August 2008

one school's solar project fuels a movement

STOP CLIMATE CHANGE

CREATE JOBS

IMPROVE HEALTH

HELIOS

kyotoUSA

SEQUOIA FOUNDATION

Berkeley, California

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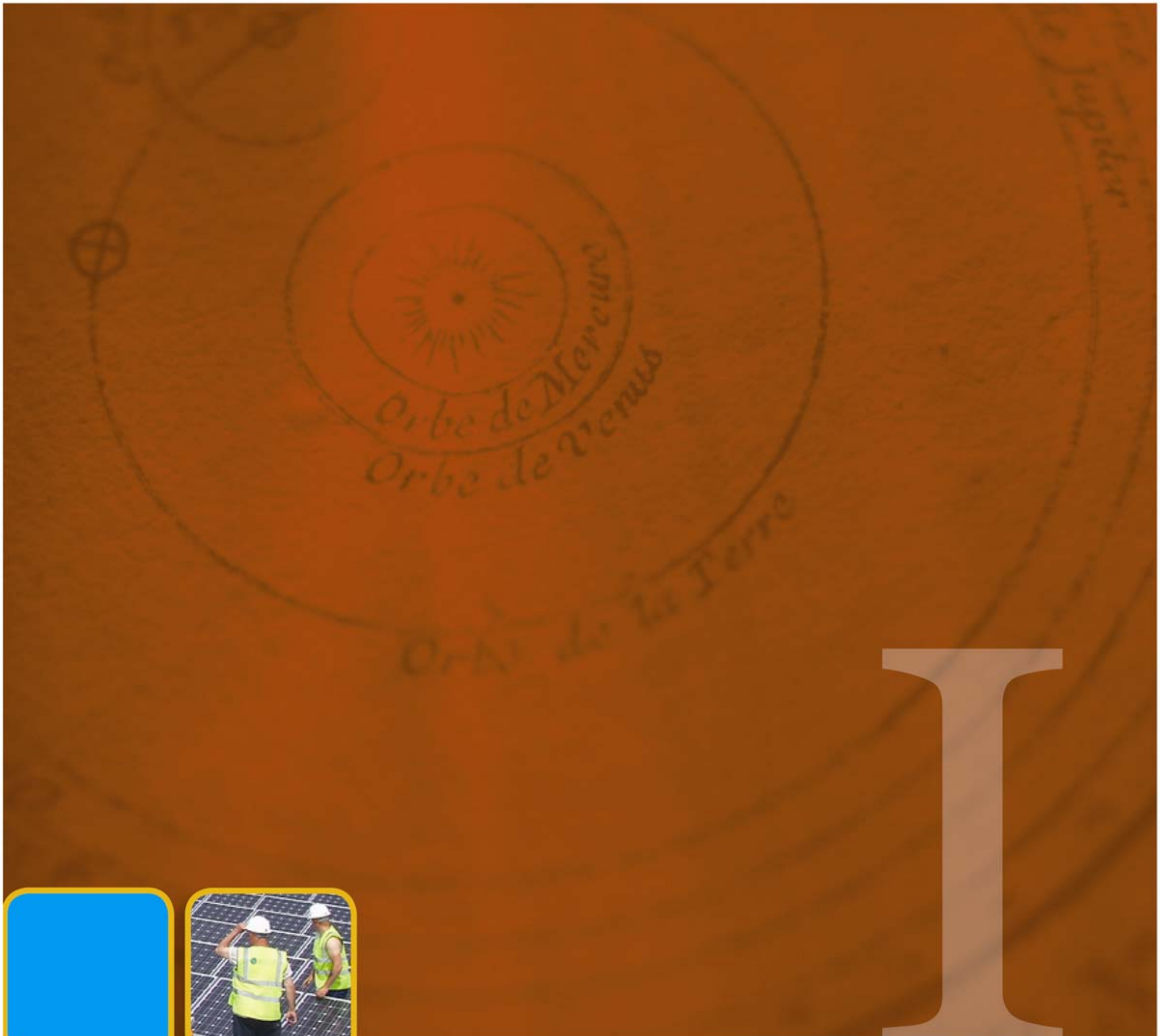

I

Executive Summary

EXECUTIVE SUMMARY

This study makes the case for installing photovoltaic systems on our public schools and for developing a Community Climate Fund in Berkeley – and in your community – that can help to overcome the financial barriers preventing our schools from moving away from their reliance on electricity produced by costly and polluting fossil fuels.

The model described here will work for any public or private (non-profit) school. It can set a School District on a path toward energy independence that will eventually eliminate a District's cost for much of the electricity derived from fossil-fuels—a cost that consumes a significant (and growing) part of a District's general fund.

In November 2007, KyotoUSA commissioned a study of the economic, environmental, and health benefits associated with installing a 100-kilowatt photovoltaic (PV) system on Washington Elementary, a Berkeley public school serving about 325 children. The study had two objectives:

1) **Identify the beneficial impacts** *beyond* the financial benefits that accrue to a school district.

2) **Investigate the potential "market" for a "Community Climate Fund"** - a source of on-going funding for energy efficiency and renewable energy projects for local public schools that would be supported by businesses, institutions, and individuals seeking to reduce their own "carbon footprint."

The three sections of the study are:

1. *PV Installations: Local Economic and Environmental Impacts Summary* – authored by Economic and Planning Systems (EPS)
2. *Analysis of Local "Offset" Program Potential*
3. *Jobs, Emissions, Health Calculator* – created by Economic and Planning Systems (EPS)

The Washington Elementary PV project was the first demonstration of **KyotoUSA's HELiOS Project** (**H**elios **E**nergy **Li**ghts **O**ur **S**chools) concept. HELiOS shows that it is possible to install PV on our schools **without increasing a school district's operating costs.** In effect, a district pays for the PV system with the money that it is no longer sending to the local utility for electricity produced by fossil fuels. There are several financial instruments that enable districts to purchase the PV systems. The HELiOS model works best when:

- A "tax exempt municipal lease" (TEML) or similar instrument is used to purchase the PV system, just as a district might buy school buses. A TEML is essentially a mortgage that a district pays off over a 20-25 year period. Interest rates are favorable and annual payments remain the same for the full period of the loan, regardless of future increases in the price of electricity. The district owns the PV system from the outset.

Other financing options include:

- "Power purchase agreements" (PPA)[1], in which a district "leases" a school's roof for 6 to 20 years to an investor who pays for and installs the PV system. The district buys its electricity from the investor for a few cents per kilowatt hour less than the local utility charges. At the end of the contract period, the district can purchase the PV system for its "fair market value."

- State modernization grants (Office of Public School Construction), federal bonds (Clean Renewable Energy Bonds) and local school bonds.

[1] HELiOS may be adaptable for PV systems installed via a PPA, especially where energy efficiency improvements to the facility would reduce overall energy consumption.

The key to making the HELiOS model work is the community's willingness to contribute funds to fill the modest "gap" that occurs in the early years when the annual payments on the TEML are higher than the expected electricity savings. (This "gap" disappears in a few short years.) For Washington Elementary, the 100 Kw PV system cost about $700,000, with a "gap" of about $30,000—most of which was raised by KyotoUSA from supporters, friends, and family.[2]

To make the HELiOS model work on a wider scale—and more quickly and efficiently—we wanted to identify a source of funding (beyond friends and relatives) to close the "gap". That's one reason we commissioned this study – to demonstrate the incredible benefits that accrue to the school district, its students, the environment, and the local economy when a school "goes solar". Based on what we've learned from the first HELiOS school and this study, **KyotoUSA and its partner the Ecology Center are laying the groundwork for a "Community Climate Fund"** that will be the source of support for future school—and other public benefit—greenhouse gas (GHG) reduction projects.

Residents and businesses can make **tax-deductible donations** to the Community Climate Fund to support a local HELiOS project. The donation goes toward a "soft offset" that helps to compensate for personal GHG emissions that the donor is unable to reduce or avoid. The donor isn't purchasing a formal, quantifiable GHG reduction, but rather will be contributing toward a "bundle of benefits" that has been identified in our study. In addition to improved economic well-being for a school district, HELiOS projects provide quantifiable local economic benefits in terms of jobs and sales of goods and services, reductions in carbon dioxide and other harmful emissions, and health benefits in areas where electricity is produced from fossil fuels.

There's work to be done on the issues associated with this study, questions to be answered, and changes in attitudes and behaviors to encourage so that we can quickly ramp up our efforts to reduce our energy consumption and produce more of it from clean, renewable sources. Please be sure to do your own due diligence in developing local projects and remember that the issues discussed here are always in flux. What you read here today describes a perspective on the value of local action that can be improved and modified to suit local conditions, and will undoubtedly be affected by the political changes that are occurring at the state and federal level. We'll be happy to discuss this project with you in more detail if you are considering launching a similar effort in your community.

We received a great deal of support, financial and moral, in making this study possible and we are grateful to everyone for their contributions. We'll be happy to share your comments with those who helped, but please keep in mind that we, at KyotoUSA, are responsible for what you read here. If there's anything amiss, it is our responsibility.

Please feel free to use this work to promote similar projects in your community. It's our gift to you and **we ask only that you use it for the benefit of others.** Contact us if you have questions, corrections or updates and we'll do our best to keep the information and ideas fresh.

Tom Kelly, KyotoUSA
Berkeley, California
August 2008

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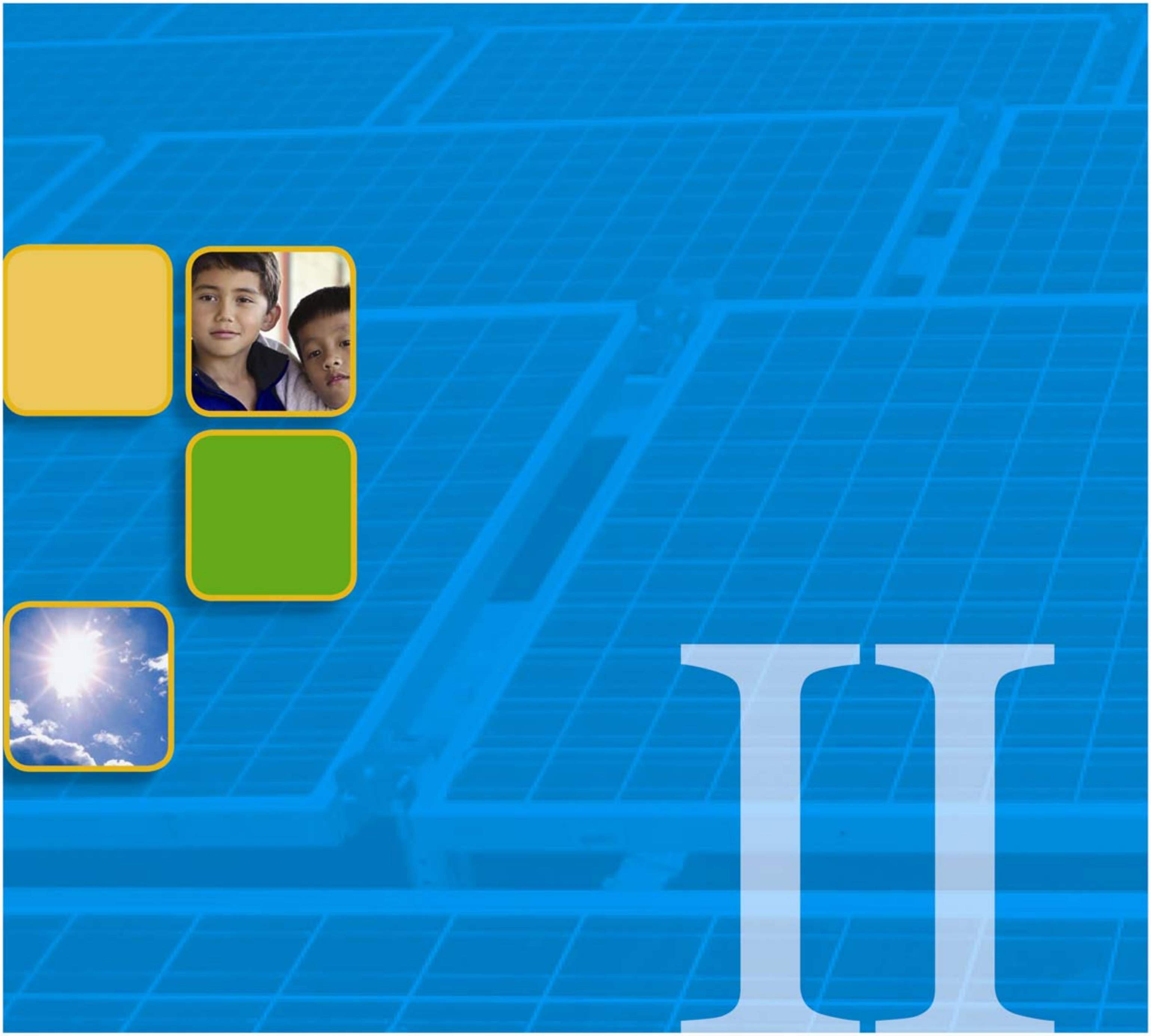
[2] Because Washington Elementary qualified for State construction grants and the contracted price for the PV system was less than anticipated, the District was able to use untapped bond funds in lieu of a TEML. Funds raised by KyotoUSA may be used for energy efficiency improvements at Washington or as seed funds for the next HELiOS school.



