions
(2) Prepare draft plan
(3) Community Workshops

**Phase IV**
(1) Draft plan review
(2) Adopt Plan

**Phase V**
(1) Annual report to NRC/CC
(2) Evaluate Actions
(3) Budget

January 2008 | February | March | April | May | June | July | August | September | October | November

Focus the Nation *January 31, 2008*
Earth Day *April 22, 2008*
4th of July
UCD 100th Celebration
Complete Review and Adopt GHG Reduction Plan

Davis