1 INTRODUCTION

Vacaville is a vibrant community with a family-friendly atmosphere and a high quality of life. Due to its location, Vacaville serves as a gateway to the Bay Area and the Central Valley, and as such, has achieved impressive growth. Through thoughtful planning over the 120 years since incorporation in 1892, Vacaville's growth reflects respect for its beautiful natural setting, preservation of its historic character, and distinct sense of place. Throughout its history, and as it moves into the 21st century, the residents and leaders of Vacaville recognize that a healthy and prosperous community must consider economic, environmental, and social goals when planning for the future, and must grow in a way that continues to promote the City's values.

Under the leadership of a Steering Committee and the City Council, and with input from the community, the City prepared an updated General Plan concurrent with this Energy and Conservation Action Strategy that is focused on maintaining a high quality of life, improving the environment, and promoting sustainable growth. ***Sustainability*** is commonly defined as "using resources in the present in a manner that does not compromise the choices and quality of life of future generations." The updated General Plan recognizes a variety of ways

that sustainability goals can be met, such as increasing alternative modes of transportation, maintaining a healthy local economy, and preserving open space.

This Energy and Conservation Action Strategy is a strategic tool to implement the General Plan. It is a detailed, long-range strategy to reduce greenhouse gas (GHG) emissions and achieve greater conservation of resources with regards to transportation and land use, energy, water, solid waste, and open space. Collectively addressing community development and conservation through these lenses will help Vacaville remain attractive, prosperous, and adaptive to social, political, and environmental changes.

This Energy and Conservation Action Strategy has been created for Vacaville to be in compliance with State requirements that address the reduction of major sources of GHG emissions. It establishes a strategy that the City and community can implement to achieve the City's GHG emissions reduction target, as identified and required by State legislation.

Implementation of this Energy and Conservation Action Strategy will guide Vacaville's actions through a series of communitywide and municipal GHG emissions reduction measures to decrease the city's contribution to GHG emissions. Communitywide GHG emission reduction measures are exclusively aimed to increase energy independence; reduce spending on gas, electricity, and water; and improve air quality from non-City operations. Municipal GHG emission reduction measures apply exclusively to City operations. Communitywide and municipal GHG emission reduction measures are discussed in Chapters 5 and 6 of this document, respectively.

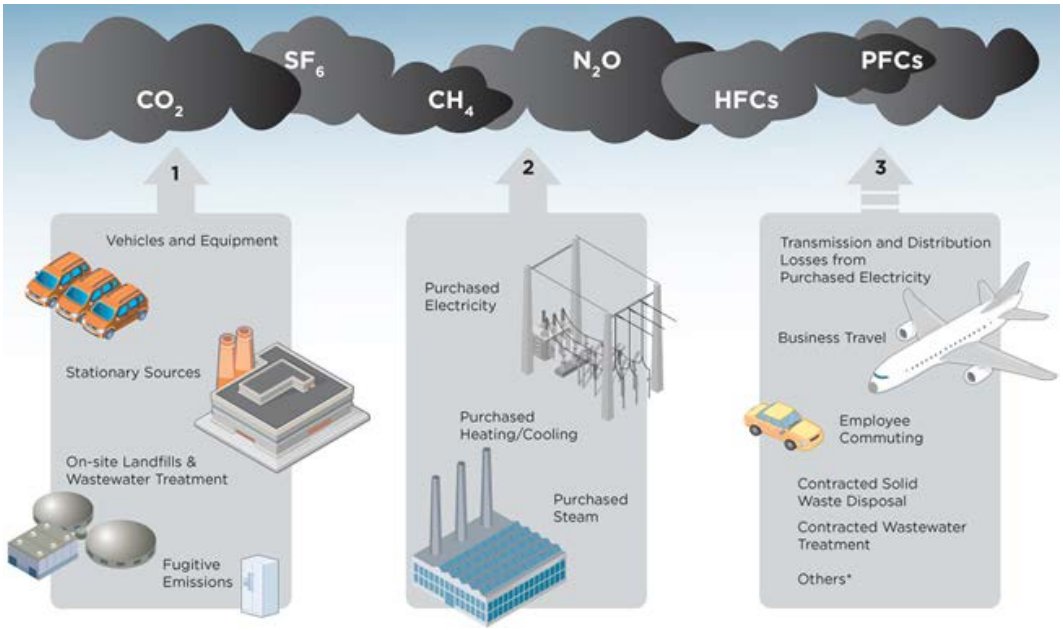
Communitywide measures aim to reduce GHG emissions from activities that occur within Vacaville.