PV Installations: Local Economic and Environmental Impacts Summary

Economic & Planning Systems
Public Finance
Real Estate Economics
Regional Economics
Land Use Policy

FINAL REPORT

PV INSTALLATIONS: LOCAL ECONOMIC AND ENVIRONMENTAL IMPACTS SUMMARY

Prepared for:

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I. BACKGROUND

Economic & Planning Systems, Inc. (EPS) was retained by KyotoUSA to prepare: (1) an analysis of direct and associated economic impacts due to the installation of solar panels similar to those planned at Washington Elementary School in Berkeley, California; (2) qualitative and quantitative discussions of health and economic impacts due to a switch from traditional grid electricity to solar power; and (3) a calculation tool which segments changes in local wages, expenditures, and pollutants through changeable inputs on power sources and amounts. The calculation tool will be presented in an electronic file format; several tables provided here illustrate the results from the calculation tool.

The aim of this analysis is to develop local economic and environmental impact conclusions which apply to the Berkeley, California, photovoltaic solar installation and are sufficiently flexible to allow conclusions to be made which apply to a wider geographic area. Throughout this report, the term "local" is defined as a county's geographic boundaries.

II. KEY FINDINGS

1. The purchase and installation of PV solar panels directly supports local jobs in design, panel mounting, and electrical connection work.

Although the Bay Area region has potential to serve as a location for relatively small-scale manufacturing, the primary economic effects due to the purchase and installation of PV solar will accrue to design, mounting, and electrical firms.[1] Economic activity within these firms will ripple through to: (1) local industries which supply the firms, including professional services and wholesale trade firms and (2) industries which serve their employees, including firms such as general merchandise, food, health, banking, etc. These secondary impacts are referred to, respectively, as indirect and induced impacts.

2. The purchase of a $1 million PV system supports 2.6 onetime jobs and about $175,000 in onetime wages, locally.

The purchase of a $1,000,000 PV solar system supports about 1.7 local jobs (for one year) directly engaged in the design, mounting, and electrical work needed to install the system. Local economic impacts refer to those occurring within the county where the PV installation is located. Including jobs in supplier industries and in employee-serving industries, an additional 0.90 jobs is attributed to the PV purchase (for a total of 2.6 jobs). The estimated employee income associated with this design, mounting, and electrical work is $130,000. Including wages for employees in supplier industries (called indirect wage impacts) and wages to employees working in service sectors (called induced impacts), total local wages resulting from the purchase of the system sum to $175,000.[2]

3. Nationally-focused studies of the PV solar industry indicate that jobs, income, and output directly related to the PV solar industry have economic multiplier effects of between three and four. [3]

Finding 2 noted that the $1 million PV system results in about 1.7 local, direct jobs and 2.6 total local jobs, including jobs in supplier and service industries supporting PV solar industries and their employees. This indicates that the PV solar installation and construction industries in Bay Area counties typically have a multiplier effect of about 1.5, meaning that for every one job created in the industry, about one-half of a job is

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[1] PV solar manufacturing now occurs in some areas of the Bay Area. One firm, Nanosolar, opened a 140,000-square-foot manufacturing facility in San Jose in 2006. Another PV manufacturer, Solyndra, is located in Fremont, California. Miasolé and OptiSolar, two other Bay Area solar firms, also have locations associated with research and development of thin film solar. In order to provide a more conservative and transferable estimate, only non-manufacturing jobs are included in the local impact estimates.

[2] The extent to which a particular locale is home to PV-related manufacturing facilities will increase this local impact.

[3] See Grover, S., "Energy, Economic, and Environmental Benefits of the Solar America Initiative", National Renewable Energy Laboratory, August 2007.

created in supplier and service industries. When geographies are broadened, such as in the National Renewable Energy Laboratory study mentioned above, a greater breadth of the supplier and service jobs impacted by growth in the PV solar industry are captured and multiplier effects of three and four are achieved.

4. **Projections for PV growth in the United States through 2015 indicate that about 80 percent of new jobs in the industry are expected to be in manufacturing firms and about 20 percent in installation and construction firms.**[4]

Within California, this projected proportion is about 65 percent in manufacturing and 35 percent in installation and construction.[5] The PV industry group estimates that there are about 20,000 people directly employed in the solar power industry in the United States, with a more than threefold increase expected through 2015, to 62,000 jobs.[6] Assuming an industry-estimated 20 to 30 percent annual growth rate in PV solar installations in the United States, roughly 33,600 new manufacturing jobs and 8,400 new installation and construction jobs are expected.

Various states have differential attributes which impact the likely distribution of these jobs. For example, one study projects that in California, about 6,800 (65 percent of California's expected job growth in PV solar) will be in manufacturing, while 3,600 jobs (35 percent) will be in installation and construction. This is due in part to the size of California's existing manufacturing base and to the likely demand for solar installations, a function of consumer preference, roof space, and the payback period for the system (which is itself a function of system price, local utility rates, and locally available incentive programs such as rebate programs).

Although California is likely to experience job growth in the manufacturing sector as a result of PV solar purchases in the United States, EPS's analysis does not project any local (Bay Area) economic activity related to the manufacture of the products. This is because no PV solar manufacturing facilities are located in Alameda County. In addition, presuming no manufacturing impacts is a more conservative approach in the potential application of this analysis to other geographic areas.

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[4] According to Renewable Energy Policy Project, "Solar PV Development: Location of Economic Activity", January 2005. The greatest proportion of existing and expected employment within the PV industry is in manufacturing. In particular, module assembly is the leading activity within the photovoltaic industry, followed by systems integration and installation. In addition to the report above, see Weissman, Jane, "Defining the Workforce Development Framework & labor Market Needs for the Renewable Energy Industries" for findings on the workforce of the PV industry.

[5] Two reports support this proportionate breakdown in solar-related jobs in California, including the Renewable Energy Policy Project study "Solar PV Development: Location of Economic Activity", January 2005; and a UC Berkeley study cited by the California Solar Initiative.

[6] The "current" jobs estimate of 20,000 reflects the latest estimate found, from a 2001 estimate, from U.S. Photovoltaic Industry Roadmap, Solar Electric Power, May 2001.

5. Solar PV installation in California will reduce emissions primarily from natural gas.

Reduction of carbon dioxide (CO_2) emissions and other air emissions due to solar PV installation vary by State and locality due to solar magnitude and seasonal variation, power generation mix, and "load shape following" generation.[7] Load shape following refers to the peak load of electricity demand during the day and the way that power plants are dispatched to meet the shape of that load demand through the integrated resource power grid. An examination of California's load shape following indicates that power provided to the grid by PV solar in the State would displace the generation of power from natural gas plants. One exception is the region served by the Los Angeles Department of Water and Power which relies heavily on coal for the generation of electricity.

6. Health impacts due to the displacement of fossil fuel-based electricity generation with technologies such as PV solar range from avoidance of employee sick-days, to reductions in hospital admissions due to respiratory and cardiovascular symptoms, to a reduction in pollutant-related deaths.

Health impacts due to emissions from fossil fuel-based power generation occur when nitrogen oxide (NO_x) and sulfur oxide (SO_x) emissions react with other chemicals to form fine particulate matter ($PM_{2.5}$). Health impacts related to inhaling $PM_{2.5}$ occur when the very fine particulates become lodged in the deep recesses of lungs, potentially leading to lung injury, inflammation, changes in respiratory rate, an increased sensitivity to allergens, and depressed resistance to infection.[8]

Reductions in health impacts related to decreases in emissions from fossil-fuel generated electricity are estimated, for every 5 gigawatts of installed PV capacity, at averting about 20 deaths, almost 40 heart attacks, and about 2,500 lost days of work, per year.[9]

A recent study also finds a cause and effect relationship between increased pollution formation rates and higher temperatures caused by greenhouse gas emissions.[10] This study focuses on the increased formation of ozone which occurs as temperatures rise. Each one degree Celsius rise in global temperatures is projected to increase air-pollution

[7] MIT and the Analysis Group for Regional Energy Alternatives prepared a study on this topic comparing generating capacity to emissions reductions by state and region. See "Emissions Reductions from Solar Photovoltaic (PV) Systems," at web.mit.edu/agrea/docs/MIT-LFEE_2004-003a_ES.pdf.

[8] From the U.S. Environmental Protection Agency's web site; see "Health and Environmental Effects Research, Particulate Matter Effects" research area.

[9] In 2006, according to the Energy Information Administration, the U.S.'s PV installed capacity was estimated at about 411 MW, about half of one gigawatt.

[10] Jacobson, Mark; "On the causal link between carbon dioxide and air pollution mortality", Geophysical Research Letters, Vol. 35, 2008.

related deaths by 20,000 people over a one year period. Areas such as California, which has six of the nation's ten most polluted cities, will be disproportionately affected, with about 300 air-pollution deaths projected to occur in the State for each one degree Celsius rise in temperature.

III. INTRODUCTION AND METHODOLOGY

KyotoUSA has partnered with the Berkeley Unified School District to encourage and support the purchase and installation PV solar panels for one school in the District, Washington Elementary School. As part of a variety of analyses being undertaken by KyotoUSA, this report explores the local economic impacts of PV solar installation as well as the levels and impacts of decreases in air pollutant emissions associated with reductions of electricity produced by the local utility.

In order to explore these two areas of impacts, EPS:

- **Analyzed information on the PV solar industry related to the cost components of a typical PV system.** A key factor in determining the local economic impact related to the purchasing and installing of a PV solar system is tracking the system costs and estimating the proportion likely to remain in the local economy.

- **Reviewed data on electricity generation by the local utility, Pacific, Gas & Electric (PG&E).** In the course of this research, we also collected similar data for the State of California and the United States.

- **Analyzed and documented various techniques for estimating emissions and emission results.** Because of the nature of electrical power generation and power imports, which expands and contracts to meet demand, rates of emissions measured for individual plants, for utility companies, and for a single State produce a variety of results, depending on the level of detail used in the estimate.

IV. ELECTRICITY GENERATION AND PROCUREMENT

Electrical power in California is both produced inside the State and imported through the nation's electric grid system from nearby states.[11] For several years, imported energy has contributed about 20 percent of California's total electricity usage.

CALIFORNIA STATE UTILITIES

Electricity in the State is sold to residential and commercial consumers by private, investor-owned utilities (IOUs) as well as municipal power utilities. Five utilities provide about 88 percent of the State's total electricity consumptions. PG&E serves most of northern California and provides about 30 percent of the State's electricity (see **Table 1** below).

