

# Climate Change Science & Policy

## UNDERSTANDING CLIMATE CHANGE

Scientists have been working for decades to track the increase of greenhouse gases in the Earth's atmosphere and the subsequent rise of temperatures. Due to anthropogenic (human) activity, the planet is warming more quickly than it would under natural conditions; the primary precipitant is the burning of fossil fuels.

In 2001, the United Nations' Intergovernmental Panel on Climate Change (IPCC),<sup>3</sup> a scientific body tasked to evaluate the risks of climate change, began assessing pre-existing scientific literature in order to understand the current and future situation of the Earth. In doing so, they found:

*"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level."*

*"Most of the observed increase in global average temperatures since the mid-20th Century is very likely due to the observed increase in [human-caused] greenhouse gas concentrations."*

*- IPCC 2007, p. 2 & p. 5*

## Climate Change v. Global Warming

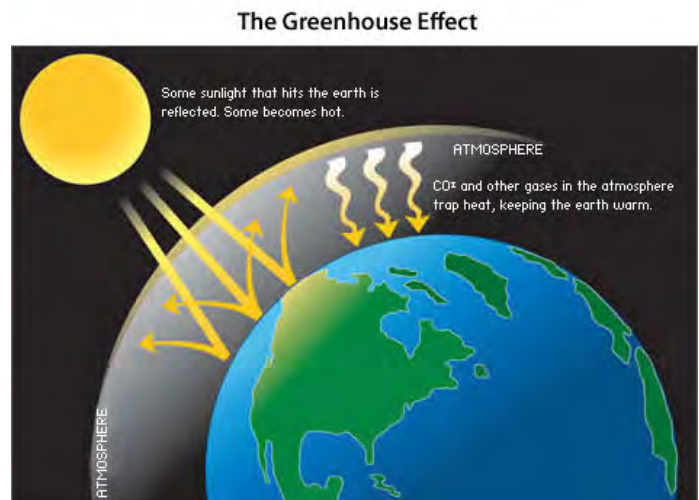
**Global Warming** – an overall warming of the planet, based on average temperature over the entire surface, which can contribute to changes in global climate patterns.

**Climate Change** – changes in regional climate characteristics, including temperature, humidity, rainfall, wind, and severe weather events.

## HOW GREENHOUSE GASES WORK TO RAISE TEMPERATURES

Although greenhouse gases—including carbon dioxide, methane, nitrous oxide, and fluorinated gases—make up less than one percent of total atmospheric gases, they exert powerful influence over global temperatures. The greenhouse gases absorb the Sun's heat as it radiates back from the Earth's surface toward space, trapping that heat in the atmosphere (see Figure 2.1).

Over the past 650,000 years, the concentration of greenhouse gases gave the Earth a balanced climate that fostered bountiful ecosystems and eventually civilization. Greenhouse gas concentrations fluctuated with the natural cycle of ice ages, but were never higher than 300 parts per million (ppm).<sup>4</sup>



Source: US Department of Energy State Energy Program's newsletter, Conservation Update.

3) The IPCC is an international scientific body established by the World Meteorological Organization and the United Nations Environmental Programme to report on the implementation of the United Nations Framework Convention on Climate Change. The group compiled existing data and research to establish a scientific consensus on various aspects of climate change. The results were published in a series of 4 reports over a 20 year period.

4) IPCC, 2007 ([http://www.ipcc.ch/publications\\_and\\_data/publications\\_ipcc\\_fourth\\_assessment\\_report\\_synthesis\\_report.htm](http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm))

Over the last century and a half, industrialization changed the balance. Since the start of pre-industrial times (1700s), atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have climbed by over 36 percent, 148 percent, and 18 percent, respectively<sup>5</sup>. Humans have caused this increase mostly by burning fossil fuels, such as coal, oil, and gas. Burning fossil fuels in cars, power plants, industry, and homes raises the level of carbon dioxide in the atmosphere. This accounts for two thirds of human-caused greenhouse gas emissions. The remaining third is primarily caused by deforestation, decomposition of organic matter within landfills, and industrial processing.