Municipal measures apply exclusively to City government operations.

This Energy and Conservation Action Strategy will support ambitious GHG emission reduction targets adopted by the State and will ensure that Vacaville is eligible for transportation and land use grant funding. The federal, State, and regional requirements are discussed in detail under the heading *Regulatory Action on Greenhouse Gas Emissions* further in this chapter.

This Energy and Conservation Action Strategy will also be utilized for tiering and streamlining future development within Vacaville, pursuant to California Environmental Quality Act (CEQA) Guideline Sections 15152 and 15183.5. It serves as the CEQA

threshold of significance within the city for GHG emissions, by which all applicable developments within the city will be reviewed.



COMMON SOURCES OF GREENHOUSE GAS EMISSIONS

This chapter provides background information on the following topics:

- Greenhouse gases and the theory of global climate change.
- Federal, State, and regional regulatory action on GHG emissions.
- Public participation in the City's sustainability planning processes.

WHAT ARE GREENHOUSE GASES?

Greenhouse gases are vapors that trap heat in the Earth's atmosphere. Federal and California State law identifies the following six gases as GHGs: [1]

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)

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

- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

Greenhouse gases emissions are measured in terms of their Global Warming Potential (GWP). The GWP is the ability of a GHG to trap heat in the Earth's atmosphere when compared to an equal amount of carbon dioxide, which assumes a GWP value of 1. The GWP is used to estimate the contribution a GHG will emit in the Earth's atmosphere.

Based on the GWP, all GHGs can be converted into carbon dioxide equivalents (CO_2e), which then enables decision-makers to consider different GHGs in comparable terms. The conversion of GHGs is done by comparing the GWP of each GHG to carbon dioxide. The carbon dioxide equivalent is a quantity that describes the amount of carbon dioxide that would have the same GWP. For example, methane is approximately 21 times more powerful than carbon dioxide on a per weight basis in its ability to trap heat. Therefore, 1 metric ton of methane would be calculated as 21 metric tons of carbon dioxide equivalent ($MTCO_2e$).

What is a metric ton of carbon dioxide?

- *About 1 metric ton of CO_2 is produced to the meet the average monthly energy demand of the typical American household for heating, cooling, cooking, electricity use, and other energy needs. This results in 12 metric tons per house per year.*
- *About 1 metric ton of CO_2 is produced for approximately each 100 gallons of gasoline used. This means if you drive a car that gets 20 miles per gallon, 1 metric ton of CO_2 is released into the atmosphere for every 2,000 miles driven. This is about two months of driving for many US drivers.*

Source: EPA

A brief description of each of the six GHGs is provided below.

Carbon Dioxide (CO_2)

The primary source of carbon dioxide from human activity is burning fossil fuels such as petroleum, coal, and natural gas in factories, electrical power plants, cars, trucks, and other similar sources. Energy use and driving are directly linked to global warming. While carbon dioxide is the most common GHG, it is the least powerful and has a GWP of 1.

Methane (CH_4)

Methane is the primary component of natural gas, which is used for space and water heating, steam production, and power generation. As provided in the example above, the GWP of

methane is 21, or 21 times that of carbon dioxide. Methane in the Earth's atmosphere occurs when organic material breaks down. Modern solid waste landfills, agricultural operations, coal mines, and oil and natural gas operations are the primary sources of human-generated methane emissions.

NITROUS OXIDE (N_2O)

The majority of nitrous oxide is produced from agricultural practices, 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, which means that nitrous oxide is 310 times more powerful than carbon dioxide and would be calculated as 310 metric tons of CO_2e.