Table 1. Power Distributors in California

Power Distributor	Share of State Power Distributed
Southern California Edison	31%
Pacific Gas & Electric	30%
Others	12%
Sacramento MUD	11%
Los Angeles Department of Water and Power	9%
San Diego Gas & Electric	7%
Total	100%

Each power company has an associated mix of fuel and energy technology sources which are used to generate the electricity sold to consumers. The fuel and technology used to generate the electricity sold by the utility, as well as the "load shape following" of the utility (see **Appendix** for illustration), determines the amount of pollution avoided when PV solar power displaces utility power. Therefore, to determine avoided-pollution that a project like the solar project at Washington Elementary would have, the mix of power generation sources is examined here.

Table 2 below shows the national mix of power sources, California's mix, and the mix of sources by major electricity provider in California. PG&E obtains most of the electricity it sells to customers from natural gas (44 percent), with nuclear power providing 23

[11] To get a sense of the distribution of power production locations around the State, see the **Appendix** for a map of power plants.

percent, hydropower at 17 percent, renewable sources making up 13 percent, and power generated from coal at 2 percent of the total. PG&E uses significantly less coal-power than the State and the United States. (2 percent compared with 16 percent for California and 49 percent for the United States).

Table 2. Mix of Fuel Sources, National, California, by California Provider

Geographic Region	Coal	Natural Gas	Nuclear	Hydro-power	Petroleum	Other	Renew-ables[4]	Total
National[1]	49%	20%	20%	7%	2%	0%	2%	100%
CA (2006) in Gigawatt-Hours[2]	46,235	122,226	38,150	56,039	0	0	32,215	294,865
Percent of Total	16%	41%	13%	19%	0%	0%	11%	100%
Southern California Edison (2006)[3]	7%	54%	17%	5%	0%	1%	16%	100%
Pacific Gas & Electric (2007)[3]	2%	44%	23%	17%	0%	1%	13%	100%
Sacramento Municipal Utility District (2007)[3]	4%	60%	<1%	21%	0%	0%	14%	100%
LA Dept of Water and Power (2007)[3]	47%	29%	9%	7%	0%	<1%	8%	100%

[1] Energy Information Administration, Electric Power Annual 2006.

[2] California Energy Commission, 2006 Net System Power Report, includes power generated in State plus CEC staff estimates of imported power.

[3] California electricity providers publish a Power Content Label noting power sources.
Estimates shown are from Power Content Labels of the various providers, for the year indicated.

[4] Expanded by renewable energy type in susbsequent table.

Sourcs: Energy Information Administration, California Energy Commission, 2006 Net Power Report; Economic & Planning Systems

About 60 percent of the renewable power distributed by PG&E is derived from biomass and small hydropower sources (both are 4 percent each of the utility's total power sales). **Table 3** illustrates the mix of renewable source for the United States, California, and California major utility.

Table 3. Mix of Renewable Electricity Only, National, CA, by CA Provider

Geographic/ Utility Region	Renewables[1] % of Total Power	Geothermal	Biomass	Wind	Small Hydro	Solar
National	2%					
CA, Gigawatt-Hours (2006)		13,708	6,285	5,370	6,236	616
Percent of Total (2006)	11%	5%	2%	2%	2%	0%
Southern California Edison (2006)	16%	9%	2%	3%	1%	1%
Pacific Gas & Electric	13%	3%	4%	2%	4%	<1%
Sacramento Municipal Utility District (2007)	14%	4%	6%	2%	2%	<1%
LA Dept of Water and Power (2007)	8%	<1%	1%	1%	6%	<1%

Sourcs: Energy Information Administration, California Energy Commission, 2006 Net Power Report; Economic & Planning Systems

POWER GENERATION TYPES

The key attributes of the various types of power generation are detailed below. Depending on the aim of particular analyses, emissions of greenhouse gases from electricity generation may be characterized on a life-cycle basis or on direct emissions per unit of electricity generated basis. The review below relies on the methodology California uses for its greenhouse gas emissions annual inventories which, in turn, are based on the Intergovernmental Panel on Climate Change (IPCC) guidelines for inventories. In general, the IPCC guidelines provide three options for estimating emissions, all of which rely on estimating emissions which occur when fuel is combusted.[12] As such, emissions related to the development of a power plant (e.g. cement use in nuclear facilities or land use impacts due to flooding for dams) are included in GHG inventories under other inventory-categories and are not included in the discussions here.

Coal. Coal is a combustible black or brownish-black sedimentary rock composed mostly of carbon and hydrocarbons. The high energy density in coal comes from the energy stored by plants that lived hundreds of millions of years ago. The United States has the largest known coal reserves, about 267.6 billion short tons, enough to last 236 years at

[12] See 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Energy.

year 2007 consumption levels.[13] The leading coal producing states in order of production volumes are Wyoming, West Virginia, Kentucky, Pennsylvania, Texas, Montana, and Colorado. Coal provides over 50 percent of the electricity for the national grid.[14] For California, the mix ranges from 13 percent to 1 percent.[15] PG&E's power mix is 2 percent coal.

Emissions from Coal-Fired Power Generation. Of all power sources for electricity, coal is the dirtiest in terms of air emissions. Burning coal produces carbon dioxide, sulfur dioxide, nitrous oxides, carbon monoxide, hydrocarbons, airborne particulates, mercury, arsenic, and lead. Coal emits carbon dioxide at double or more the rate of natural gas emissions and produced 83 percent of the total CO_2 emissions for United States electricity production in 2004.[16]

Natural Gas. Natural gas is a non-renewable gaseous fossil fuel consisting primarily of methane but also containing ethane, propane, butane and pentane. It is found in oil fields, isolated natural gas fields, and coal beds. Before it can be used as a fuel source, natural gas must be processed to remove all gases other than methane. In the past, when natural gas was discovered, it could not be profitably sold, so it was simply burned at the oil field, a process known as "flaring." Today, natural gas is used in the United States primarily for electricity generation, as well as for industrial, commercial and residential use.

California's natural gas sources in 2006 were as follows:[17]

- 13.5 percent in State.
- 23.4 percent from Canada.
- 27.7 percent from Rocky Mountain states.
- 40.3 percent from the Southwest.

Natural gas generates about 20 percent of U.S. electricity, 40 percent of California's electricity and about 45 percent of the electricity supplied by PG&E.

Emissions from Natural Gas Fired Power Plants. Natural gas emits carbon dioxide, carbon monoxide, nitrogen oxides, and particulates. It emits minimal amounts of sulfur dioxide and no mercury.

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[13] U.S. Energy Information Administration (EIA).
[14] U.S. Department of Energy.
[15] California Energy Commission, U.S. Environmental Protection Agency.
[16] Environmental Protection Agency, U.S. Emissions Inventory 2006, Energy 3-4.
[17] California Energy Commission.

Nuclear Fission. Nuclear energy is produced by a controlled nuclear chain reaction and creates heat which is used to boil water, produce steam, and drive a steam turbine. The turbine can be used for mechanical work and also to generate electricity. The cycle of nuclear energy begins with uranium, which is mined, enriched, and processed into nuclear fuel, then delivered to a nuclear power plant. After usage, the spent fuel is delivered to a reprocessing plant or a final repository for geological disposition. The world's resources of uranium, economically recoverable at a price of $130 per kilogram, are enough to last 80 years at current rates of consumption.[18]

The United States, France, and Japan are the top three producers of nuclear energy. The United States produces the most electricity from nuclear power, providing 20 percent of the electricity it consumes, while France produces the highest percentage of its electricity from nuclear power—80 percent in 2006.[19] California's average mix is 13 percent nuclear power. PG&E's electric power mix is 23 percent from nuclear energy.

Emissions from Nuclear Power Plants. Nuclear power produces no air pollutants or greenhouse gases.[20] However, solid waste in the form of spent fuel rods remain highly radioactive and a threat to public health and safety for 10,000 years. Some 80,000 metric tons of nuclear waste remain to be stored in the United States alone.[21] Whereas the amount of waste can be reduced through reprocessing, the United States has stopped civilian reprocessing as part of U.S. non-proliferation policy, since reprocessed material such as plutonium can be used to make nuclear weapons.

Hydroelectric Power. Most hydroelectric power comes from the potential energy of dammed water driving a water turbine and generator. The energy extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. This height difference is called the head. The amount of potential energy in water is proportional to the head. To obtain very high head, water for a hydraulic turbine may be run through a large pipe called a penstock.[22]

Worldwide, China produces the most hydroelectric power. The United States is fourth in worldwide production, with almost 80 GW installed capacity.[23] Hydroelectric power is 7 percent of the mix for the United States, and almost 20 percent of California's power mix. Hydroelectric power provided about 20 percent of PG&E's power mix. Hydroelectric power does not directly emit greenhouse gases through power generation.

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[18] International Atomic Energy Agency; Nuclear Energy Agency.

[19] International Atomic Energy Agency.

[20] Greenhouse gas emissions are produced as plants are constructed and uranium ore is mined and refined. However, greenhouse gas emission inventories attribute these emissions to those industries and not to the energy generation.

[21] Natural Resources Defense Council.

[22] Energy Information Association.

[23] BP Annual Report, 2006.

Geothermal. Geothermal energy consists of the energy stored in the Earth's crust, from the heat generated deep inside the Earth by the slow decay of radioactive particles, a process that happens in all rocks. Geothermal power plants use the steam or hot water inside the Earth to generate electricity or heat homes. Geothermal energy is considered renewable because the Earth is continually generating heat. There are four primary types of geothermal power plants:

- Dry steam power plants, which use steam piped directly from a geothermal reservoir to turn generator turbines.
- Flash steam power plants, which convert high-pressure hot water deep in the Earth to steam, which drives the generator turbines. The steam is later condensed to water and injected back into the ground to be reused. Most geothermal plants are flash steam.
- Binary power plants, which transfer heat from geothermal hot water to another liquid. The heat creates steam, which turns the generator turbines.
- Ground source heating for small commercial and residential.

Most geothermal resources are found near active volcanoes or at the edge of a tectonic plate. The United States generates more geothermal energy than any other country. Most of the geothermal energy potential in the United States is located in the western states, Alaska, and Hawaii. Four states have geothermal plants—California, Nevada, Alaska, and Hawaii. The Geysers power plant in northern California is the largest dry steam geothermal plant in the world.[24]

Less than 1 percent of the electricity generated in the United States is from geothermal energy. California generates 5 percent of its electricity from geothermal energy. PG&E uses 3 percent geothermal energy in its power mix.

Emissions from Geothermal. Dry steam and flash steam plants emit carbon dioxide at between 1 and 3 percent of the rate of fossil fuel plants. Other emissions include low levels of nitrous oxide, and sulfur dioxide.

Biomass and Other Solid Waste. Biomass energy is derived from three distinct energy sources: wood, waste, and alcohol fuels. Wood energy is derived both from direct use of harvested wood as a fuel and from wood waste streams. The largest source of energy from wood is pulping liquor or "black liquor," a waste product from processes of the pulp, paper, and paperboard industry. Waste energy is the second-largest source of biomass energy. The main contributors of waste energy are municipal solid waste (MSW), manufacturing waste, and landfill gas. Biomass alcohol fuel, or ethanol, is derived almost exclusively from corn. Its principal use is as an oxygenate in gasoline.[25]

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[24] Energy Information Association.

[25] Energy Information Association.

Considered a renewable resource, biomass solid waste can be co-fired in coal power plants, reducing CO_2 emissions. Biomass energy generated 1.4 percent of the electricity mix in the United States in 2007.[26] California used biomass to generate 2 percent of its electricity, and PG&E's mix is about 4 percent biomass.

Emissions from Biomass. The emissions levels of biomass depend on the exact fuel and technology used. Biomass plants emit high levels of nitrous oxide, and carbon monoxide, as well as moderate amounts of large particulate matter. Carbon dioxide emissions from biomass are generally considered lower than emissions from fossil fuels, and in some cases net zero because growing plants sequester carbon.

