

## **2007 POLICY RESEARCH DOCUMENT #1—Climate Change**

The FCL Education Fund has embarked on a series of research projects to assist the Policy Committee of FCL in revising its statements of policy. Every year, FCL updates several of its standing policy documents. The “Concern for the Environment” policy was last revised in 1992 and is scheduled for revision in 2008.

This paper is a background document that reviews the issues surrounding greenhouse gas emissions. It summarizes the current state of policy and science, and suggests positions that the FCL Policy Committee may need to consider in its deliberations during 2008. Comments are appreciated, and should be e-mailed to Jim Lindburg at [jiml@fclca.org](mailto:jiml@fclca.org) or sent to him at 717 K Street, Sacramento, 95814. To the extent there are differences between this document and the approved policy statement, the FCL staff will rely upon the 1992 statement until it is officially revised.

### **California in a Changing Climate: 2007**

by Karen Street

In June 2005, Governor Schwarzenegger signed executive order # S-3-05, establishing targets for greenhouse gas emissions reductions:

- By 2010, reduce to 2000 emission levels
- By 2020, reduce to 1990 emission levels
- By 2050, reduce to 80 percent below 1990 levels

A Climate Action Team (CAT) was created to study how emissions reductions can be made and to report on the results. According to the first report, the State can initially reduce carbon emissions without much economic cost, in part because California businesses expect to benefit financially from participating in the initial research and development.

#### *Background*

California is a state of beauty, from the unique Monterey Bay to spectacular mountain ecosystems, from spring flowers to fog-dependent coastal trees. One of the few Mediterranean climates on Earth, California contains a globally significant degree of plant and animal diversity, but is also one of 25 world ecological hot spots, having lost at least 70 percent of its habitat (CalAcademy).

In the next two decades, California's population of 36 million is expected to increase by seven to 11 million people (PPIC), putting even more stress on housing, traffic, water and land use. Within the lifetime of younger Californians, these problems will be further exacerbated by global warming. Earth's temperature is rising, glaciers are melting; the climate has become more variable, leading locally to species extinction (Boggs). A decreasing percentage of precipitation falls as snow, snowmelt occurs five to 30 days earlier, and birds, flowers, and insects migrate or mate earlier in the year, not necessarily at well-coordinated times. These changes contain the fingerprint of global warming from increased greenhouse gas emissions: for example, night is warming faster than day and winter faster than summer.

Storm intensity and frequency are expected to increase in many parts of the world. Many scientists believe that the intensity of storms is already exceeding normal variations and that the predicted increase in severity of hurricanes has already been observed. Ecosystem disruption will occur with the spread of pests (the spruce and pine beetles are taking a major toll on boreal

forests); additionally, flora and fauna in fragmented ecosystems will need to move rapidly, often across areas of human development, to reach an area with appropriate temperature and precipitation. Sudden climate changes are possible: almost all of the 20<sup>th</sup> century increase in Alaska's temperature occurred *in* 1977.

The changes are caused by increasing atmospheric concentrations of carbon dioxide and other greenhouse gases. Greenhouse gases include methane, nitrous oxide, and chlorofluorocarbons (CFC's), which also damage the ozone layer, as well as ozone. Soot is also warming the Earth. The actual amount of warming is masked by reflective aerosols (tiny particles, mostly from fossil fuel pollution, suspended in the air) which temporarily cool the planet while global temperature continues to rise. The primary source of greenhouse gases is the burning of fossil fuels. Additionally, carbon previously stored in trees is released into the atmosphere when trees are burned for deforestation, some 10 percent to 30 percent of the carbon dioxide added each year.