Scientists project the global temperature will continue to rise — the question is how much. In 2007, the IPCC developed a range of future “business as usual” scenarios, which indicated that greenhouse gas concentrations could reach 600 to 1,000 ppm by the end of this century, resulting in global temperature increases of 3.6 to 10.4 degrees Fahrenheit.

## EFFECTS OF CLIMATE CHANGE

Climate change has the potential to impact environmental resources through changes in air temperatures and precipitation patterns. As the average temperature of the Earth increases, weather is affected. Rainfall patterns change. Droughts and flashfloods are likely to become more frequent and intense. Mountain snowcaps will continue to shrink. Climate change and the resulting rise in sea level are likely to threaten buildings, roads, underground infrastructure, and power lines. Agricultural patterns will change as crops and productivity shift along with the climate. These physical changes will impact public health, economics, biogeography, and ecology. We can expect to see worsening air quality, an increase in the number of weather-related tragedies, and possible increases in infectious disease. Higher temperatures contribute to increased smog, which is damaging to plants, animals, and humans. Climate change increases fire hazards and makes forests more susceptible to pests and diseases.

The degree of impact will vary by region and with the ability of different societal and environmental systems to adapt<sup>6</sup> (IPCC, 2007). According to the California Energy Commission<sup>7</sup> (2006), some of the primary effects of climate change in California may include more extreme heat days per year and changes in precipitation patterns. These have the potential to produce secondary impacts on snow pack, sea level, health, agriculture and food supply, forests, and ecosystems and biodiversity. Below is a summary of potential effects that could be experienced in California as a result of climate change.

## Higher Temperatures

California’s climate is expected to become considerably warmer during this century. The degree to which this occurs depends on the growth of contributory human activities, such as the burning of fossil fuels. The State of California Climate Action Team (CAT) 2009 Biennial Report<sup>8</sup> projects that in the first 30 years of the 21st century, temperature increases are likely to range from about 0.5 to 2 °C (0.9 to 3.6 °F) and by the last 30 years of the 21st century, temperature increases may range from about 1.5 to 5.8 °C (2.7 to 10.5 °F). The projection for the first 30 years is lower largely because warming over the next few decades will be affected largely by past emissions.

Historically, extreme warm temperatures in California have mostly occurred in July and August, but as greenhouse gases increase and the climate changes, the occurrence of these events will likely extend from June to September<sup>9</sup>. All of the California Environmental Protection Agency’s Climate Action Team’s (CAT) 2009 simulations indicate that extremely hot daytime and nighttime temperatures (heat waves) will increase in frequency, magnitude, and duration from the historical period; this has serious implications for emergency response and electricity demand in the state.

5) U.S Environmental Protection Agency, (2009) 2009 U.S. Greenhouse Gas Inventory Report.

6) IPCC, 2007 ([http://www.ipcc.ch/publications\\_and\\_data/publications\\_ipcc\\_fourth\\_assessment\\_report\\_synthesis\\_report.htm](http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm))

7) California Energy Commission. (2007). California Energy Commission Climate Change Portal.

8) CAT, 2009 (<http://www.climatechange.ca.gov/publications/cat/>)

9) Ibid.

## Precipitation

Most of California is characterized by a Mediterranean precipitation pattern, with most of the annual precipitation falling between November and March. The CAT projections indicate that California's Mediterranean precipitation pattern is expected to continue, with cool and wet winters and hot dry summers. The model-driven climate simulations indicate a high degree of variability from year to year in annual precipitation. While it will retain its overall character, models of the California climate also project increased vulnerability to drought by mid-21st century. Even if precipitation levels were to remain unchanged over the 21st century, the higher temperatures would increase evaporative water loss and thus produce overall drier conditions. Additional reductions in precipitation would exacerbate the challenges associated with increased evaporative water loss.