HYDROFLUOROCARBONS (HFCS)

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

PERFLUOROCARBONS (PFCS)

Perfluorocarbons are compounds consisting of carbon and fluorine, primarily created as byproducts of aluminum production and semiconductor (e.g. radios, computers, and telephones) manufacturing; they do not occur naturally. Perfluorocarbons are powerful GHGs that range in GWP from 5,700 to 11,900. Perfluorocarbons are a particular concern because they can remain in the Earth's atmosphere for up to 50,000 years after they are released.

SULFUR HEXAFLUORIDE (SF_6)

This gas is most commonly used as an electrical insulator in high voltage equipment that transmits and distributes electricity, and does not occur naturally. Like perfluorocarbons described above, sulfur hexafluoride is an extremely powerful GHG and has a GWP of 23,900. However, sulfur hexafluorides have a small occurrence and contribute very little to overall GHGs in the Earth's atmosphere.

OTHER COMPOUNDS

In addition to the six major GHGs discussed above, many other compounds have the potential to build up in the Earth's atmosphere. Some of these compounds have been identified as the cause of ozone damage and their gradual phase-out is currently in effect. These compounds include ozone, 1,1,1-trichloroethane,[2] hydrochlorofluorocarbons, and chlorofluorocarbons.

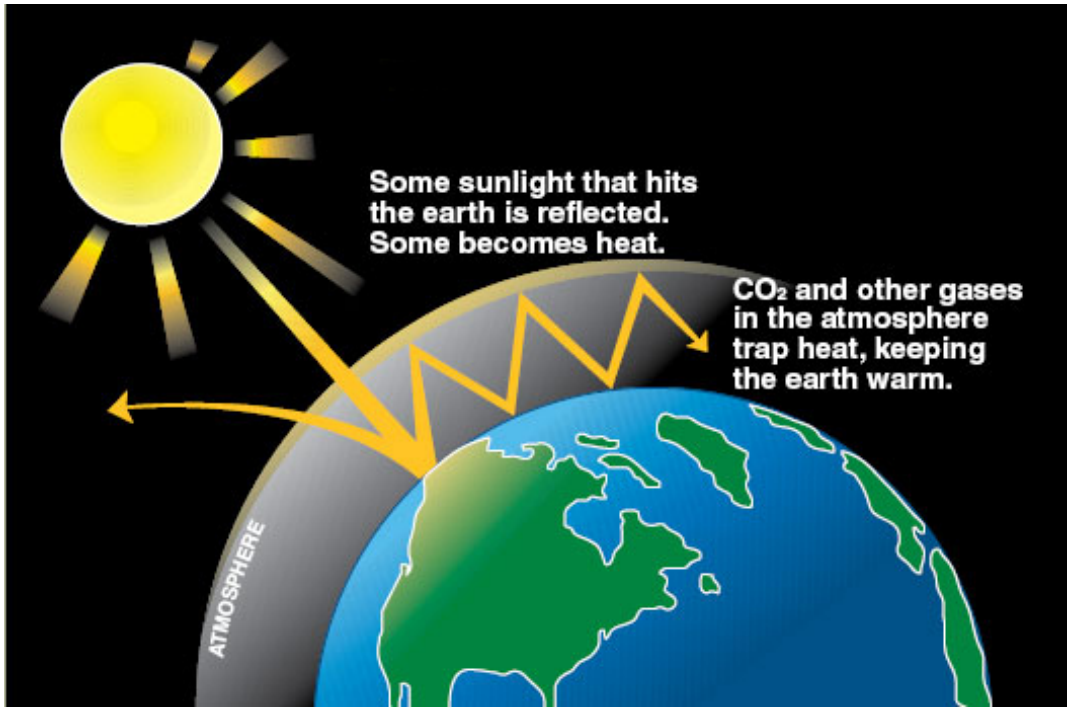
GLOBAL CLIMATE CHANGE THEORY

Currently, global climate change is a controversial topic in the United States. Some people disagree that the climate is changing; others assert that changes in the Earth's climate are part of natural cycles and are not caused by human activity. Although there is extensive scientific research and documentation that supports theories of human-caused global climate change, some scientists believe that the evidence is inconclusive. This section presents the basic concepts underlying the science of global climate change in order to explain why those who are concerned about global climate change, such as California legislators, are seeking to reduce the impacts of specific human activities on the Earth's atmosphere.

