

GREENHOUSE GAS EMISSIONS

This technical memorandum describes existing sources and quantities of greenhouse gas (GHG) emissions in Vacaville. The manner in which cities are designed and built has significant consequences on GHG emission levels. As a result, different development and planning strategies impact a community's carbon footprint differently. GHG emissions in California are directly affected by infrastructure and development decisions: how we build our buildings, where we put them, and the quality and types of infrastructure that are required to serve them.

A. Greenhouse Gases and Global Warming

The earth's atmosphere contains a group of naturally occurring gases that are responsible for maintaining a habitable climate. These gases allow sunlight to enter the earth's atmosphere freely and then prevent a portion of the resulting heat from exiting the atmosphere. Because of their ability to contain heat, these gases are known as greenhouse gases, or GHGs. Natural levels of GHGs exist in balanced proportion, resulting in steady maintenance of the temperature within earth's atmosphere. Emissions from human activities, such as electricity production and motor vehicle use, elevate the concentrations of GHGs, upsetting their natural balance. When GHG concentrations exceed natural concentrations in the atmosphere, the "greenhouse effect" of trapped heat is enhanced, and the phenomenon known as global warming occurs.

1. Greenhouse Gases

The natural process through which heat is retained in the troposphere, the lowest layer of the earth's atmosphere, is called the "greenhouse effect." The greenhouse effect traps heat in the troposphere through a three-fold process as follows:

1. Short wave radiation emitted by the sun is absorbed by the earth.
2. The earth emits a portion of this energy in the form of long wave radiation.

3. GHGs in the upper atmosphere absorb this long wave radiation and emit some of it back toward the earth.

This “trapping” of the long wave (thermal) radiation emitted back toward the earth is the underlying process of the greenhouse effect.

California State law identifies the following gases as GHGs: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).¹ The most common GHG that results from human activity is carbon dioxide, followed by methane and nitrous oxide. Many other trace gases have a greater ability to absorb and re-radiate long wave radiation; however, these gases are not as plentiful.

For this reason, and to gauge the potency of GHGs, scientists at the Intergovernmental Panel on Climate Change (IPCC) have established an international unit of measure, called Global Warming Potential (GWP). All GHGs have a GWP and this value is used to compare the abilities of different GHGs to trap heat in the atmosphere. GWPs are based on the heat-absorbing ability of each gas relative to that of carbon dioxide, as well as the decay rate of each gas, which is the amount of gas removed from the atmosphere over a given number of years. The GWP of a gas is determined by using carbon dioxide as the reference gas with a GWP of 1, which serves as the baseline unit to which all other GHGs are compared.

GWPs can be used to estimate the relative impact GHGs will have on global climate change. Assigning a GWP value allows policy makers to compare the impacts of emissions and reductions of different gases. For instance, methane is a significant contributor to the greenhouse effect and has a GWP of 21. This means methane is approximately 21 times more heat-absorptive than carbon dioxide per unit of mass.

¹ California Health and Safety Code, Section 38505(g).

Based on the GWP, all GHGs can be converted into carbon dioxide equivalents (CO_{2e}). For a given mixture and amount of GHGs, the CO_{2e} is a quantity that describes the amount of carbon dioxide that would have the same global warming potential when measured over a specified period, generally 100 years. The carbon dioxide equivalency for a gas is obtained by multiplying the mass and the GWP of the gas. GHGs include, but are not limited to, the gases described below.

a. Carbon dioxide (CO₂)

Carbon dioxide is primarily generated by fossil fuel combustion in stationary (e.g. factories) and mobile (e.g. cars) sources. Due to the emergence of industrial facilities and mobile sources over the past 250 years, the concentration of carbon dioxide in the atmosphere has increased by 35 percent. The vast majority of GHG emissions come from the combustion of fossil fuels such as petroleum, coal, and natural gas. Carbon dioxide is a by-product of combustion, which is elemental to traditional energy production. The production of energy in electrical power plants and automobile engines are two common examples of fossil fuel combustion and resulting carbon dioxide emissions. For this reason, energy use and driving are inextricably linked to global warming. As explained above, the GWP for carbon dioxide is one. In 2009, energy-related production of carbon dioxide accounted for approximately 87 percent of GHG emissions in the United States.²

b. Methane (CH₄)

Methane is the primary component of natural gas, which is used for space and water heating, steam production, and power generation. The GWP of methane is 21, or 21 times that of carbon dioxide. Methane, which accounted for approximately 10 percent of 2009 GHG emissions in the United States,³ results from the process of organic decomposition. Modern landfills, agricul-

² United States Energy Information Administration website.
http://www.eia.gov/energy_in_brief/greenhouse_gas.cfm. Accessed September 8, 2011.