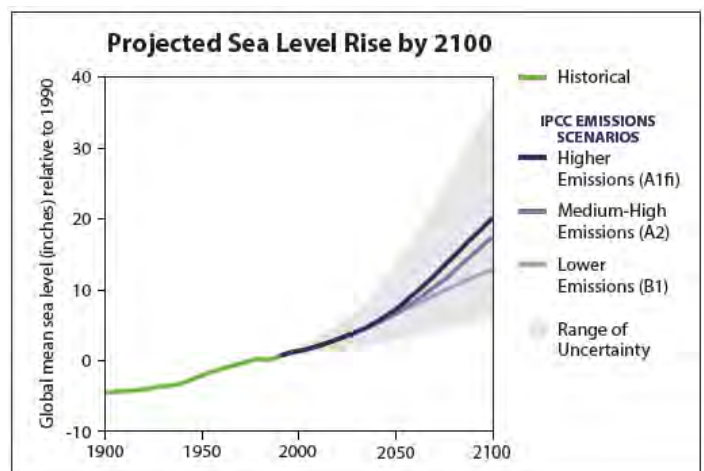
## Loss in Snow Pack

One area of considerable concern is the effect of climate change on California's water supply. During the winter, high in the Sierra Nevadas, snow accumulates in a deep pack, preserving much of California's water supply for the hot, dry summer. If winter temperatures are warmer, more precipitation will fall as rain, decreasing the size of the snowpack. Less spring runoff from a smaller snowpack will reduce the amount of water available for hydroelectric power production and agricultural irrigation. Evidence of this problem already exists. Throughout the 20th century, annual April to July spring runoff in the Sierra Nevada has been decreasing, with water runoff declining by about ten percent over the last 100 years.

## Sea Level Rise

A rise in sea level is already occurring in California, with a 3 to 8 inch rise in the last century. As sea level continues to rise, there will be an increased rate of extreme high sea level events. These events can occur when high tides coincide with winter storms and can be exacerbated by El Niño occurrences. Sea levels at the California coast often rise substantially during El Niño winters, when the Eastern Pacific Ocean is warmer than usual and westerly wind patterns are strengthened. This can lead to severe consequences for the large populations living along California's coast, including flooding of low-lying property, loss of coastal wetlands, erosion of cliffs and beaches, saltwater contamination of drinking water, and damage to roads, bridges and underground infrastructure.

The San Francisco Bay Conservation and Development Commission (BCDC) has projected that sea level in the San Francisco Bay will rise another 16 inches (1.3 ft) by mid-century and 55 inches (4.5 ft) by 2100 (see image next page). A rise in sea level may have a significant impact on our built environment including underground infrastructure, shoreline development, and structures built on fill materials. Fill materials are materials used to artificially raise the level of the ground near bodies of water, such as in Benicia's Downtown Historic District. In addition, the Benicia Industrial Park is particularly vulnerable to such impacts due to its shoreline location. BCDC identified ports as being one of the most vulnerable sets of infrastructure in the region<sup>10</sup>. Damage to Bay Area ports as a result of a rise in sea level is expected to have a large impact on the regional economy.





Source: California Climate Change Center.