The Earth's atmosphere is composed of naturally occurring and human-caused GHGs that trap heat in the atmosphere and regulate the Earth's temperature. This phenomenon, known as the greenhouse effect, is responsible for maintaining a climate suitable for human life. Greenhouse gases in the Earth's atmosphere play an important role in maintaining the Earth's temperature as they trap heat emitted from the Earth's surface which otherwise would have escaped to space, as shown in Figure 1-1.

[2] 1,1,1-trichloroethane was used as an industrial solvent before being banned under the Montreal Protocol in 1996.

FIGURE 1-1 **THE GREENHOUSE EFFECT**



Source: State of Washington Department of Ecology, "What is Climate Change," http://www.ecy.wa.gov/climatechange/whatis.htm, accessed on October 11, 2012.

Water vapor and carbon dioxide are the most abundant GHGs in the Earth's atmosphere. As discussed above, the six GHGs that are considered the main contributors to man-made global climate change are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

While human activity results in the release of some GHGs that occur naturally, such as carbon dioxide and methane, other gases, like hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, are completely human-made.

Human activities, including but not limited to burning fossil fuels and removing trees, result in the release of carbon in the form of carbon dioxide into the Earth's atmosphere. Without these human activities, carbon dioxide would be naturally stored underground in sediments, such as petroleum, coal, and natural gas, or on the Earth's surface as plant life. As these types of human activities have increased from the time of the industrial revolution over 200 years ago, the amounts of GHGs in the atmosphere also increased, consequently enhancing the natural greenhouse effect.

It is believed that this enhanced greenhouse effect has contributed to global warming, which is defined as an increased rate of warming of the Earth's surface temperature. As more GHGs build up in the Earth's atmosphere, more heat is trapped in the Earth's atmosphere, thereby increasing evaporation rates and temperatures near the surface. The warming of the Earth induces large-scale changes in ocean circulation patterns, precipitation patterns, global ice cover, biological distributions, and other large-scale changes to the Earth's systems that are collectively referred to as global climate change.