³ United States Energy Environmental Protection Agency, April 15, 2011, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*.

tural operations, coal mines, and oil and natural gas operations are the primary sources of methane emissions.

c. Nitrous oxide (N₂O)

Nitrous oxide is produced by both natural and human related sources. Natural sources of nitrous oxide are bacteria in the soil and oceans. The majority of nitrous oxide produced by human activity is a result of agriculture, including nitrogen fertilizers and animal waste, which promote nitrous oxide production from naturally-occurring bacteria. Industrial processes and internal combustion engines also produce nitrous oxide. The GWP of nitrous oxide is 310. Nitrous oxide accounted for approximately 4 percent of total nation-wide emissions in 2009.⁴

d. Hydrofluorocarbons (HFCs)

Hydrofluorocarbons are typically used as foam-blown insulation and as refrigerants for both stationary refrigeration and mobile air conditioning. The use of hydrofluorocarbons for cooling and foam blowing is growing as the continued phase out of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) gains momentum. The GWP of hydrofluorocarbons ranges from 140 to 6,300. Hydrofluorocarbons do not occur naturally; they are only produced from human-related sources.

e. Perfluorocarbons (PFCs)

Perfluorocarbons are compounds consisting of carbon and fluorine, primarily created as byproducts of aluminum production and semiconductor manufacturing. They are potent GHGs that range in GWP from 5,700 to 11,900. Another area of concern regarding PFCs is their long atmospheric lifetime (up to 50,000 years). Perfluorocarbons do not occur naturally; they are only produced from human-related sources.

⁴ United States Energy Environmental Protection Agency, April 15, 2011, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009*.

f. Sulfur Hexafluoride (SF₆)

This gas is most commonly used as an electrical insulator in high voltage equipment that transmits and distributes electricity. Sulfur hexafluoride, the most potent GHG to be evaluated by the IPCC, has a GWP of 23,900. However, its global climate change contribution is not as high when compared to carbon dioxide because of a relatively small presence. Sulfur hexafluoride does not occur naturally; it is only produced from human-related sources.

2. Other Compounds

In addition to the six major GHGs discussed above, many other compounds have the potential to contribute to the greenhouse effect. Some of these substances have been identified as stratospheric⁵ ozone depletors, and their gradual phase out is currently in effect. These compounds include ozone, 1,1,1-trichloroethane,⁶ hydrochlorofluorocarbons, and chlorofluorocarbons.

3. Sources of Greenhouse Gas Emissions

Carbon dioxide, methane, nitrous oxide, and other GHGs are emitted as the result of certain natural and technological processes. Many human activities rely on those processes. Therefore, emissions levels can be minimized by reducing those activities. In California, as of 2008, transportation accounted for about 37 percent of the GHG emissions, industrial and commercial processes contributed about 28 percent, and the use of electric power emitted about 24 percent of the total GHG emissions.⁷

⁵ The stratosphere is the layer of the earth's atmosphere above the troposphere.

⁶ 1,1,1-trichloroethane was used as an industrial solvent before being banned under the Montreal Protocol in 1996.

⁷ California Environmental Protection Agency Air Resources Board, May 12, 2010, *California Greenhouse Gas Inventory for 2000-2008*.

B. Greenhouse Gas Emissions in Vacaville

In 2011, the Solano Transportation Authority (STA) inventoried baseline GHG emissions that occurred in 2005 for unincorporated Solano County and the incorporated cities in Solano County: Dixon, Fairfield, Rio Vista, Suisun City, and Vacaville. STA inventoried GHG emissions for the following sectors: energy consumption (electricity and natural gas), transportation, solid waste, wastewater treatment, potable (i.e. drinking) water, industrial stationary sources, and miscellaneous sources. This inventory provides a baseline against which to measure future reductions in GHG emissions.