Wind. Wind power is the conversion of wind into electricity using wind turbines. Wind is considered a renewable resource which is plentiful and widely distributed. Wind power is generated in large-scale wind farms connected to electrical grids as well as individual turbines for isolated locations. Good selection of wind farm location and placement of wind turbines within the site is critical to the economic development of wind power. The three bladed wind turbine is the most common modern design because it minimizes forces related to fatigue.

Wind supplies less than 1 percent of the total mix of electricity in the United States. California receives 2 percent of its power resource mix from wind, and wind supplies about 2 percent of PG&E's power resource mix. Wind-generated electricity produces no emissions.

Solar. Energy from the sun has been harnessed throughout history for uses ranging from cooking and heating, to disinfecting, welding, irrigation, and refrigeration. Solar energy or solar power is electricity generated from sunlight. This can be done through the photovoltaic (PV) effect or by heating a transfer fluid to produce steam to run a generator.

Solar Photovoltaic (PV). A solar cell or photovoltaic cell is a device that converts sunlight into electricity using the photovoltaic effect. Solar cells are typically manufactured out of single crystal silicon, polycrystalline silicon, or amorphous silicon. Cells are assembled to form modules, which then can be linked in photovoltaic arrays. Solar PV cells convert sunlight into direct current (DC) electricity. In a grid-connected PV system, the electricity passes through an inverter to become alternating current (AC) to be fed into the grid. In a stand-alone system the electricity not immediately used is stored in batteries. Ninety percent of solar PV systems are grid-tied systems. At the end of 2007, global solar PV production was 12,400 megawatts.[27] Germany, Japan, and the United States represent 89 percent of the total worldwide PV installed capacity.

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[26] EPA.

[27] Earth Policy Institute, Solar Cell Production Jumps 50 Percent in 2007.

Concentrating Solar Thermal. Concentrating solar thermal (CST) are large-scale generating systems that use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The heat produced is then used to generate electricity. The excess heat and steam can be stored or used for secondary commercial applications (cogeneration). The main design methods for CST are the solar trough, solar power tower, and parabolic dish. The Solar Energy Generating System (SEGS) installed in southern California in 1985, is the largest operational solar system of any kind, with a combined capacity of 350 megawatts. Recently, a 250-megawatt system to be located in eastern Kern County in Southern California was proposed. Composed of about 500,000 parabolic mirrors, the Beacon Solar Energy Project is scheduled for a construction start in late 2009.[28]

In the United States, California and Arizona have the most installed solar power in their electricity mixes, although the percentages in both cases are less than 1 percent. PG&E uses solar energy to produce less than 1 percent.[29] Solar generated electricity produces no emissions.

[28] Los Angeles Times, March 28, 2008.
[29] PG &E.

V. EMISSIONS QUANTIFICATION

A variety of institutions and government agencies document and analyze emissions from power generators. The key sources relied upon for estimating emissions from electricity generation and the results from applying the estimation techniques to sources of emissions data are described below.

EMISSIONS DATA SOURCES AND RESULTS

Environmental Protection Agency (EPA). The EPA publishes and periodically updates a national inventory, organized by State, of environmental attributes of electric power systems. The database, called "eGRID," documents air emissions for nitrogen oxides, sulfur dioxide, carbon dioxide, and mercury, per megawatt-hour (MWh) of electricity consumed. (See **Appendix** for details.)

MIT Analysis of Emissions Reductions related to PV Solar. In 2004, the Massachusetts Institute of Technology (MIT), the Analysis Group for Regional Energy Alternatives, and the Laboratory for Energy and the Environment published a report analyzing emissions reductions due to the installation of PV solar across the country. This report takes into account data from the EPA's eGRID while also accounting for how power sources in various regions are taken on- and off-line, depending on power costs, generator capacity, plant maintenance schedules, demand, etc.

Table 4 reports the emissions of key pollutants from the EPA and MIT sources, as well as PG&E's reporting of carbon emissions.

Table 4. Emissions by Power Generation, CALI Region, National

Source	CO_2	SO_2	NO_x	Mercury (Hg)
			lbs/MWh	
CALI Region				
EPA eGRID[1]	700	0.128	0.342	0.00130
MIT Study[2]	1,291	0.21	0.85	*not estimated*
PG&E[3]	524	----	*not estimated*	-----
U.S. Total				
EPA eGRID[4]	1,363	5.436	2.103	0.02690

[1] Reflects actual emissions of pollutant, in "CALI" region. CALI is almost geographically equivalent to the State of California.

[2] MIT study reports estimated emissions reduced based on simulated, installed PV capacity, by NERC region (North American Electric Reliability Corporation). The emissions are shown for the CALI Region, converted to lbs/MWh.

[3] As reported in PG&E's carbon calculator. These emissions are estimated utilizing the California Public Utilities Commission (CPUC)-approved ClimateSmart electric emissions rate of 0.524 lbs CO2 per kWh — This approximation is based on the average emissions rate for PG&E's electric portfolio, consistent with the emissions rate that is independently certified and registered each year with the California Climate Action Registry (see www.climateregistry.org).

[4] Total U.S. emission rates in lbs per MWh.

Source: EPA eGRID database; Analysis Group for Regional Energy Alternatives, Laboratory for Energy and the Environment, and MIT; Economic & Planning Systems

Extrapolating these emission rates per MWh for the CALI region for a PV solar system the size purchased for Washington Elementary indicates that the avoided emissions range from: 82,000 to 202,000 pounds of CO_2; 20 to 30 pounds of SO_2; 54 to 133 pounds of NO_x; and about 0.2 pounds of mercury. Emission rates for the United States of these pollutants are significantly higher than for the CALI region. See **Table 5** for details.

Table 5. Emissions Reductions: 100 KW PV Solar System; CALI Region, National

Source	Size	CO_2	SO_2	NO_x	Mercury (Hg)
		lbs for specified PV System			
Size of PV System					
Manufacturing rating (KW)	100				
Est. KWh[1]	156,950				
Converted to MWh	157				
CALI Region					
EPA eGRID[2]		109,865	20	54	0.20
MIT Study[2]		202,635	33	133	*not estimated*
PG&E[2]		82,242	----	*not estimated*	-----
U.S. Total					
EPA eGRID[2]		213,923	853	330	4.2

[1] Assumes average generating period is about 4.3 hours per day.
[2] Converting pounds to metric tons results in the following estimate for the CO_2 reduction estimate:

CALI - EPA	49.8
CALI - MIT	91.9
PG&E	37.3
USA - EPA	97.0

Source: EPA eGRID database; Analysis Group for Regional Energy Alternatives, Laboratory for Energy and the Environment, and MIT; Economic & Planning Systems

VI. POLLUTANTS AND HUMAN HEALTH IMPACTS

In order to describe health impacts related to the generation of electricity from fossil-based fuels, pollutants associated with electricity generation are described below. An analysis of the adverse health impacts which are linked to the emissions of some of the pollutant types follows.

GREENHOUSE GASES

CARBON DIOXIDE

Carbon dioxide is formed by a carbon atom double bonded to two oxygen atoms. At room temperature it is a colorless odorless gas, and in solid form (-108 degrees F) it is known as dry ice. Carbon dioxide is produced naturally in the atmosphere from animal respiration, and is used by plants for photosynthesis. Of the four primary greenhouse gases (along with methane, nitrous oxide, and fluorinated gases), CO_2 contributes the most to global warming. CO_2 is a greenhouse gas produced by human activities, primarily through the combustion of fossil fuels, but also through deforestation. Its concentration in the earth's atmosphere has risen 35 percent since the beginning of industrialization. In 2006, 2.24 trillion metric tons of CO_2 were produced in the United States as a result of electric energy generation.[30] Health risks include:

- Concentrations of CO_2 greater than 10 percent in the air can lead to kidney damage, coma, or death.
- Asphyxiation from lowering the oxygen content of the air. High concentrations of CO_2 released from lakes caused the fatalities of nearly two thousand people in two separate incidents in Cameroon in the mid-1980s.[31]
- As concentrations of greenhouse gas emissions continue to increase global temperatures, the formation of ground level ozone is increased. Ground level ozone is one of the primary causes of air pollution associated with cardiovascular, respiratory, and asthma hospitalizations and attacks.

METHANE (CH_4)

Methane is a hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 23 times that of carbon dioxide (CO_2). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas

[30] Environmental Protection Agency, "U.S. Greenhouse Gas Inventory".
[31] New York Times, "Trying to Tame the Roar of Deadly Lakes", February 27, 2001.

and petroleum, coal production, and incomplete fossil fuel combustion. The global warming potential (GWP) is from the Intergovernmental Panel on Climate Change's (IPCC's) Third Assessment Report.

OTHER AIR POLLUTANTS

NITROGEN OXIDES (NO_x)

Nitrogen oxides are any binary compound of oxygen and nitrogen, or a mixture of such compounds. NO_x is a generic term for mono-nitrogen oxides (NO and NO_2). In the presence of excess oxygen (O_2), nitric oxide (NO) will be converted to nitrogen dioxide (NO_2), When NO_x and volatile organic compounds (VOCs) react in the presence of sunlight they form photochemical ozone, a primary ingredient in urban smog, and a significant form of air pollution especially in the summer.

The human health impacts associated with exposure to NO_x for children, people with lung diseases such as asthma, and people who work or exercise outside include adverse effects of smog such as damage to lung tissue and reduction in lung function such as:[32]

- Decreased ability of the lungs to function properly, increasing respiratory illness, especially in children that are active outdoors.
- Various types of breathing problems: including shortness of breath, coughing, wheezing, chest tightness, headaches and nausea.
- Pronounced allergic reactions.
- Increased hospital admissions for respiratory problems, especially for children with pre-existing conditions such as asthma.
- Reduced ability to exercise resulting in poor athletic performance.

CARBON MONOXIDE (CO)

Carbon monoxide (CO) is a colorless, practically odorless, and tasteless gas or liquid. It results from incomplete oxidation of carbon in combustion. Sources of CO include gas heaters, automobile exhaust, tobacco smoke, and power plant emissions.

Exposure to CO exposure is life-threatening to humans and other aerobic forms of life, as inhaling even relatively small amounts of it can lead to hypoxic injury, neurological damage, and possibly death. A concentration of as little as 0.04 percent (400 parts per

[32] Health and Environmental Impacts of NOx. United States Environmental Protection Agency. December 26, 2007.

million) carbon monoxide in the air can be fatal. Non-fatal results of exposure to CO include headaches, confusion, flu-like symptoms, vertigo and nausea. Long-term severe neurological manifestations from CO poisoning include dementia, gait disturbance, speech disturbance, cortical blindness and depression.

SULFUR DIOXIDE (SO_2)

Sulfur dioxide belongs to the family of sulfur oxide gases (SOx). These gases dissolve easily in water. Sulfur is prevalent in all raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. Over 65 percent of SO_2 released to the air, or more than 13 million tons per year, comes from electric utilities, especially those that burn coal. SO_2 contributes to respiratory illness, particularly in children and the elderly, and aggravates existing heart and lung diseases.

PARTICULATE MATTER (PM)

Particulates are tiny solid or liquid droplets found in the air. These particles come in many shapes and sizes, and from many different sources. Some particles, like soot or smoke, are large or dark enough to be seen by the naked eye. These coarse particles (PM-10) are generally emitted from sources such as road and wind borne dust, materials handling, and crushing and grinding operations. Others are so small they can only be seen with special microscopes. These "fine" particles measure less than 2.5 micrometers in diameter (PM-2.5)—about the size of bacteria—and are of particular concern because they can be breathed deep into the lungs and generally contain more toxic substances.