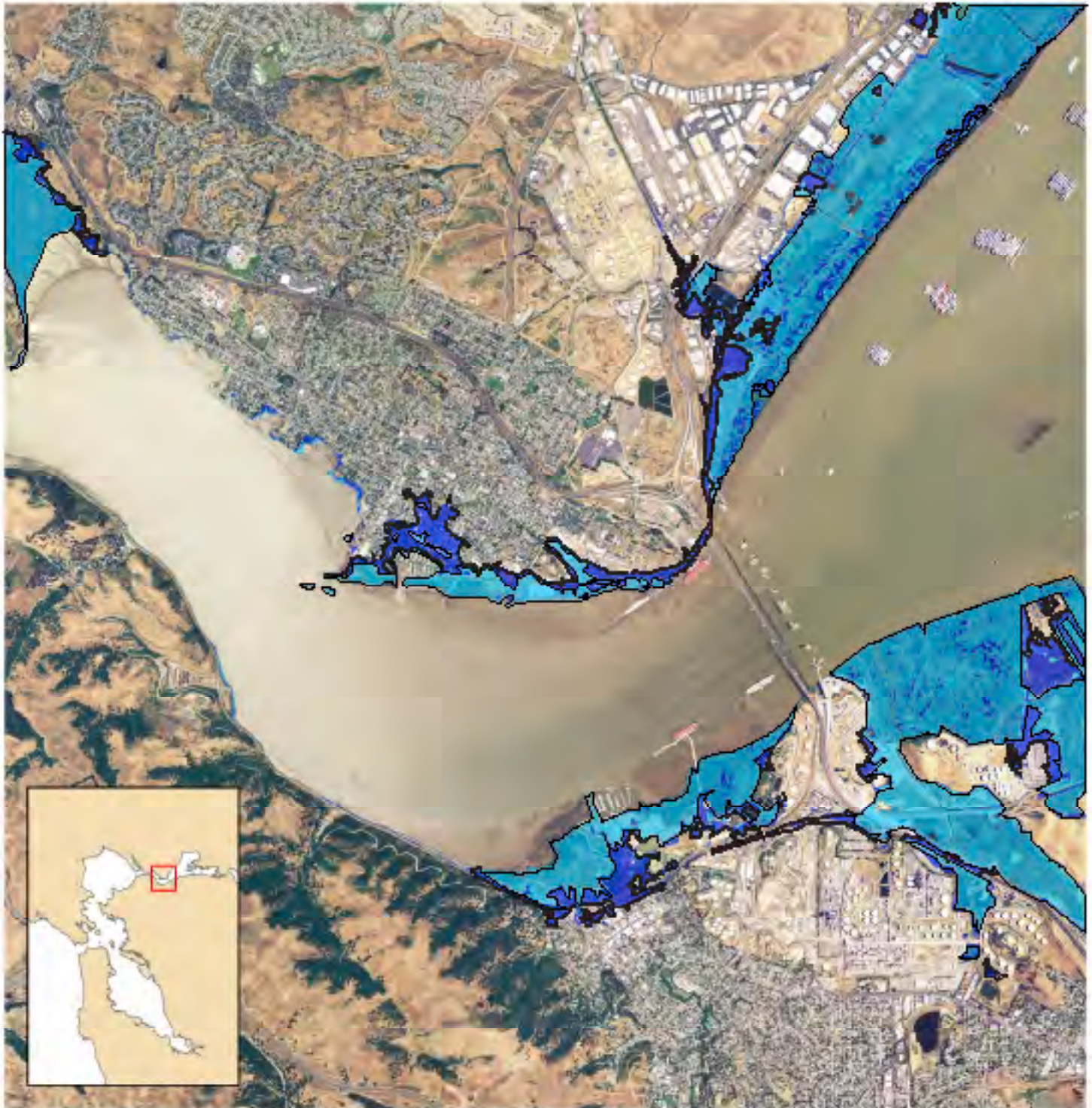
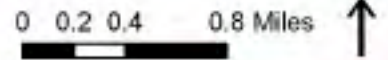
<sup>10</sup> San Francisco Bay Conservation and Development Commission, (2009). Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline. ([http://www.bcdc.ca.gov/planning/climate\\_change/climate\\_change.shtml](http://www.bcdc.ca.gov/planning/climate_change/climate_change.shtml))





# Carquinez Strait Shoreline Areas Vulnerable To Sea Level Rise

-  Area vulnerable to an approximate 55 - inch sea level rise
-  Area vulnerable to an approximate 16 - inch sea level rise



NOTE: Inundation data from Knowles, 2008. Additional salt pond elevation data by Siegel and Bachand, 2002. Inundation data does not account for existing levees or other shoreline protection. Aerial imagery is NAIP 2005 data.

## Air Quality

Higher temperatures also increase harmful air pollutants -- more fuel evaporates, engines work harder, and demands for electric power increase. High temperatures, strong sunlight, and a stable air mass are ideal for formation of ground-level ozone, the most health-damaging constituent of smog. As the temperature rises and air quality diminishes, heat related health problems also increase. Drier conditions increase the potential for large wildfires, which further worsen air quality.