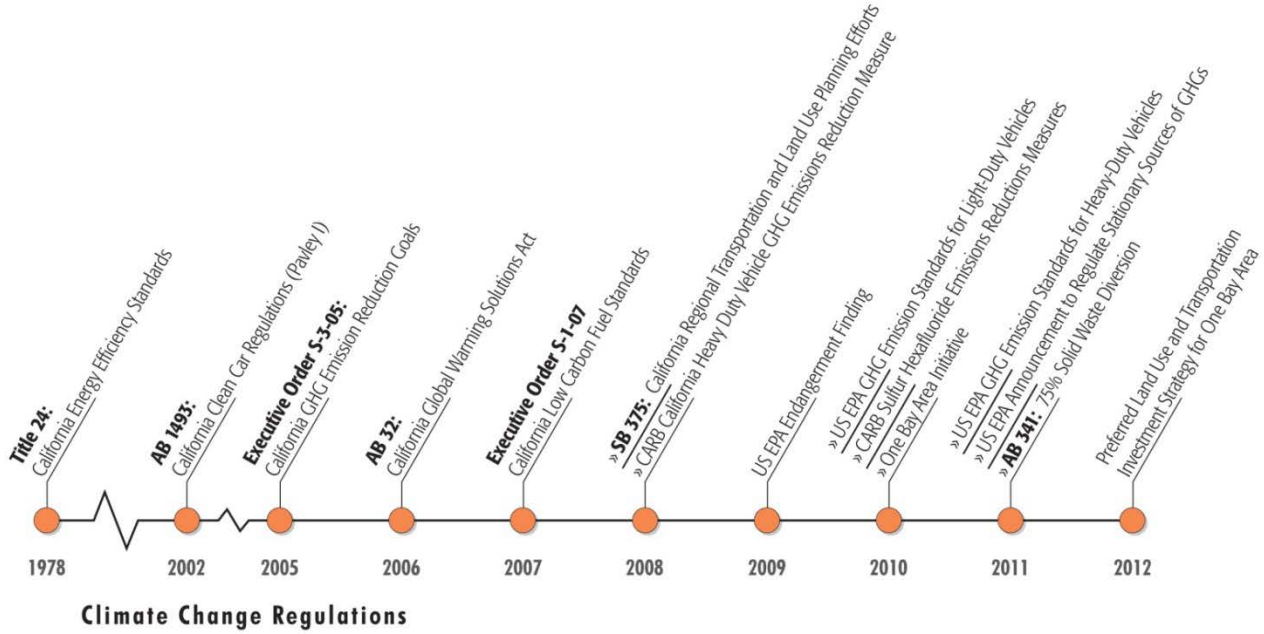
REGULATORY ACTION ON GREENHOUSE GAS EMISSIONS

Many federal, State, and regional government agencies and organizations are working to develop and implement solutions to control GHG emissions and slow their effects on natural ecosystems.

At the federal level, in December 2009, the US Environmental Protection Agency (EPA) found that elevated concentrations of the six key GHGs in the atmosphere, which are discussed earlier in this chapter, endanger the public health and welfare of current and future generations. In collaboration with the National Highway Traffic Safety Administration, the EPA established GHG emission standards for light-duty vehicles (e.g. cars) in 2010 and heavy-duty vehicles (e.g. trucks) in 2011. Additionally, on January 2, 2011, the EPA announced that it would regulate GHG emissions from major stationary sources of GHGs, including oil refineries and fossil fuel burning power plants, through modifications to the existing Clean Air Act permitting programs. At the State level, California's major laws and regulations include:

- **Energy Efficiency Standards (1978)** to reduce the State's energy consumption by providing regularly updated standards that incorporate new energy efficiency goals, methods, and technologies.

- **Clean Car Regulations (Assembly Bill 1493, 2002)** to decrease GHG emissions from new passenger vehicles and light duty trucks through California Air Resources Board (CARB) adopted regulations.
- **Executive Order S-3-05 (2005)** to reduce emissions to 2000 levels by 2010, to 1990 levels by 2020, and to 80 percent below 1990 levels by 2050 through a California Environmental Protection Agency (Cal/EPA) led multi-agency effort that identified GHG emission reduction strategies and measures.
- **Global Warming Solutions Act (AB 32, 2006)** to cap California's GHG emissions at 1990 levels by 2020 through CARB-identified discrete, early and easy-to-implement actions to reduce emissions and through a CARB-developed statewide scoping plan to identify how to meet the emissions reduction targets.
- **Executive Order S-01-07 (2007)** to reduce the carbon content of passenger vehicle fuels by 10 percent by 2020 through establishing a low carbon fuel standard (LCFS) for transportation fuels sold in California.[3]



[3] On December 29, 2011, the US District Court for the Eastern District of California issued several rulings in federal lawsuits challenging the LCFS. One of the court's rulings preliminarily prohibits CARB from enforcing the regulation during the time of the litigation. In January 2012, CARB appealed the decision and on April 23, 2012, the Ninth Circuit Court granted CARB's motion for a stay of the injunction while it continues to consider CARB's appeal of the lower court's decision.

- **Regional Transportation and Land Use Planning Efforts (SB 375, 2008)** to support AB 32 by requiring California metropolitan planning organizations (MPOs) to prepare a sustainable communities strategy to reduce vehicle miles traveled (VMT) in their regions and demonstrate their ability to reach CARB targets for 2020 and 2035 and by providing incentives for governments and developers to implement compact and efficient growth patterns.
- **Heavy Duty Vehicle GHG Emissions Reduction Measure (2008)** to improve the fuel economy of heavy duty vehicles through requiring long-haul truckers to retrofit their trailers with fuel-efficient tires and aerodynamic devices.
- **Sulfur Hexafluoride Emissions Reductions Measures (2010)** to reduce sulfur hexafluoride emissions from semiconductor (e.g. radios, computers, and telephones) and non-semiconductor applications through CARB-adopted regulations including reporting and reduction requirements for semiconductor operations and new restrictions on the use and sale of sulfur hexafluoride.
- **Solid Waste Diversion (AB 341, Chesbro, 2011)** to reduce waste diversion by 75 percent by 2020 through requiring the Department of Resources, Recycling, and Recovery (CalRecycle) to provide strategies for achieving the reduction, certain businesses to arrange for recycling services, and local governments to implement a commercial recycling program, and through revising technical and procedural facets of solid waste facility regulatory laws.