The average world temperature has increased 0.8 C (1.4 F) since 1880, and is now increasing about 0.2 C (0.4 F) per decade. If atmospheric levels of greenhouse gases were to stabilize now, the planet is already committed to warming another 0.6 C (1 F) as the Earth's temperature catches up to current greenhouse gas levels. Using a variety of computer models, the Climate Action Team looks at three scenarios for economic and population growth and fossil fuel intensity: 21<sup>st</sup> century increase may range from 1.5 C (low emissions scenario), 4.5 C (medium emissions scenario), or 5.8 C (high emissions scenario). The difference in the effects between the scenarios is small before 2035, but becomes more dramatic afterwards. [Climate feedbacks included in the Intergovernmental Panel on Climate Change (IPCC) 2007 report indicate increases are likely to be even greater by 2100.]

A few tenths of a degree may seem trivial, but a total increase over 1880 levels of 1.5 C— the level that may commit the polar bear to extinction and the coral reefs to extensive bleaching and possible extinction—is already unavoidable, barring unthinkably rapid changes in policy. That is, with 1.4 C already accounted for, we will reach the 1.5 C level soon if it has not already occurred. A total increase of 2 C, which we could occur before 2050, and be committed to by 2015 or even earlier, *given our current energy choices*, may lead to catastrophic sea level rise of three to four meters per century, resulting in widespread hunger, health problems, and water shortages. At 2.5 C, agricultural productivity is expected to decrease everywhere on Earth; regionally, this change has already begun (Holdren, DEFRA). Clearly, no matter which economic and technological path we choose, it will be necessary to reduce greenhouse gas emissions. Business as usual is not an option.

#### *Likely impacts in 21<sup>st</sup> century California*

*Overall:* Generally, temperatures will be not only higher but more variable, so that the number of extreme events will increase. Even where precipitation increases, soil will be drier because of higher temperatures. Sea level rise this century was expected in 2001 to be less than 33 inches (high estimate), but ice sheets are now known to be melting faster than expected, and actual sea level rise may be more than double this figure.

*From the Climate Action Team:*

*Public Health.* Increases in the number of extreme events (heat and wildfires) will increase air pollution (now causing 9,000 deaths in California yearly, and \$60 billion in economic costs). The number of days meteorologically conducive to high pollution may increase as little as 25 percent to 35 percent (low emissions scenario) or up to 75 percent to 85 percent (high emissions scenario) in the most polluted areas of Los Angeles and the San Joaquin Valley. Ground level

ozone is projected to increase 4 percent to 10 percent (low emissions scenario) or as much as 25 percent (high emissions scenario).

The number of days warmer than 90 F in Los Angeles, 95 F in Sacramento, may increase to 100 days (high emissions scenario), and deaths may increase in Los Angeles alone by hundreds/year, primarily among the elderly, already ill, and the poor. Added air conditioning alone may increase the demand for electricity by 10 percent over current use.

*Water Resources* By 2035-2064, Sierra Nevada snowpack could decrease 10 to 40 percent. By 2100 the decrease could be 90 percent. Water demand is expected to increase because of warmer temperature, from 2 percent (low emissions scenario) to 13 percent (medium emissions scenario). Both droughts and floods may increase.

*Agricultural Impact.* The largest California economic losses are expected to come from agriculture and forestry. California agriculture is a \$68 billion industry, and supplies half of U.S. fruits and vegetables. Since 1950, the number of growing days/season has increased by a day/decade, benefiting farmers. Currently, temperature and atmospheric carbon increases are increasing yield, but yield will decline as temperatures continue to climb. Stone fruit may be smaller and of poorer quality, grapes may ripen early and suffer quality reduction, tomato yields will decline, and lettuce and other crops may suffer burn. Additionally, the timing of insect pollinators and the timing of flowering may move out of sync. Weeds, insect pests, and pathogens should grow faster and over a wider range as temperatures increase.

Increases in atmospheric carbon can increase photosynthesis, but it can decrease concentrations of mineral nutrients and nitrogen in the plant. The fruit flavor of strawberries improves, but grain protein decreases along with bread-making qualities.