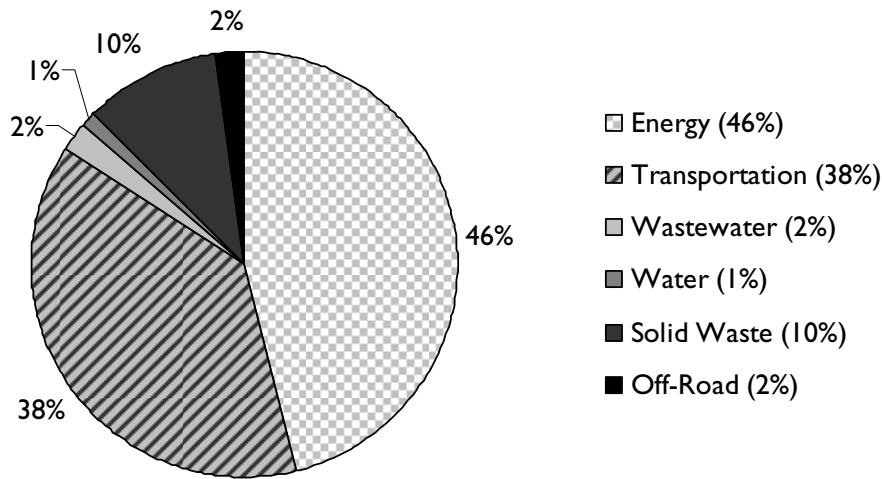
In Vacaville, 510,980 metric tons⁸ of CO_{2e} were emitted in 2005. Vacaville's GHG emissions are similar to the State's inventory in that the energy and transportation sectors represent the largest sources of GHG emissions, as described below.

As shown in Figure 1, the energy sector represented 46 percent of the total GHG emissions in Vacaville. GHG emissions related to the energy sector result from the use of natural gas and electricity in residential, commercial, and industrial buildings within the city limit.

The second largest source of 2005 GHG emissions in Vacaville was the transportation sector, representing 38 percent of the total GHG emissions. To determine the GHG emissions from the transportation sector, STA inventoried exhaust emissions based on vehicle miles traveled (VMT) from private and City-owned vehicles on trips that begin and/or end in the city. Trips that both started and ended in Vacaville represented 30 percent of the VMT, while trips that either started or ended in another jurisdiction represented 70 percent of the VMT.

⁸ Carbon dioxide equivalent is measured by weight in metric tons.

Figure 1 2005 GHG Emissions in Vacaville



The treatment of wastewater produced approximately 2 percent of the total 2005 GHG emissions. STA calculated this number based on the GHG emissions that occurred from wastewater processing and the energy consumed to power the wastewater treatment plant.

Off-road equipment, including construction equipment, industrial equipment, lawn and gardening equipment, other and light commercial equipment, contributed approximately 2 percent of the total 2005 GHG emissions in Vacaville. STA used the California Air Resource Board's OFFROAD2007 model to calculate this number.

Energy consumption associated with potable water treatment, distribution, and conveyance generated 1.1 percent of the total 2005 GHG emissions in Vacaville. STA based the energy emissions on water consumption data provided by City staff.

C. Regulatory Framework

This section summarizes existing State and regional laws, regulations, and agencies that address GHG emissions.

1. State Laws and Regulations

This section summarizes State laws and regulations that pertain to GHG emissions in Vacaville.

a. Assembly Bill 1493 (AB 1493) (2002)

AB 1493 requires the California Air Resources Board (CARB) to develop and adopt regulations that reduce GHG emitted by passenger vehicles and light duty trucks.

b. Executive Order S-3-05 (2005)

In June 2005, Governor Schwarzenegger established California's GHG emissions reduction targets in Executive Order S-3-05. The Executive Order established goals to reduce statewide GHG emissions to the following levels:

- ◆ Reduce emissions to 2000 levels by 2010.⁹
- ◆ Reduce emissions to 1990 levels by 2020.
- ◆ Reduce emissions to 80 percent below 1990 levels by 2050.