More than two dozen community health studies since 1987 have linked particulate matter to reduction in lung function, increased hospital and emergency room admissions, and premature deaths. The Natural Resources Defense Council estimates that at current particulate pollution levels, approximately 64,000 premature deaths from heart and lung disease may be occurring each year.[33]

MERCURY (HG)

Mercury is a toxic heavy metal that is a byproduct of thermo combustion of fossil fuels, especially coal. Mercury and compounds containing mercury can accumulate in the environment and are highly toxic to humans and animals if inhaled or swallowed. Exposure can permanently damage the brain, kidneys, and fetuses. One seventieth of a

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[33] Natural Resources Defense Council BREATH-TAKING: Premature Mortality Due to Particulate Air Pollution in 239 American Cities, May 1996. Information from this report is available at http://www.nrdc.org/air/pollution/bt/btinx.asp

teaspoon—the amount in a thermometer—in a 25 acre lake can render the fish unsafe to eat.[34]

HUMAN HEALTH IMPACT ESTIMATES

Regulatory agencies at the Federal (EPA), State (CARB), and local (air quality management districts) levels monitor and report on concentrations of criteria air pollutants and provide assessments of health risks associated with exposure through inhalation. Those air pollutants include carbon monoxide, ozone, lead, nitrogen oxide, particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide. The US Supreme Court, in its decision on Massachusetts et al. vs. Environmental Protection Agency, ruled that the EPA has the authority to regulate CO_2.

Although many guidelines published by these agencies provide air pollution "thresholds" for various pollutants – above which, human inhalation may lead to adverse health impacts, a recent study by the National Renewable Energy Laboratory provides an assessment (NREL), on a national level, of the likely reductions in adverse health impacts due to reduced emissions.[35] **Table 6** reports the results of this study. The study examines a scenario where the President's Solar American Initiative (January 2006) attains its goal of installing 5 to 10 gigawatts of PV solar in the United States by 2015. As shown, as installed capacity of 5 gigawatts of PV solar would result in 22 deaths avoided per year, roughly 100 hospital admissions or visits for heart attacks, chronic bronchitis, asthma and other symptoms, and thousands of work-loss days and minor, restricted activity days. For a system sized at 100 kilowatts, health benefit effects are negligible.

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[34] Union of Concerned Scientists.

[35] A direct relationship between emissions and the concentration of a pollutant is rarely simple to derive, due to the differential patterns of emissions dispersal, depending on local geographic and weather conditions.

Table 6. Health Impacts Associated with Displacement of Traditional Power with Solar Power

Health Impacts	Per 5 Gigawatts[1]	Per 1 Gigawatt[1]	Per 1 Megawatt	Per 100 Kilowatt
Cases Reduced				
Mortality	22	4	0.004	0.00044
Chronic Bronchitis	15	3	0.003	0.00030
Heart Attacks	36	7	0.007	0.00072
Hospital Admissions - Respiratory	11	2	0.002	0.00022
Hospital Admissions - Cardiovasc	9	2	0.002	0.00018
Emergency room visits, Asthma	24	5	0.005	0.00048
Acute Bronchitis	35	7	0.007	0.00070
Lower Respiratory Symptons	397	79	0.079	0.00794
Upper Respiratory Symptons	319	64	0.064	0.00638
Work Loss Days	2,538	508	0.508	0.05076
Minor Restricted Activity Days	17,439	3,488	3.488	0.34878

[1] NREL study estimated health benefits under a scenario in which the low-end of the Solar America Initiative is implemented (5 GW of PV solar capacity installed). All other effect-levels shown are extrapolated from this 5 GW amount.

Source: Energy, Economic, and Environmental Benefits of the Solar America Initiative; National Renewable Energy Laboratory, August 2007; Economic & Planning Systems

VII. PV Solar Industry Economic Impacts

Total U.S. employment within the PV industry is estimated to be about 20,000 people which includes about 25 companies with roughly 36 manufacturing sites located in the United States.[36] These roughly 20,000 jobs are estimated to be split into manufacturing jobs (80 percent) and construction and installation jobs (20 percent).[37] The PV industry's "roadmap,"—which sets forth industry and governmental actions needed to grow PV installations—includes a modest projection of about 20-30 percent growth per year. At this growth rate, the 20,000 U.S. jobs would increase to more than 150,000 jobs by 2025.

REGIONAL IMPACTS ANALYSES

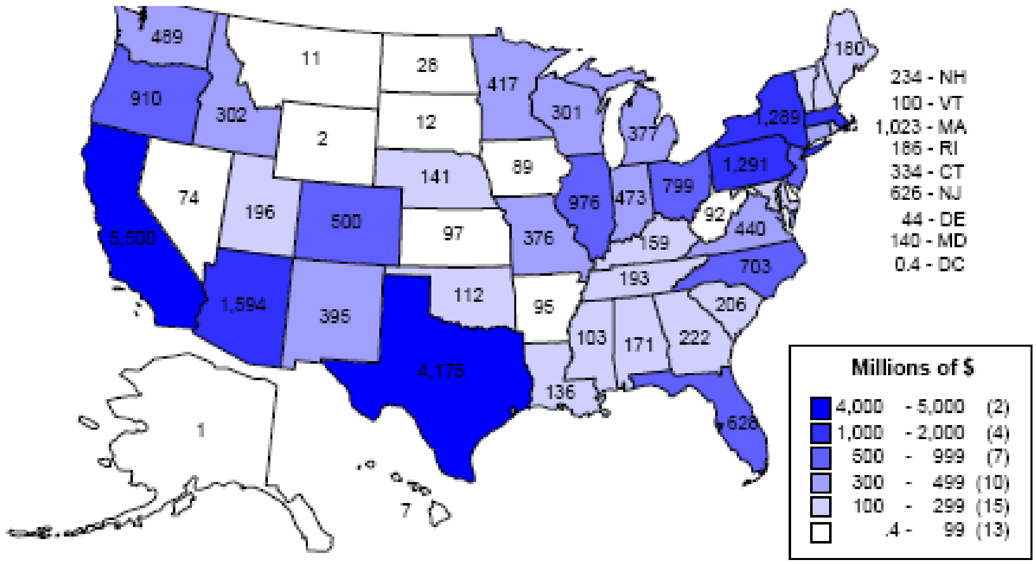
The likely geographic distribution of the growth in solar industry jobs has been analyzed in a relatively recent (2005) study.[38] This study estimates the likely State-level distribution of the PV industry's projected 42,000 additional jobs by 2015. PV solar manufacturing jobs are distributed by reviewing the existing proportion of firms and employees in industries similar to the manufacturing jobs projected to be created in the PV solar industry. The results are shown below, in **Figure 1**. California, Texas, Arizona, and New York are projected to gain 6,900, 5,200, 2,000, 1,600 and 1,600 jobs, respectively, in manufacturing due to PV solar industry growth in the United States.

36 The U.S. Photovoltaic Industry Roadmap, Solar Electric Power, May 2001.

37 Renewable Energy Policy Project; Sterzinger, G., Svrecek, M., *Solar PV Development: Location of Economic Activity*, January 2005, See Chapter Two.

38 Sterzinger, G., Svrcek, M., Renewable Energy Policy Project, "Solar PV Development, Location of Economic Activity, January 2005.

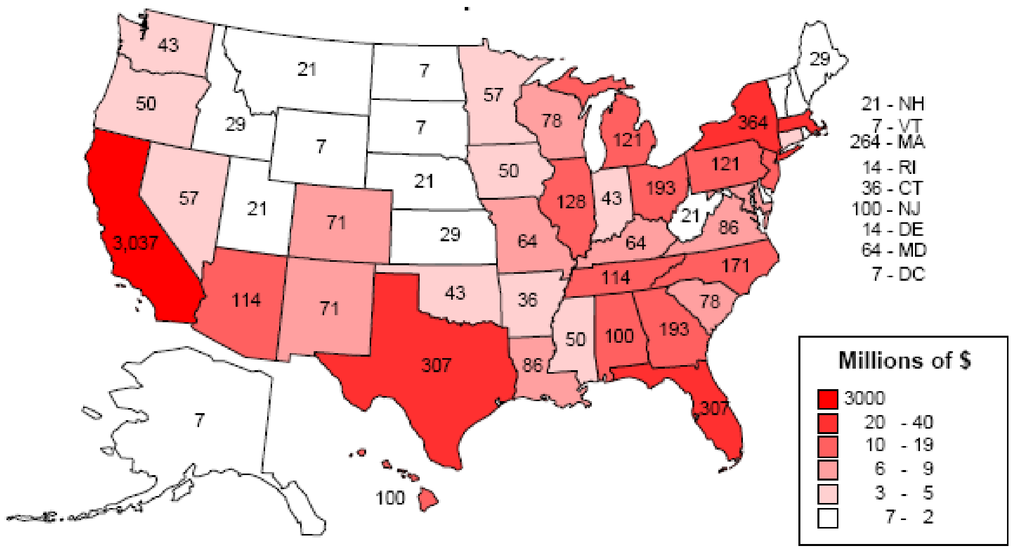
Figure 1. PV Manufacturing Investment, Assuming Solar Industry Roadmap Goals, 2015



Source: Renewable Energy Policy Project; Sterzinger, G., Svrecek, M., *Solar PV Development: Location of Economic Activity*, January 2005.

The Renewable Energy Policy Project document also analyzes the likely geographic distribution of PV solar jobs in the installation and construction sectors. Demand for workers in these types of jobs will depend on a State's demand for solar installations – which is a function of consumer preference, roof space, etc., and on the payback period for the system (which is itself a function of system price, local utility rates, rebates, etc.). **Figure 2** below illustrates the results of the analysis. California, by far, is estimated to be the greatest beneficiary of this job growth, estimated to capture almost 3,600 jobs, 40 percent of the total 8,400 jobs projected in installation and construction.

Figure 2. PV Construction and Installation Investment, Assuming Solar Industry Roadmap Goals, 2015



Source: Renewable Energy Policy Project; Sterzinger, G., Svrecek, M., *Solar PV Development: Location of Economic Activity*, January 2005.

LOCAL ECONOMIC IMPACT

EPS modeled the likely local economic impacts resulting from the purchase and installation of a typical, larger-scale PV solar installation in a Bay Area county. Installations of PV solar in a typical Bay Area county are unlikely to increase demand for manufacturing in the area. As the *Solar PV Development: Location of Economic Activity* study indicated, PV solar manufacturing jobs are likely to be situated in areas already rich in manufacturing. The Bay Area, with a relatively small manufacturing base, is much more likely to benefit from installation and construction jobs.

In order to quantify the scale of potential employment and wage benefits in PV solar installation and construction, typical costs for PV solar, segmented by type, are shown in **Table 7**. Total estimated costs per watt vary and have been decreasing in recent years, thus the estimated $9 per watt shown in the table is *not* utilized for analysis purposes. The key factor in this table is the proportion of the costs which go towards materials versus labor.

As shown, about 70 percent of the cost per PV solar watt goes towards purchasing the system module, inverter, rack, and electrical components. This portion of the costs would support manufacturing of these items. About 30 percent of the total costs of the system are changed for mounting, electrical system, and design labor.

Table 7. Typical PV Solar Costs, by Cost Category

Item	Est. $/Watt	% of Total Costs
Materials		
Modules	$4.50	50%
Inverter	$1.08	12%
Rack	$0.63	7%
Electrical	$0.18	2%
Labor		
Mounting	$1.17	13%
Electrical	$1.17	13%
Design	$0.27	3%
Total	$9.00	100%

Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy Solar Energy Technologies Multi-Year Technical Plan, 2003-2007 and Beyond; Economic & Planning Systems

Note: The estimated $9 per watt shown in this table is *not* utilized to calculate economic impacts (the price per watt varies significantly by market and has been decreasing in recent years). Only the *proportions* of the cost components are utilized in the impacts calculation.

Assuming an expenditure of $1,000,000 on a PV solar system, the above proportions of material and labor expenditures can be applied to the total system costs to estimate local labor wages. **Table 8** reports this estimate, including a profit margin for the employing firm.