## Public Health

According to the California Climate Change Report Center's July 2006 report, *Our Changing Climate: assessing the Risks to California*, warmer temperatures and changes in precipitation have serious public health implications<sup>11</sup>. Research suggests that the most serious effects will be related to increased frequency of extreme conditions such as longer, more intense heat waves. Severe heat accompanied by drier conditions and poor air quality could increase the number of heat-related deaths, illnesses and asthma attacks throughout the state. Currently, Solano County has the highest childhood asthma rate, with nearly a quarter (23.6%) of its population between the ages of 5 and 17 having been diagnosed as asthmatic. Within the county, the Vallejo/Benicia area has the highest asthma-related hospitalization rate for 0-4 year olds<sup>12</sup>. Changes in global climate also cause disease-carrying vectors, such as mosquitoes, to thrive in new areas. In addition to mosquitoes, warmer and wetter temperatures will provide prime breeding grounds for ticks, mites, rodents, and the diseases that these vectors carry. Other factors that influence the probability and magnitude of public health disasters such as pandemics are population density, housing type (detached single family residential, apartment buildings, etc.); and, sewage and waste management. The State of California is also working to establish strategies to address the potential impacts of climate change on public health.<sup>13</sup>

## Agriculture

California has a \$30 billion agricultural industry that produces half of the United States' fruits and vegetables. Higher CO<sub>2</sub> levels can stimulate plant production and increase plant water-use efficiency. However, if temperatures rise and drier conditions prevail, water demand will increase, crop-yield may be threatened by a less reliable water supply, and greater ozone pollution could render plants more susceptible to pest and disease outbreaks. Temperature increases may change the time of year that certain crops, such as wine grapes, bloom or ripen, and thus affect their quality<sup>14</sup> (California Climate Change Center, 2006). In addition, high temperatures are known to stress dairy cows, resulting in reduced milk production, which is a three billion dollar industry in California.

## Ecosystems and Wildlife

California is one of the most climatically and biologically diverse areas in the world, supporting thousands of plant and animal species. Climate change is expected to intensify the threat to ecosystems by increasing the risk of wildfire and altering the distribution and character of natural vegetation and wildlife. Soil moisture is likely to decline in many regions, and intense rainstorms are likely to become more frequent. Sea level will dramatically increase along most of the U.S. coastline. Rising temperatures could have major impacts on plants and animals, including: 1) timing of ecological events; 2) geographic range; 3) species' composition within their respective communities; and, 4) ecosystem processes such as carbon cycling and storage<sup>15</sup>.

11) California Energy Commission (2006). *Our Changing Climate: assessing the Risks to California*. (<http://www.energy.ca.gov/2006publications/CEC-500-2006-077/CEC-500-2006-077.PDF>)

12) Solano County, (2009) Solano County Public Health - Asthma Education.

13) California Energy Commission (2009). *Public Health Adaptation Strategies* (<http://www.climatechange.ca.gov/adaptation/publichealth/index.html>)

14) California Energy Commission. (2006) *Our Changing Climate: Assessing the Risks to California*

15) Parmesan C. (2006) Ecological and evolutionary responses to recent climate change. *Annu. Rev. Ecol. Evol. Syst.* 37:637–69. and Parmesan, C. and H. Galbraith (2004) Observed Impacts of Global Climate Change in the US.



## POLICY AND LEGISLATION

As a result of the overwhelming evidence that climate change is a real and increasing challenge, governments have created policies at international, Federal, State, and local levels to reduce greenhouse gases.

### International Mandates for Climate Protection

Over a decade ago, most countries joined an international treaty - the United Nations Framework Convention on Climate Change (UNFCCC)<sup>16</sup> - to begin considering what could be done to reduce global warming and to cope with inevitable temperature increases. More recently, a number of nations approved an addition to the treaty, the Kyoto Protocol.

The Kyoto Protocol sets binding targets for its signatories to reduce greenhouse gas emissions in industrialized nations. These reductions amount to an average of five percent below 1990 levels over the five year period from 2008 to 2012. The agreement was not ratified by the United States, but was one of the inspirations for California's State law, Assembly Bill 32 - The Global Warming Solutions Act of 2006, and the U.S. Mayors Climate Protection Agreement, which includes over 900 mayors who have pledged their cities to meet or beat the Kyoto Protocol's standard by 2012. Benicia Mayor Elizabeth Patterson signed the agreement in 2008.