In addition to federal- and State-level regulations and policies, there are regional-level regulations and policies relating to GHG emissions. The majority of Vacaville is within the Yolo-Solano Air Quality Management District (YSAQMD), and the extreme southeast corner of Vacaville is in the Bay Area Air Quality Management District (BAAQMD). The YSAQMD reports its emissions from business operations to the Climate Registry, a national nonprofit registry that provides tools and resources to help calculate, verify, report, and manage GHG emissions in a publicly transparent and credible way.[4] The YSAQMD does not yet have its own GHG standards; however, the BAAQMD has a regional Climate Protection Program with measures to help meet GHG reductions. The YSAQMD has allowed projects to use the BAAQMD GHG emissions thresholds while the YSAQMD develops its own GHG standards and criteria.

[4] See www.theclimateregistry.org.

In addition to its Climate Protection Program with measures to help meet GHG reductions, the BAAQMD also requires that all pollution sources warranting an air quality permit estimate what their GHG emissions would be and pay a fee[5] based on the metric ton of carbon dioxide equivalent ($MTCO_2e$) emissions. Consistent with SB 375, the BAAQMD, the Association of Bay Area Governments (ABAG), the Metropolitan Transportation Commission (MTC), and the Bay Area Conservation and Development Commission (BCDC) established One Bay Area, an initiative to coordinate regional GHG emission reduction efforts. One Bay Area's Plan Bay Area has a sustainable communities strategy, which links land use and transportation to GHG emission reduction goals. Vacaville's plans, projects, and development must be consistent with Plan Bay Area in order for the City to be eligible for transportation and land use grant funding.

Additionally, the MTC has committed the Bay Area region, including Vacaville, to a 15 percent reduction in GHG emissions by 2035 and has adopted a Preferred Land Use and Transportation Investment Strategy. This includes a commitment to locate new development in core urban areas and guidelines for evaluating projects and potential grants against the stated goals of Plan Bay Area.

SUSTAINABILITY CHALLENGES

Like other communities in California and around the world, the City of Vacaville faces a number of sustainability challenges. This section describes sustainability challenges related to the GHG emission-generating sources covered in this Energy and Conservation Action Strategy.

TRANSPORTATION AND LAND USE

During the second half of the 20th century, transportation and driving patterns in the US shifted dramatically. Vehicle miles traveled (VMT) per person increased by around 140 percent between 1956 and 1998.[6] This growth in VMT is the result of increasing car trips and increasing average trip length. These increases have been driven by a variety of factors, including changes in demographics, land use, urban design, and public transportation

[5] A fee of $0.042 per metric ton of carbon dioxide equivalent (MTCO2e) was required at the time this document was prepared and could be subject to change over time.

[6] Puentes, Robert and Adie Tomer, 2008, *The Road…Less Traveled: An Analysis of Vehicle Miles Traveled Trends in the US,* Brookings Institution, Washington D.C.

systems. It means that the number of miles driven in America has increased much more dramatically than the increase in population.

As the proportion of two-income households grew, and as jobs shifted to areas further from the traditional town center, long car commutes became more common. This has been true of Vacaville, as more residents work outside of Vacaville in places like Fairfield, Vallejo, and Benicia. In addition, changes in land use and in building and streetscape design also contributed to increased car trips. The separation of uses and driver convenience often came at the expense of pedestrians and other non-automotive users. As commercial areas became more disconnected from residential neighborhoods, it became less convenient to reach these destinations by means other than a car. Auto-oriented designs, which can be unpleasant, intimidating, or even dangerous for non-drivers, have made non-automotive transportation modes more difficult and less appealing to use. Additionally, public transit systems have seen their coverage decreased and their services cut as funding declines, and in some cases they have been removed completely.