Table 8. Estimated Local Wages - Typical Large-Scale PV System

Item	% of Total System Costs[1]	Profit/ Admin. Factor[2]	Amount
Expenditure (in $)			$1,000,000
Local Labor			
Mounting	13%	55%	$58,500
Electrical	13%	55%	$58,500
Design	3%	55%	$13,500
Total			$130,500

[1] From U.S. Department of Energy, Energy Efficiency and Renewable Energy.

[2] In order to conservatively estimate the proportion of a professional services firm's total expenditures which go towards employee wages, EPS reviewed applicable IMPLAN sectors. Taking into account business taxes, facilities costs, supplies, travel and other non-wage expenditures, approximately 55 percent of a Bay Area professional services' firms expenditures are personnel-related.

Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy Solar Energy Technologies Multi-Year Technical Plan, 2003-2007 and Beyond; Economic & Planning Systems

In addition to the employment of those directly engaged in the installation and construction of the PV solar system, two types of indirect economic impacts are also estimated using an input-output model, IMPLAN. IMPLAN is a commonly-used model in economic analyses, tracing the affects of direct expenditures (i.e., the expenditure to purchase and install the PV panels) on indirect industries which provide intermediate goods and service to the industries directly affected by the initial expenditure. In addition, the direct and indirect industries enhance employment and wages which induces employee purchases.

IMPLAN is used in this analysis to capture economic activity at the county-level, with purchases and investments which occur outside the county considered to be "imports" and excluded from the analysis accounting. Indirect and induced impacts are estimated through the use of multipliers supplied by the IMPLAN software. For Bay Area counties, the indirect and induced income multipliers for the PV solar installation/construction sector are 1.13 and 1.22. This means that for every $100 in wages to the PV solar industry in the Bay Area, $13 and $22 in wages are expected in indirect (supplier) industries and induced (consumables/services) industries in the county. The same types of multipliers are used to estimate employment impacts.

Table 9 below illustrates the results of the analysis, relying on the $130,500 in local wages estimated in the prior table, related to a $1,000,000 expenditure on PV solar in a Bay Area county. As shown, total direct, indirect, and induced wages related to this project are estimated at $175,500. Also, total direct, indirect, and induced onetime jobs are estimated at 2.62 for the project.

Table 9. Direct, Indirect, and Induced Impacts – Income and Employment

Impact	Direct	Indirect	Induced	Total
Income Impacts				
Est. Income[1]	$130,500	--	--	$130,500
Indirect/ Induced Income Mulltpliers[2]	--	1.13	1.22	--
Total one-time income impacts	**$130,500**	**$16,800**	**$28,200**	**$175,500**
Employment Impacts				
Est. Employment	1.64	--	--	1.64
Indirect/ Induced Income Multipliers	--	1.20	1.40	--
Total one-time employment impacts	**1.64**	**0.33**	**0.66**	**2.62**

[1] From prior table.
[2] Derived from IMPLAN model, averaged from data for Bay Area counties. Installation and construction jobs are IMPLAN job sector 443 - "Other computer related services including facilities" which corresponds to NAICS codes 541513 - "Computer facilities management services" and NAICS 541519 - "Software installation services, computer". This selected sector is consistent with a recent RAND study entitled "Generating Electric Power in the Pacific Northwest, Implications of Alternative Technologies".

Source: IMPLAN; Economic & Planning Systems

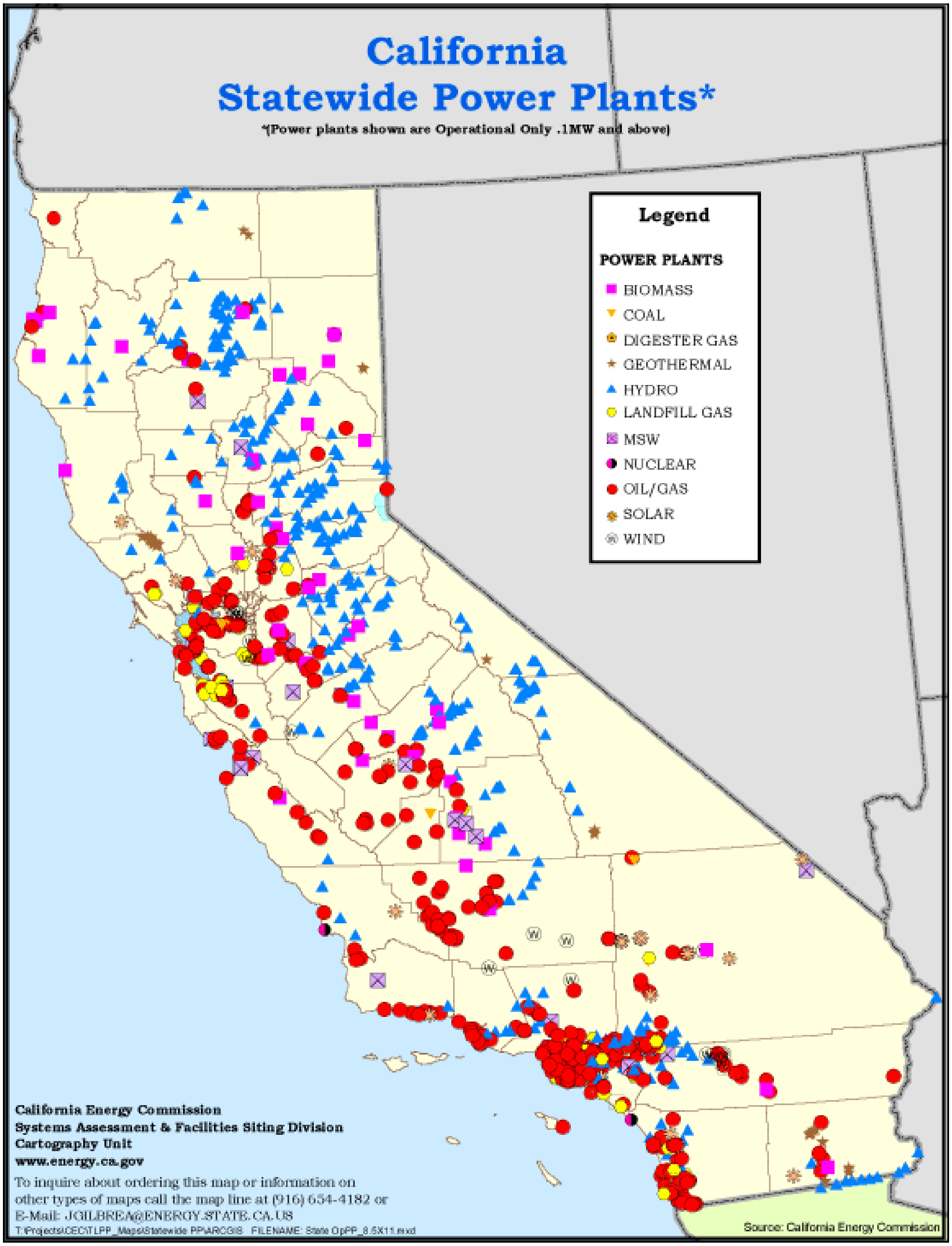
Economic & Planning Systems

Public Finance
Real Estate Economics
Regional Economics
Land Use Policy

APPENDIX

- Location of California Power Plants
- Load Shape Following
- EPA eGRID
- CARB GHG Inventory Database
- Power Content Label Example
- California's Electricity Sources Figure

Location of California Power Plants

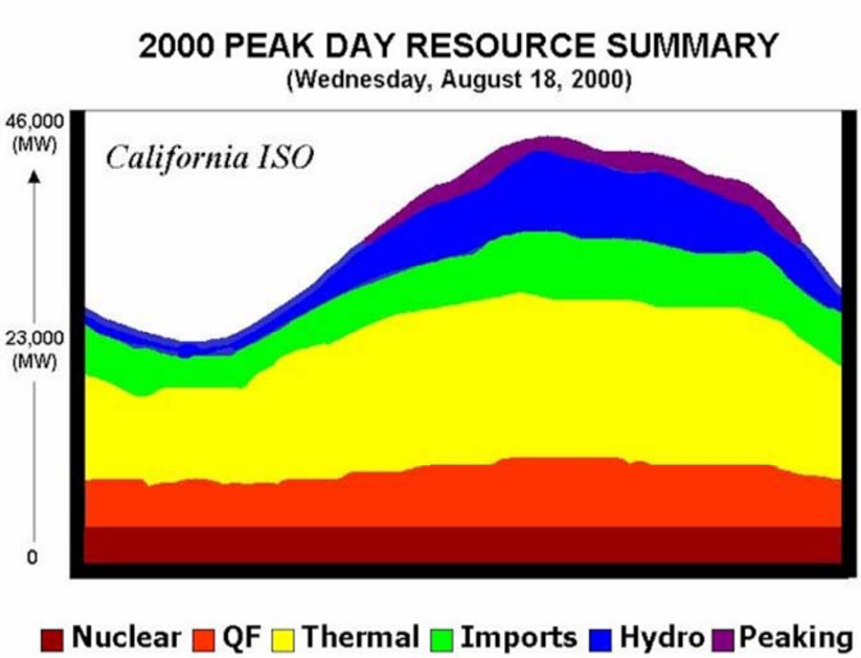


Source: California Energy Commission. See: http://www.energy.ca.gov/maps/power_plant.html.

Load Shape Following

Reduction of CO_2 emissions and other air emissions due to solar PV installation vary by State and locality due to solar magnitude and seasonal variation, power generation mix, and load shape following generation.[1] Load shape following refers to the peak load of electricity demand during the day, and the way that power plants are dispatched to meet the shape of that load demand through the integrated resource power grid.

The following graph of California's daily energy demand illustrates this concept.



Source: Common Purpose Institute at www.treepower.org/quickfacts.html

- Lowest cost, Base Load Units (nuclear and coal) are run first (**brown** and **red** areas).
- Intermediate Load Units (e.g., natural gas combined cycle) are dispatched next.
- Finally, highest cost Peaking Load Units (natural gas and oil combustion turbines) are run, as represented in the graph's **purple area**.

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[1] MIT and the Analysis Group for Regional Energy Alternatives prepared an excellent study on this topic comparing generating capacity to emissions reductions by state and region. See, "Emissions Reductions from Solar Photovoltaic (PV) Systems, at web.mit.edu/agrea/docs/MIT-LFEE_2004-003a_ES.pdf

EPA eGRID

See attached pages for the EPA's 2004 inventory of emissions and fuel by State and region.

eGRID2006 Version 2.1 (April 2007)
Year 2004 Summary Tables

1. State Emissions
2. State Resource Mix
3. eGRID Subregion Emissions
4. eGRID Subregion Resource Mix
5. eGRID Subregion Emission Rates
6. NERC Region Emissions
7. NERC Region Resource Mix
8. NERC Region Emission Rates

Year 2004 State Emissions

(Source: eGRID2006 Version 2.1, April 2007)