### Federal Mandates for Climate Protection

There is no federal mandate for greenhouse gas emission reporting or reduction in the United States. However, in April 2007, the U.S. Supreme Court ruled that the U.S. EPA has not only the authority, but also the obligation, to regulate greenhouse gases as "serious and well recognized" pollutants.<sup>17</sup> In April 2009, the EPA released a 133-page endangerment finding noting that, "...Greenhouse gases that are responsible for [climate change] endanger public health and welfare in the meaning of the Clean Air Act." The eventual judgment from the EPA may open the door for regulation of greenhouse gas emissions via the provisions of the Clean Air Act.

## State Mandates for Climate Protection

In 2005, California Governor Arnold Schwarzenegger signed Executive Order S-3-05, setting a goal of reducing emissions to 1990 levels by 2020 and 80 percent below 1990 levels by 2050. In response to the Executive Order, the California EPA created the Climate Action Team, which, in March 2006, published the first Climate Action Team Report. The 2006 CAT Report identifies a recommended list of strategies that the State could pursue to reduce greenhouse gas emissions. These strategies would be implemented by various state agencies, within their existing authority, to meet the Governor's targets. The strategies include, but are not limited to the reduction of passenger cars and light duty truck emissions, the reduction of idling times for diesel trucks, an overhaul of shipping technology/infrastructure, increased use of alternative fuels, increased recycling, and landfill methane capture.

In September 2006, the California State Legislature adopted Assembly Bill 32, the Global Warming Solutions Act of 2006, as an implementation strategy for the Governor's Executive Order. The law directs the California Air Resources Board (CARB) to adopt regulations to require the reporting and verification of statewide GHG emissions and to monitor and enforce compliance with the program. It conforms to Executive Order S-3-05 by requiring the reduction Statewide of greenhouse gas emissions to 1990 levels by 2020 (which represents reducing emissions by approximately 30 percent from emissions levels projected for 2020).

Since 2007, the California State Attorney General's office has been urging cities and counties to address emissions from new construction as part of the review process under the California Environmental Quality Act (CEQA). In 2007, the State Attorney General sued San Bernardino County for failing to consider greenhouse gas emissions in its proposed general plan update. The case was settled and the County agreed to develop a greenhouse gas emissions reduction plan. Additionally, in January 2008, the Sierra Club filed a lawsuit to block the City of Stockton's General Plan, claiming that it failed to address the amount of greenhouse gases the plan would emit into an already heavily polluted San Joaquin Valley. The Attorney General's Office subsequently entered into negotiations with Stockton, citing concerns about the General Plan and the need to evaluate greenhouse gas reduction impacts under CEQA. The Attorney General reached a settlement agreement with the City and the

<sup>16</sup>) The UNFCCC is a United Nations treaty that aims to stabilize greenhouse gas emissions and mitigate climate change

<sup>17</sup>) Massachusetts v. Environmental Protection Agency (EPA), No. 05-1120

Sierra Club in September 2008, under which the City will adopt a Climate Action Plan designed to reduce sprawl and increase infill development, promote public transit, and increase the number of energy-efficient buildings.

In October 2008, California continued its climate leadership by adopting the country's first comprehensive land use planning law to tackle related greenhouse gas emissions. Senate Bill 375, supports the implementation of AB 32 and signals a fundamental shift in community design. The three goals of SB 375 are to:

1. Use the regional transportation planning process to help achieve AB 32 goals.
2. Use CEQA streamlining as an incentive to encourage transit-oriented residential projects that help achieve AB 32 goals.
3. Coordinate the regional housing needs allocation process with the regional transportation planning process, providing monetary incentives for sustainable development.