Because of the obstacles created by development and design, driving is often the only viable mode of transportation. Consequently, residents have fewer opportunities for physical activity, and those who cannot drive, including children, seniors, and disabled people, can have trouble accessing services.

ENERGY

Energy production is a major economic, security, and environmental challenge at the local, national, and global levels. Although Vacaville receives its energy from Pacific Gas & Electric Company (PG&E), which provides an energy mix that is cleaner than what many other US utilities provide, it still relies on fossil fuels – coal, oil, and natural gas – for about half of its energy.[7]

[7] Pacific Gas and Electric website, http://www.pge.com/myhome/environment/pge/cleanenergy/, accessed on May 1, 2012.

The US imports approximately 60 percent of its petroleum from foreign countries. This dependence potentially makes our economy and security vulnerable to political and resource instability in other parts of the world.

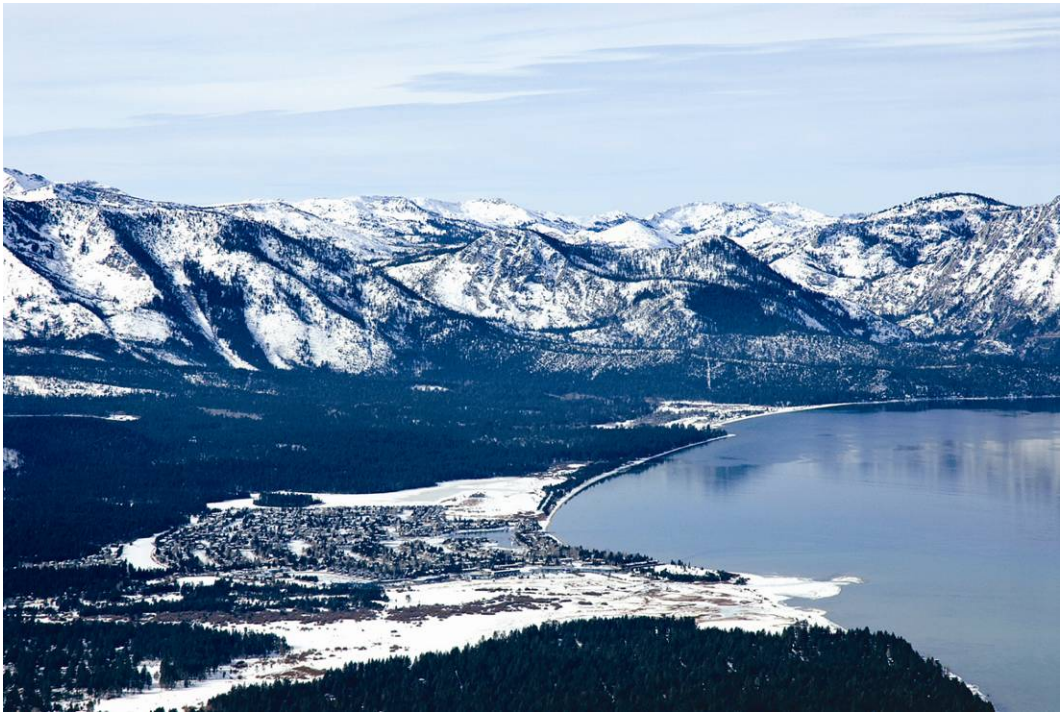
The combustion of fossil fuels to produce heat or electricity, or to power internal combustion engines, is a main contributor to GHG emissions and other environmental problems. Because fossil fuels are found deep in the ground, they must be extracted and transported to provide energy. Surface and groundwater pollution can occur during extraction, storage, and transportation. Land subsidence can result when oil and gas are removed from below ground with nothing left to support the land above. There is also the potential for storage tank leakage and oil spills during transportation, causing widespread pollution and requiring costly cleanup efforts.

WATER

Water conservation is important both to protect water resources, which are expected to be negatively impacted by GHG emissions, and to reduce these GHG emissions that occur when water is treated and transported.