State	Carbon dioxide (CO_2) Emissions (tons)	Carbon dioxide (CO_2) Output emission rate (lb/MWh)	Sulfur dioxide (SO_2) Emissions (tons)	Sulfur dioxide (SO_2) Output emission rate (lb/MWh)	Nitrogen oxides (NO_x) Emissions (tons)	Nitrogen oxides (NO_x) Output emission rate (lb/MWh)	Nitrogen oxides (NO_x) Ozone season emissions (tons)	Nitrogen oxides (NO_x) Ozone season output emission rate (lb/MWh)	Mercury (Hg) Emissions (lbs)	Mercury (Hg) Output emission rate (lb/GWh)
AK	3,610,850	1,106	3,925	1.203	12,006	3.679	5,223	3.980	9.08	0.0014
AL	89,170,715	1,299	423,774	6.172	144,028	2.098	55,308	1.775	5,138.02	0.0374
AR	33,174,715	1,280	87,555	3.379	44,717	1.726	20,883	1.781	1,095.99	0.0211
AZ	60,271,433	1,219	60,941	1.232	87,534	1.770	39,459	1.713	1,416.42	0.0143
CA	67,521,916	700	12,369	0.128	32,972	0.342	14,306	0.321	244.97	0.0013
CO	47,532,473	1,986	64,095	2.678	71,851	3.002	30,248	2.955	516.99	0.0108
CT	12,279,200	754	8,120	0.499	11,771	0.723	4,784	0.656	369.54	0.0113
DC	65,937	3,614	173	9.500	92	5.046	41	5.104	N/A	N/A
DE	6,766,288	1,804	36,964	9.854	11,338	3.022	4,059	2.652	344.61	0.0459
FL	145,001,520	1,348	427,255	3.972	250,880	2.332	117,107	2.295	2,240.47	0.0104
GA	87,968,286	1,388	577,234	9.110	108,055	1.705	33,861	1.163	3,405.56	0.0269
HI	9,443,135	1,655	23,913	4.190	21,439	3.757	9,443	3.829	133.09	0.0117
IA	42,013,951	1,943	139,452	6.450	82,069	3.796	33,280	3.711	2,256.73	0.0522
ID	772,582	144	999	0.186	795	0.148	309	0.106	N/A	N/A
IL	110,778,055	1,155	379,355	3.954	147,827	1.541	39,112	0.944	7,944.16	0.0414
IN	133,604,381	2,098	869,726	13.658	230,114	3.614	69,114	2.577	5,067.24	0.0398
KS	43,753,706	1,871	123,936	5.299	93,410	3.994	39,342	3.872	1,042.62	0.0223
KY	96,943,071	2,051	516,430	10.926	166,079	3.514	41,083	2.042	3,587.02	0.0379
LA	55,070,532	1,201	121,252	2.645	76,334	1.665	36,288	1.738	1,125.20	0.0123
MA	28,747,714	1,226	82,207	3.506	30,861	1.316	10,997	1.145	659.00	0.0141
MD	33,653,280	1,293	287,193	11.035	64,417	2.475	20,455	1.825	2,111.54	0.0406
ME	7,279,799	772	8,316	0.882	9,072	0.962	3,134	0.843	42.94	0.0023
MI	83,611,983	1,413	350,977	5.930	128,769	2.176	47,789	1.902	3,253.89	0.0275
MN	41,578,073	1,588	109,047	4.164	90,409	3.452	37,264	3.414	1,487.44	0.0284
MO	82,049,736	1,881	288,669	6.619	128,865	2.955	43,345	2.302	3,388.91	0.0389
MS	28,416,834	1,409	88,607	4.393	50,860	2.522	22,490	2.305	488.34	0.0121
MT	21,058,639	1,573	23,023	1.720	38,108	2.846	14,209	2.491	83.51	0.0031
NC	76,835,963	1,218	481,150	7.626	126,407	2.004	38,236	1.402	3,346.07	0.0265
ND	37,395,379	2,386	150,272	9.589	78,304	4.997	31,713	4.880	2,443.22	0.0780
NE	24,055,889	1,503	77,647	4.852	49,065	3.066	19,060	2.851	936.06	0.0292
NH	9,309,461	779	57,346	4.800	11,737	0.982	4,408	0.892	57.89	0.0024
NJ	19,844,217	713	53,926	1.937	27,815	0.999	10,473	0.804	630.16	0.0113
NM	32,808,310	1,992	38,454	2.335	74,901	4.548	33,660	4.530	2,268.79	0.0689
NV	29,530,258	1,573	54,662	2.911	47,201	2.514	21,445	2.452	348.18	0.0093
NY	62,338,427	907	238,894	3.476	72,764	1.059	29,265	0.967	1,553.02	0.0113
OH	131,711,020	1,779	1,116,846	15.085	273,158	3.689	67,435	2.114	7,490.48	0.0506
OK	52,334,635	1,726	105,405	3.476	83,122	2.741	37,215	2.556	2,800.52	0.0462
OR	11,742,575	456	13,848	0.538	13,593	0.528	4,126	0.423	169.74	0.0033
PA	130,537,293	1,216	1,009,188	9.403	202,820	1.890	55,415	1.206	10,921.58	0.0509
RI	2,590,683	1,071	181	0.075	780	0.322	346	0.298	N/A	N/A
SC	44,750,212	915	228,082	4.663	69,397	1.419	24,708	1.152	1,248.16	0.0128
SD	4,563,840	1,215	15,015	3.999	17,924	4.773	6,835	3.814	116.52	0.0155
TN	61,767,470	1,266	310,758	6.369	113,241	2.321	27,932	1.342	2,332.35	0.0239
TX	280,096,255	1,472	596,661	3.135	216,984	1.140	97,706	1.098	10,792.13	0.0284
UT	40,520,255	2,121	36,666	1.919	73,083	3.825	31,901	3.809	288.12	0.0075
VA	46,229,502	1,211	221,790	5.808	75,903	1.988	26,169	1.566	1,214.87	0.0159
VT	18,978	7	71	0.026	580	0.212	218	0.194	N/A	N/A
WA	18,275,216	360	8,203	0.162	22,501	0.443	8,529	0.397	661.05	0.0065
WI	51,852,709	1,713	195,177	6.448	81,522	2.693	32,625	2.572	2,324.76	0.0384
WV	89,482,632	1,988	481,283	10.693	176,426	3.920	39,991	2.105	4,817.98	0.0535
WY	51,023,824	2,278	88,411	3.946	94,580	4.222	39,205	4.275	1,825.69	0.0407
U.S.	**2,681,753,803**	**1,363**	**10,695,446**	**5.436**	**4,138,481**	**2.103**	**1,481,550**	**1.704**	**106,040.62**	**0.0269**

Year 2004 State Resource Mix

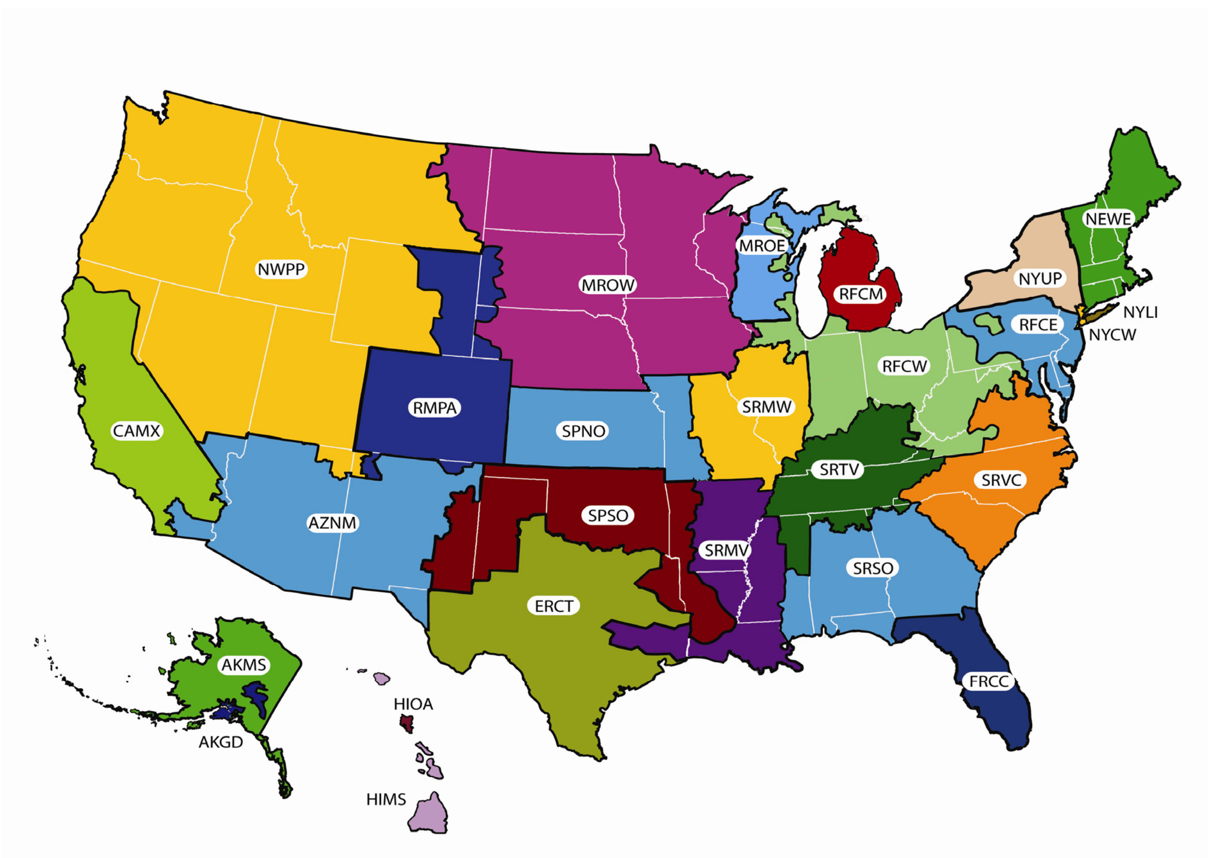
(Source: eGRID2006 Version 2.1, April 2007)