*Sea Level Rise.* Sea level is rising about two centimeters per decade (less than one inch), 7.6 inches during the 20<sup>th</sup> century. The 2007 IPCC report predicts as much as a 23 inch increase during the 21<sup>st</sup> century from thermal warming alone (warmer liquids expand), but many experts predict that this century, the contribution from glacier and ice sheet melt may exceed contributions from warming. California sea level increase may be even greater. It is higher during El Nino years, up to 0.8 feet in January 1998, and climate models predict more frequent El Nino conditions. Coastal structures will be in danger from increased storms on higher oceans; it is estimated that a one meter sea level rise would “inundate developed and natural areas, accelerate coastal erosion, cause salinity contamination of groundwater aquifers and rivers, damage port facilities, erode recreational beaches, and disrupt wetlands and natural habitats (Gleick).” Floods in the Sacramento/San Joaquin Delta may jeopardize levees and other structures, with dramatic impacts on water distribution. With a sea level rise of one meter, “the pumping of freshwater out of the delta to users to the south could be jeopardized (EPA)”. Expensive levees, expensive to build and expensive to maintain, would be needed to protect portions of the San Francisco Bay Area, as sea levels continue to rise (Gleick).

*Silviculture (forestry).* The extent and nature of forests will change this century, with some regions (alpine and sub-alpine) losing range, others (conifers and pines) losing productivity, and others (possibly) gaining. A net shift of woodland and shrub-land to grassland is expected because of the increase in forest fire frequency. Models show wildfire increases of 35 percent by mid-century, 55 percent by 2100 (medium emissions scenario), but more is likely because of the increase in extreme events, both temperature and precipitation. According to the CAT, “although society has developed a number of ways to adapt to wildfires, climate change, along with the multiplying impacts of other stresses such as population growth and land-use change may be

pushing California outside of its coping range.” Pests and pathogens are expected to increase their range and impact; pine pitch canker has already spread.

*Electricity Sector Impacts.* Hydropower now contributes 15 percent of our electricity (from nine percent to 30 percent, depending on yearly rainfall). It will be less available with decreasing stores of water, and will be even less available during the high demand months of late spring and summer. In most scenarios, there will be a decrease of seven percent by mid-century and 30 percent (medium emissions scenario) by 2100. This must be replaced by other sources of electric power. Demand is expected to increase between one percent to three percent by 2025 and three percent to 20 percent by 2100.

*Economic Effects.* The largest economic effects will likely come from reduced supply and increased demand for water in the spring and summer. Tourism is worth \$75 billion annually to California (\$22 billion at the coasts) and provides a million jobs. Winter recreational activities will decline.

### *Solutions*

There are a number of technology choices for reducing greenhouse gas emissions (mitigation), and all are critical. In order of their expected contribution over the next four decades:

- significantly improving energy efficiency
- developing more renewable energy (both for fuels and electric power)
- expanding nuclear energy
- carbon capture and storage—a new, more expensive coal power plant design is expected to allow a fair amount of carbon dioxide to be *sequestered*, stored in oil wells and the seams of coal mines. (This is a temporary solution, possibly lasting the century.)

We need all solutions: large and small, today’s and tomorrow’s. Technologies whose contribution is smaller (e.g., slowing deforestation and increasing afforestation, using low greenhouse gas-emitting agriculture, and improving waste management) or those which take a long time to kick in (hydrogen fuel cells and nuclear fusion have timelines of decades to almost a century) should not be rejected, though they may receive less policy emphasis initially.

*Cap-and-Trade* is crucial: it allows society to set a maximum safe level of greenhouse gases which decreases with time and then lets the business community sort out the most efficient way to reduce emissions.

### *Public Policy (see appendix)*

Legislation at state and regional levels to increase the integration of housing and transit (in order to reduce use of private cars and help make life more affordable for the poor) has not been considered here, but is an important part of the solution.