The Secretary of the California Environmental Protection Agency (EPA) is required to coordinate efforts of various agencies in order to collectively and efficiently reduce GHGs, in addition to submitting biannual progress reports to the Governor and State Legislature disclosing progress made toward GHG emissions reductions. In addition, a separate biannual report must be submitted illustrating the impacts of global warming on California's water supply,

⁹ A 2010 inventory for the State has not been conducted, so it is not yet known whether this goal was achieved. Note that neither the 2010 nor 2050 goals are a legislative mandate for the State; AB 32 creates a legislative mandate to achieve the 2020 goal.

public health, agriculture, the coastline, and forestry, as well as reporting possible mitigation and adaptation plans to combat these impacts.

c. Assembly Bill 32 (AB 32), California Global Warming Solutions Act (2006)

AB 32, the Global Warming Solutions Act of 2006, was passed by the California legislature and signed into law by Governor Arnold Schwarzenegger. AB 32 is California's first major commitment to addressing global warming, and sets a timeline for reducing California's GHG emissions to 1990 levels by the year 2020. AB 32 identifies CARB as the lead agency responsible for implementing the bill, and in 2008, CARB published the Climate Change Proposed Scoping Plan (Scoping Plan). The Scoping Plan is an analysis of the best approach to achieve the 2020 reduction target, citing local governments as an essential partner. The Scoping Plan states that local governments have "...broad influence and, in some cases, exclusive authority over significant emission sources through their planning and permitting processes, local ordinances, outreach and education efforts and municipal operations."¹⁰

The Scoping Plan distinguishes various areas where local jurisdictions can focus on GHG reductions. Two areas in particular, community transportation and community design, fall directly under the context of land use planning. Using effective land use planning, local jurisdictions can allow and encourage community transportation choices that promote low carbon travel options, such as public transit, bicycling, and walking. Local government can use its broad influence to incorporate bicycle paths and sidewalks into new and existing travel routes, which provide opportunities for residents to reduce their VMT and therefore reduce their GHG emissions.

Local governments can also engage in land use planning to reduce GHG emissions through community design. Local governments can promote compact development projects and those with mixed-use residential and commercial components, which allow residents to live, work, and shop without driving

¹⁰ California Air Resources Board, October 2008, *Climate Change Proposed Scoping Plan*, pages C-49 through C-54.

between destinations. Additionally, local governments can adopt policies that encourage infill development. With increased density, local jurisdictions can accommodate the same amount of growth on less land, setting aside more land for non-developed uses such as open space, which incorporate plants that absorb GHGs. Ultimately, the most carbon-efficient urban form is one that integrates alternative modes of community transportation with compact, mixed-use community design.

AB 32 depends on local governments to implement strategies to reduce GHG emissions. Local governments, like the City of Vacaville, can utilize the General Plan Update process to further the discussion of reducing local GHG emissions. The City of Vacaville will prepare a Climate Action Plan as part of the General Plan Update to help reduce GHG emissions within the city. In addition, the General Plan Update will include policies to help reduce GHG emissions. For example, the General Plan Update could include policies to encourage higher density, mixed-use development; increase energy efficiency of buildings; or enhance bicycle and pedestrian facilities. The General Plan Update and Climate Action Plan will have a synergistic relationship, with both documents informing and strengthening the policies within each document.

d. Senate Bill 97 (SB 97), Modification to the Public Resources Code (2007) SB 97 directed the California Office of Planning and Research (OPR) to develop California Environmental Quality Act (CEQA) guidelines for the analysis and, if necessary, mitigation of GHG emissions or the effects of GHG emissions. In March 2010, the new CEQA Guidelines pertaining to GHG emissions became effective. Through these Guidelines, OPR recommends that each public agency develop an approach to address GHG emissions that is based on best available information. The approach includes three basic steps: (1) identify and quantify emissions; (2) assess the significance of the emissions; and (3) if emissions are significant, identify mitigation measures or alternatives that will reduce the impact to a less-than-significant level. The Guidelines encourage agencies to consider a number of factors in evaluating GHG emissions, including the impact of the project on attaining the State's

goal of reducing GHG emissions to 1990 levels by 2020, as directed in AB 32, and the extent of potential reductions in GHG emissions from the proposed project in comparison to the existing setting.