## Related State Legislation

The State of California has passed the following legislation aimed at combating climate change and promoting economic sustainable development:

- Senate Bill 1771 requires the California Energy Commission (CEC) to prepare an inventory of the state's greenhouse gas emissions, to study data on global climate change, and to provide government agencies and businesses with information on the costs and methods for reducing greenhouse gases. It also established the California Climate Action Registry to serve as a certifying agency for companies and local governments to quantify and register their greenhouse gas emissions for possible future trading systems.
- Assembly Bill 1493 (2002) requires the California Air Resources Board (CARB) to develop and adopt regulations that achieve the maximum feasible reduction of greenhouse gases from vehicles primarily used for non-commercial transportation by January 2005.
- Senate Bill 1078 (2002) establishes a Renewable Portfolio Standard requiring electricity providers to increase purchases of renewable energy resources by 1 percent per year until they have attained a portfolio of 20 percent renewable resources.

- Senate Bill 1368 (2006) requires the CEC and the California Public Utilities Commission to set a global warming emissions standard for electricity used in California — regardless of whether it is generated in-state or purchased from other states.
- California Solar Initiative Program (2006) is a comprehensive \$2.8 billion program that provides incentives toward residential and commercial solar development over 11 years.
- Senate Bill 97 (2007) directs the Governor's Office of Planning and Research to develop CEQA guidelines "for the mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions."
- Assembly Bill 811 (2008) authorizes cities and counties in California to designate districts within which willing property owners could enter into contractual assessments to finance the installation of renewable energy generation, as well as energy efficiency improvements, that are permanently fixed to the property owner's residential, commercial, industrial or other real property. These financing arrangements would allow property owners to finance renewable energy generation and energy efficiency improvements through low-interest loans that would be repaid as an item on the property owner's property tax bill.

## LOCAL ACTION

In addition to California State law, there have been three significant events that have influenced climate protection planning in Benicia:

- I. Valero Improvement Project Settlement Agreement: In 2002/2003 as a condition of the Valero Improvement Project, the City of Benicia and the Valero Refinery worked jointly to develop a project that would supply up to 2 million gallons per day of recycled water from the City's wastewater treatment plant for use by the refinery. Valero committed to financially support the water reuse project in the approximate amount of up to \$15 million. In 2006, the cost projections for the project were up to \$40 million, which was significantly beyond the financial commitment made by Valero to support its development. In 2007, at the direction of the City Council, the water reuse project was put on hold pending securing funding in the approximate amount of \$40 million. In 2008, Valero applied to amend the permits for the Valero Improvement Project. In doing so, a settlement agreement was reached between

Valero Refinery, City of Benicia, and the Good Neighbor Steering Committee (GNSC). GNSC is an unincorporated association of Benicia residents and business owners who are concerned about potential environmental impacts of Benicia refinery operations generally and the VIP and its amendments specifically. The terms of the \$14 million settlement agreement were incorporated into the conditions of approval for the amended project. Within the \$14 million, \$10 million was allocated for water conservation type projects over five years (\$2 million/year) and \$600,000 for implementation of the Climate Action Plan over three years (\$200,000/year). The remaining funds were allocated for watershed and buffer land acquisition, establishment of a City tree program, and energy efficiency projects at the Benicia Unified School District. The majority of the funds will be administered by the City Council based upon the recommendations of the Community Sustainability Commission. As of late 2009, the GNSC and Valero Refinery were drafting modifications that would effectively expand the water conservation allocation to also include energy efficiency.

2. Community Sustainability Commission: The City Council established the Community Sustainability Commission (CSC) in September 2009 with the charge of making recommendations on implementation of the Climate Action Plan and allocation of VIP water conservation and Climate Action Plan settlement funds.
3. Comprehensive Renewable Energy RFP: In May 2009, the City issued a request for proposals (RFP) for projects and programs that would transition the City from non-renewable energy sources to renewable energy sources at little or no cost to the City. This includes the potential development of a wind and/or solar micro-utility on City-owned parcels north of Lake Herman Road, solar photovoltaic (PV) and/or solar thermal collection installations at City facilities, establishment of an AB 811/Clean Energy Municipal Finance program similar to Berkeley FIRST, energy efficiency retrofits at City facilities, and communitywide energy audits and retrofits. In September 2009, the City Council approved the first contracts for a renewable energy project manager and a subsidized residential energy audit program.