No legislation has been proposed to require Californians to pay the cost of mitigation in poorer countries. From 1850 to 2004, the U.S., with only 4.5 percent of the world’s population, emitted 28 percent of the world’s carbon dioxide. Responsible for far more than our share of greenhouse gases, should we be responsible for more than our share of the solution? We are also wealthy, with a per capita GDP of \$42,000, compared to a world value of \$6,300, \$6,800 in Mexico, \$1,300 in China, and \$600 in sub-Saharan Africa. EcoEquity points out how little time there is and how disproportionately climate change will hurt the poor and those whose fault it isn’t.

### *Changing Our Behavior*

Policy analysts have not yet detected the effect of people voluntarily living with less; their graphs show only increasing per capita consumption. Their assumption, that too few people will voluntarily change, may be correct at present. We may wish to change that. If enough people decrease their greenhouse gas footprint to be detectable to policy makers, finding solutions will be easier.

### *Adaptation*

Though it is more expensive than mitigation (reducing emissions in the first place), adaptation will be necessary under all scenarios. We should begin now to adapt: charging replacement cost for water used, planning for higher sea levels, limiting construction based on the future and not just the past. Unfortunately, the ability to adapt to large changes is limited, especially for natural unmanaged systems. The ability to cope and to adapt varies geographically, and across economic sectors and populations, aggravating inequality.

### *Conclusion*

Rapid and radical reductions in greenhouse gas emissions will help preserve the state we love, and reduce the cost of adaptation. Failure to reduce greenhouse gas emissions sufficiently will leave younger Californians with a world far different than the one today; it will mean that we in California have not seen our lives testify to equality, stewardship, and peace.

## *Appendix*

### Legislation and Regulations (Farrell)

#### *Already passed or ordered:*

AB 1493 (Pavley, 2002) 30 percent reduction in automobile GREENHOUSE GASES emissions (40 percent increase in fuel economy) by 2016

Renewable Portfolio Standard (2003) originally required 20 percent renewables for electricity in 2017, amended version requires 20 percent in 2010, and a target of 33 percent in 2020

CPUC new energy efficiency programs (2004) – authorizes \$1 billion to avoid building 613 MW power plants, 3,000 GWh of electricity/year.

CPUC “Carbon Adder” for planning future power plants assumes that carbon cap and trade or carbon taxes will be applied. Utilities assume a price of \$8/ton C in 2005, and increase the assumed price five percent/year.

CEC/CPUC Greenhouse gases performance standard (2005) requires base load electricity to have lifecycle greenhouse gas emissions less than if the entire base load was supplied by combined cycle gas turbine. Lifecycle includes the costs from mining to waste.

Executive Order S-3-05 GREENHOUSE GASES (2005), Governor Schwarzenegger, setting GREENHOUSE GASES emissions targets.

California Solar Initiative (2006) will spend \$2.8 billion over 11 years to install perhaps 3,000 MW solar panels.

CPUC emission cap (2006) for the electric sector, eventually to include natural gas.

#### *Proposed*

Climate Action Team recommendations (2006) – lots of detail here in their report.

SB 1368 codifies/extends greenhouse gases performance standard (2006)

AB 32 (Nunez/Pavley) stationary cap and trade (2006)

AB 1007 (Pavley) more on vehicles, alternative fuels

The Energy Policy Initiatives Center keeps track of energy legislation (<http://www.sandiego.edu/epic/>).

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## **About the Author**

California educator Karen Street specializes in helping non-scientists of all ages understand the complex issues related to climate change. Karen teaches classes, workshops, and programs on climate change and environmental priorities, as well as maintaining a blog at <http://pathsoflight.us/musing>. She corresponds widely with climatologists and policy-makers at work on the problems caused by global warming.

Karen worked initially as an electronics engineer, later as a math and physics teacher. In the past decade of writing and teaching about the environment, she has followed the work of leading scientists in peer-reviewed publications. She regularly submits her own writings on science and policy issues to established experts in the relevant fields, and incorporates their generous and detailed responses.