The Vacaville General Plan Update will be subject to these CEQA Guidelines.

e. Senate Bill 375 (SB 375), California's Regional Transportation and Land Use Planning Efforts (2008)

SB 375, passed by the State Assembly and Senate in August 2008, is another significant component of California's commitment to GHG reduction. In essence, SB 375 coordinates transportation funding and land use planning on a regional level as a means to achieve AB 32's goals.

The goal of SB 375 is to reduce emissions from cars and light trucks by incentivizing compact development. The first step outlined in SB 375 calls for metropolitan planning organizations (MPOs) and CARB to establish a region's GHG reduction target. Then, the MPO must develop a sustainable communities strategy (SCS), a plan for a compact development pattern that will enable the region to meet its GHG reduction target. SB 375 requires the GHG reduction target and the SCS to be incorporated into the Regional Transportation Plan (RTP). The Metropolitan Transportation Commission (MTC) is the MPO for the Bay Area region, which includes Vacaville, and it is anticipated that MTC will release the Draft SCS in November 2012.

The California Air Resources Board (CARB) released the draft GHG reduction target for the Bay Area region in August 2010. Using a 2005 baseline year, CARB recommends a 7 percent reduction in per capita GHG emissions from cars and light trucks in the Bay Area by 2020 and a 15 percent reduction by 2035.

Transportation and development projects consistent with the SCS will be given priority for State and regional funding. Additionally, SB 375 grants SCS-consistent residential development projects streamlined environmental

review processes. SB 375 also changes Housing Element law, extending the planning period for the Housing Element to eight years, and linking Housing Element timelines to RTP timelines for increased consistency.

2. Yolo Solano Air Quality Management District

Although a small portion of Vacaville is within the Bay Area Air Quality Management District (BAAQMD), the majority of the city is within the Yolo Solano Air Quality Management District (YSAQMD). YSAQMD is tasked with achieving and maintaining healthful air quality for its residents by establishing programs, plans, and regulations enforcing air pollution control rules in order to attain all State and federal ambient air quality standards and to minimize public exposure to airborne toxins and nuisance odors.

In addition, when preparing an Environmental Impact Report (EIR) the YSAQMD is the commenting agency for GHG emissions under CEQA. The YSAQMD does not have any adopted significance thresholds for evaluating GHG emissions, but does recommend a qualitative analysis for “sizable projects.”

D. Implications for the General Plan Update

Based on the information contained in this memorandum, the General Plan Update process should consider the following in relation to GHG emissions:

- ◆ Work to achieve consistency with the regional SCS in order to maintain access to State and regional funding. This will also provide the opportunity to streamline SCS-consistent residential development projects.
- ◆ Through the General Plan Update’s land use alternatives process, the City is considering adding a new designation for mixed use. This would help to support the goals of AB 32 and SB 375 by encouraging residential uses within walking distance of office and commercial uses, which would reduce GHG emissions.

- ◆ Consider adopting policies and programs as part of the General Plan Update that encourage infill development, encourage mixed-use development, and promote compact development projects.
- ◆ Consider adopting policies and programs as part of the General Plan Update and Climate Action Plan to reduce the consumption of electricity, including: adopting energy efficiency performance standards for new buildings; implementing an energy audit program for existing residential and commercial buildings to identify ways to improve energy efficiency; and creating an energy efficient outdoor lighting program.
- ◆ Explore alternate modes of transportation options and identify ways to encourage people to use public transportation or carpool to travel between Vacaville and other jurisdictions.
- ◆ Examine bicycle and pedestrian access and identify ways to improve and expand bicycle and pedestrian circulation systems.
- ◆ Consider adopting policies and programs as part of the General Plan Update and Climate Action Plan to encourage the use of low and zero emission vehicles.
- ◆ As part of the Climate Action Plan, identify a GHG reduction target, and establish policies and programs to meet that target.

CITY OF VACAVILLE
GENERAL PLAN UPDATE
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