Though the 2010-2011 water year brought some relief to drought conditions in California, the winter of 2011-2012 marked the fourth year of dry conditions within the past five years. The year 2009 featured the driest spring and summer on record, low water content in the Sierra snowpack, and a historic low in the State's reservoir levels. As of early 2009, the drought had damaged crops and prevented farmers from planting or replanting 100,000 acres of agricultural land, causing agricultural revenue losses of more than $300 million.[8] Such drought conditions also threaten aquatic ecosystems, increase the risk of wildfires, increase food prices, and harm livelihoods dependent on agriculture, natural resources, and tourism. Responding to these wide-ranging impacts, the Governor proclaimed a State of

[8] Office of the Governor, State of California, February 27, 2009, Press Release, *Gov. Schwarzenegger Takes Action to Address California's Water Shortage.*



Emergency in February 2009, calling for an immediate 20 percent reduction in water use by urban water users and the use of efficient water management practices by agricultural users.[9]

SOLID WASTE

The production and transport of consumer products creates large amounts of GHGs. A large percentage of these products are disposed of after only one use, requiring more raw materials to be extracted to replace these products. Making new products or buildings from raw materials generally requires more energy, uses more water, and creates more air and water pollution

[9] Office of the Governor, State of California, February 27, 2009, Press Release, *Gov. Schwarzenegger Takes Action to Address California's Water Shortage.*

than reusing materials or making the same product from recycled materials, thereby increasing GHG emissions.

Once in the landfill, solid waste continues to emit GHGs as it rots, most notably methane, which as previously noted is approximately 21 times more potent than carbon dioxide in terms of its global warming impacts. Landfills also release harmful contaminants such as vinyl chloride and benzene. In addition, as rainwater filters through the layers of solid waste in a landfill, it absorbs harmful chemicals, which are then carried into soil, surface water, and groundwater contamination. Poor management of landfills can increase disease carriers and create nuisances related to odor, litter, and dust.

The GHG emissions and other environmental problems associated with solid waste can be reduced through diverting waste from landfills by reducing consumption of single-use or disposable products, reusing, and recycling.

OPEN SPACE AND AGRICULTURE

Within its Sphere of Influence and Urban Growth Boundary, Vacaville has approximately 2,500 acres of public open space and 2,500 acres of agricultural land. These open space areas can store carbon in trees and plants. Conversion of these open space lands to development can release GHGs into the Earth's atmosphere. Forests, orchards, and other open spaces with long-lived plants can store significant carbon.[10]

Depending on the types of farming practices used, agricultural land uses can serve to "sequester," or hold, varying amounts of carbon dioxide and other GHGs. When trees and plants are removed as part of the process of converting agricultural land to other uses, the carbon that is stored in the plants and trees is released into the Earth's atmosphere. This process eliminates the possibility of using the land for plants that would store carbon in the future and disrupts the biological processes that allow land to hold GHGs. In addition,

[10] International Panel on Climate Change (IPCC), 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*; and IPCC, 2000, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.

developing on forest land or agricultural land can result in the release of nitrous oxide emissions from the soil when it comes into contact with oxygen.

PUBLIC OUTREACH AND PARTICIPATION

Preliminary measures to include in this Energy and Conservation Action Strategy were drafted based on measures that have been successful in other California and Bay Area communities. These preliminary measures were then reviewed by a technical advisory committee made up of City staff from multiple departments. Based on this direction, the measures were refined in preparation for review and input by the public and Steering Committee.

The City held a community workshop on March 17, 2012 to discuss draft sustainability targets and measures for this Energy and Conservation Action Strategy. The workshop included a formal presentation to acquaint participants with the principles of sustainability planning. Participants were given the opportunity to view and comment upon comprehensive lists of potential communitywide and municipal measures for GHG reduction, as well as to suggest other potential measures. These comments served to influence which measures were emphasized and included in the Energy and Conservation Action Strategy. A summary of the input from the workshop is provided as Appendix A.

Following this workshop, the General Plan Steering Committee, which is composed of members of three different city commissions, the Planning Commission, Community Services Commission, and Housing and Redevelopment Commission, held a public meeting on March 22, 2012 to review the draft GHG reduction measures. The public was invited to provide comments, and the Steering Committee provided direction on edits to the draft measures, which were incorporated into this Energy and Conservation Action Strategy.