State	Nameplate capacity (MW)	Net generation (MWh)	Generation resource mix (percent)									
			Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal
AK	2,063	6,526,711	9.9	11.5	55.5	0.0	0.1	23.0	0.0	0.00	0.000	0.0
AL	33,295	137,328,137	54.4	0.2	11.6	0.1	2.8	7.7	23.0	0.00	0.000	0.0
AR	13,863	51,825,221	48.9	0.9	9.6	0.0	3.7	7.1	29.8	0.00	0.000	0.0
AZ	28,263	98,897,707	40.3	0.0	24.2	0.0	0.0	7.0	28.4	0.00	0.004	0.0
CA	64,910	192,809,576	1.2	1.2	51.7	1.0	3.1	17.3	15.7	2.22	0.296	6.2
CO	12,549	47,865,491	74.9	0.0	22.4	0.0	0.1	2.1	0.0	0.46	0.000	0.0
CT	8,454	32,562,800	13.1	5.1	24.9	1.7	2.9	1.4	50.8	0.00	0.000	0.0
DC	868	36,487	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.00	0.000	0.0
DE	3,610	7,502,542	63.3	9.6	22.2	4.8	0.0	0.0	0.0	0.00	0.000	0.0
FL	59,182	215,130,784	28.8	17.3	35.6	0.3	2.4	0.1	14.5	0.00	0.000	0.0
GA	38,487	126,725,244	63.1	0.7	4.8	0.0	2.5	2.2	26.6	0.00	0.000	0.0
HI	2,624	11,413,465	14.1	77.3	1.1	1.4	3.3	0.8	0.0	0.07	0.000	1.9
IA	11,643	43,240,158	81.6	0.3	1.9	0.0	0.3	2.2	11.4	2.41	0.000	0.0
ID	3,298	10,734,407	0.9	0.0	15.9	0.0	5.3	77.6	0.0	0.00	0.000	0.0
IL	51,438	191,864,321	49.2	0.4	1.8	0.2	0.3	0.1	48.0	0.04	0.000	0.0
IN	29,172	127,361,875	94.7	0.3	1.7	2.5	0.1	0.3	0.0	0.00	0.000	0.0
KS	11,731	46,780,900	73.9	1.8	1.8	0.0	0.0	0.0	21.7	0.76	0.000	0.0
KY	22,951	94,529,947	91.1	3.8	0.6	0.0	0.4	4.0	0.0	0.00	0.000	0.0
LA	28,391	91,692,052	25.8	4.5	44.3	1.6	3.3	1.2	18.6	0.00	0.000	0.0
MA	16,317	46,891,121	22.4	16.0	43.7	1.1	3.2	0.9	12.7	0.00	0.000	0.0
MD	13,380	52,052,768	56.1	6.3	2.3	1.2	1.3	4.8	28.0	0.00	0.000	0.0
ME	4,383	18,863,662	1.9	6.8	52.1	1.4	20.3	17.6	0.0	0.00	0.000	0.0
MI	33,323	118,374,150	58.0	0.8	12.7	0.2	2.2	0.4	25.8	0.00	0.000	0.0
MN	12,411	52,381,244	64.9	1.5	2.8	0.3	2.2	1.4	25.4	1.51	0.000	0.0
MO	20,612	87,222,401	86.0	0.2	3.3	0.1	0.0	1.4	9.0	0.00	0.000	0.0
MS	15,879	40,336,807	42.4	7.8	20.5	0.1	3.9	0.0	25.4	0.00	0.000	0.0
MT	5,214	26,776,348	65.0	1.6	0.1	0.1	0.2	33.1	0.0	0.00	0.000	0.0
NC	29,084	126,186,277	59.8	0.5	2.0	0.1	1.4	4.4	31.8	0.00	0.000	0.0
ND	5,021	31,341,612	94.0	0.1	0.0	0.2	0.0	4.9	0.0	0.68	0.000	0.0
NE	7,126	32,008,704	63.9	0.1	0.9	0.0	0.1	2.9	32.0	0.12	0.000	0.0
NH	4,543	23,892,859	17.1	8.1	22.6	0.2	3.9	5.5	42.6	0.00	0.000	0.0
NJ	21,680	55,680,410	18.4	2.5	28.4	0.7	1.6	0.0	48.4	0.00	0.000	0.0
NM	6,796	32,940,360	88.8	0.1	9.1	0.0	0.0	0.4	0.0	1.56	0.000	0.0
NV	9,812	37,553,015	48.6	0.3	43.6	0.0	0.0	4.3	0.0	0.00	0.000	3.2
NY	41,284	137,436,647	16.6	15.4	19.6	0.4	1.5	16.9	29.6	0.07	0.000	0.0
OH	37,004	148,075,516	86.6	0.9	0.9	0.2	0.3	0.3	10.8	0.00	0.000	0.0
OK	21,127	60,641,220	55.7	0.1	38.3	0.0	0.4	4.5	0.0	0.94	0.000	0.0
OR	12,548	51,526,306	6.9	0.1	26.2	0.1	1.4	64.1	0.0	1.20	0.000	0.0
PA	50,064	214,662,230	54.6	1.9	4.6	0.5	1.0	1.1	36.1	0.14	0.000	0.0
RI	1,997	4,837,893	0.0	1.0	98.9	0.0	0.0	0.1	0.0	0.00	0.000	0.0
SC	24,091	97,834,338	39.8	0.9	3.9	0.1	1.7	1.3	52.3	0.00	0.000	0.0
SD	2,826	7,510,214	48.2	0.3	1.5	0.0	0.0	47.9	0.0	2.10	0.000	0.0
TN	22,753	97,578,245	59.8	0.2	0.3	0.0	0.6	9.8	29.3	0.00	0.000	0.0
TX	107,170	380,659,334	38.5	0.6	47.3	1.2	0.3	0.3	10.6	0.82	0.000	0.0
UT	6,496	38,211,975	95.8	0.1	2.4	0.0	0.0	1.2	0.0	0.00	0.000	0.5
VA	24,487	76,378,503	46.3	5.1	7.1	0.4	3.4	0.5	37.1	0.00	0.000	0.0
VT	1,087	5,470,376	0.0	0.3	0.1	0.0	7.2	21.7	70.5	0.21	0.000	0.0
WA	27,420	101,547,794	10.3	0.1	8.3	0.3	1.6	70.5	8.8	0.15	0.000	0.0
WI	16,133	60,543,245	69.6	1.2	4.0	0.1	1.9	3.3	19.6	0.17	0.000	0.0
WV	17,269	90,021,580	97.3	0.3	0.3	0.2	0.0	1.8	0.0	0.18	0.000	0.0
WY	6,872	44,806,793	96.7	0.1	0.2	0.0	0.0	1.3	0.0	1.38	0.000	0.0
U.S.	**1,052,996**	**3,935,071,766**	**50.2**	**3.0**	**17.4**	**0.5**	**1.4**	**6.6**	**20.0**	**0.34**	**0.015**	**0.3**

Year 2004 eGRID Subregion Emissions

(Source: eGRID2006 Version 2.1, April 2007)

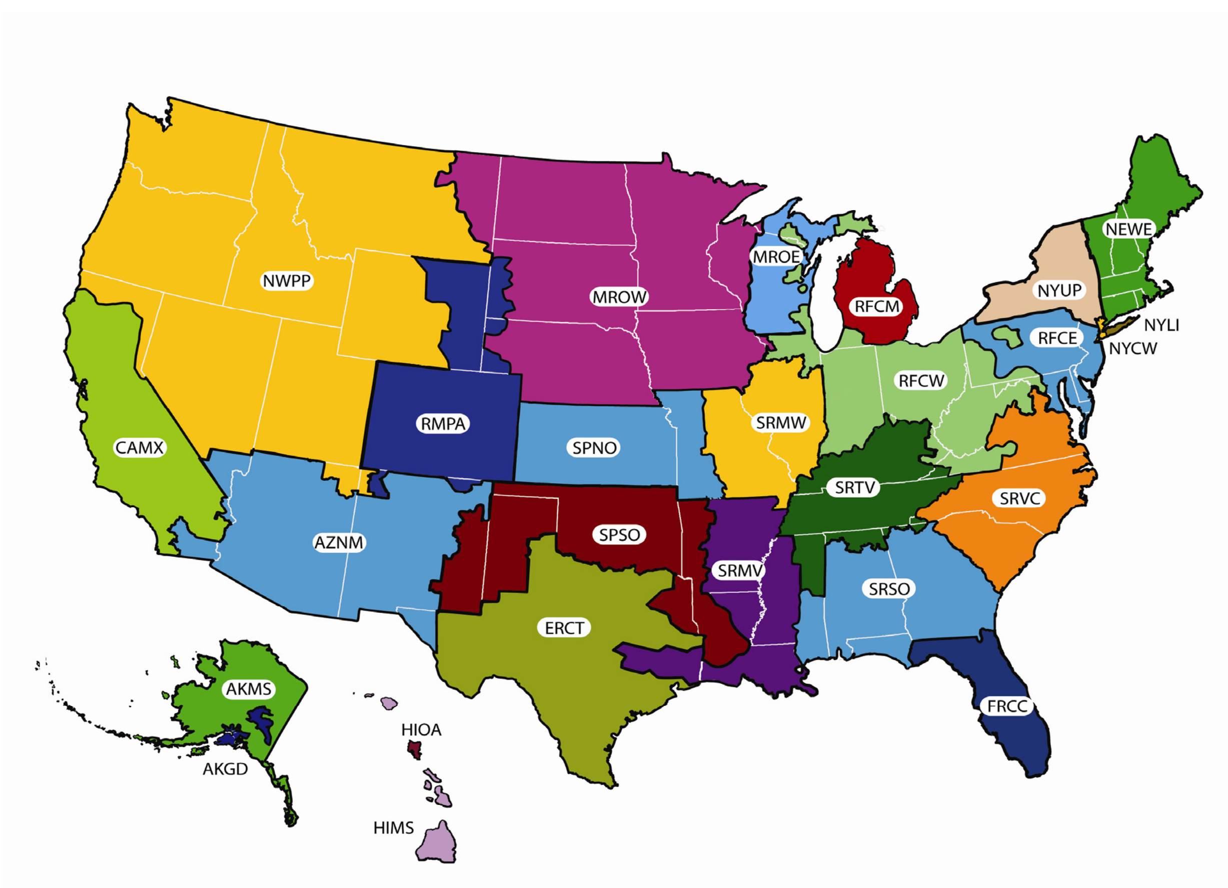
		Carbon dioxide (CO_2)		Sulfur dioxide (SO_2)		Nitrogen oxides (NO_x)				Mercury (Hg)	
eGRID subregion acronym	eGRID subregion name	Emissions (tons)	Output emission rate (lb/MWh)	Emissions (tons)	Output emission rate (lb/MWh)	Emissions (tons)	Output emission rate (lb/MWh)	Ozone season emissions (tons)	Ozone season output emission rate (lb/MWh)	Emissions (lbs)	Output emission rate (lb/GWh)
AKGD	ASCC Alaska Grid	3,307,005	1,257	3,497	1.329	7,872	2.993	3,265	3.138	9.08	0.0017
AKMS	ASCC Miscellaneous	303,844	480	428	0.677	4,134	6.532	1,958	7.210	N/A	N/A
AZNM	WECC Southwest	83,237,345	1,254	95,846	1.444	138,246	2.083	62,742	2.007	3,366.15	0.0254
CAMX	WECC California	93,924,761	879	59,781	0.559	81,099	0.759	35,468	0.722	494.76	0.0023
ERCT	ERCOT All	217,692,276	1,421	486,348	3.174	150,320	0.981	68,132	0.950	8,918.75	0.0291
FRCC	FRCC All	134,081,883	1,328	365,544	3.620	229,195	2.269	107,760	2.240	1,842.27	0.0091
HIMS	HICC Miscellaneous	2,242,390	1,456	9,228	5.992	10,770	6.994	4,778	7.232	N/A	N/A
HIOA	HICC Oahu	7,200,745	1,728	14,685	3.524	10,669	2.561	4,665	2.583	133.09	0.0160
MROE	MRO East	27,352,133	1,859	110,360	7.500	47,883	3.254	19,318	3.015	902.88	0.0307
MROW	MRO West	160,970,728	1,814	521,538	5.877	338,443	3.814	136,490	3.675	7,681.22	0.0433
NEWE	NPCC New England	60,225,835	909	156,241	2.358	64,801	0.978	23,887	0.858	1,129.37	0.0085
NWPP	WECC Northwest	115,244,347	921	158,302	1.265	203,398	1.626	81,811	1.564	2,427.60	0.0097
NYCW	NPCC NYC/Westchester	15,433,603	922	11,798	0.705	14,999	0.896	6,814	0.860	216.84	0.0065
NYLI	NPCC Long Island	10,112,144	1,412	38,451	5.370	13,113	1.831	5,167	1.569	81.19	0.0057
NYUP	NPCC Upstate NY	36,854,854	820	188,646	4.196	44,744	0.995	17,324	0.907	1,254.99	0.0140
RFCE	RFC East	150,046,502	1,096	1,100,532	8.035	233,832	1.707	74,381	1.237	11,323.74	0.0413
RFCM	RFC Michigan	78,608,383	1,641	326,828	6.824	117,421	2.452	42,871	2.136	3,155.04	0.0329
RFCW	RFC West	464,982,319	1,556	3,046,935	10.199	848,629	2.841	228,255	1.796	26,086.72	0.0437
RMPA	WECC Rockies	83,206,519	2,036	83,106	2.033	127,634	3.123	54,321	3.103	1,331.91	0.0163
SPNO	SPP North	65,563,407	1,971	201,581	6.061	132,464	3.983	55,351	3.807	1,815.17	0.0273
SPSO	SPP South	121,318,039	1,761	271,949	3.948	175,728	2.551	78,360	2.421	5,336.48	0.0387
SRMV	SERC Mississippi Valley	91,271,649	1,135	184,090	2.290	117,444	1.461	55,495	1.505	1,772.28	0.0110
SRMW	SERC Midwest	124,972,368	1,844	471,277	6.955	171,366	2.529	44,708	1.538	5,516.32	0.0407
SRSO	SERC South	187,745,174	1,490	1,064,642	8.451	273,243	2.169	101,321	1.750	8,781.34	0.0349
SRTV	SERC Tennessee Valley	172,431,724	1,495	833,388	7.225	298,834	2.591	78,728	1.585	5,843.69	0.0253
SRVC	SERC Virginia/Carolina	173,423,825	1,146	890,426	5.886	282,201	1.865	88,177	1.333	6,619.73	0.0219
U.S.		**2,681,753,803**	**1,363**	**10,695,446**	**5.436**	**4,138,481**	**2.103**	**1,481,550**	**1.704**	**106,040.62**	**0.0269**



Year 2004 eGRID Subregion Resource Mix

(Source: eGRID2006 Version 2.1, April 2007)

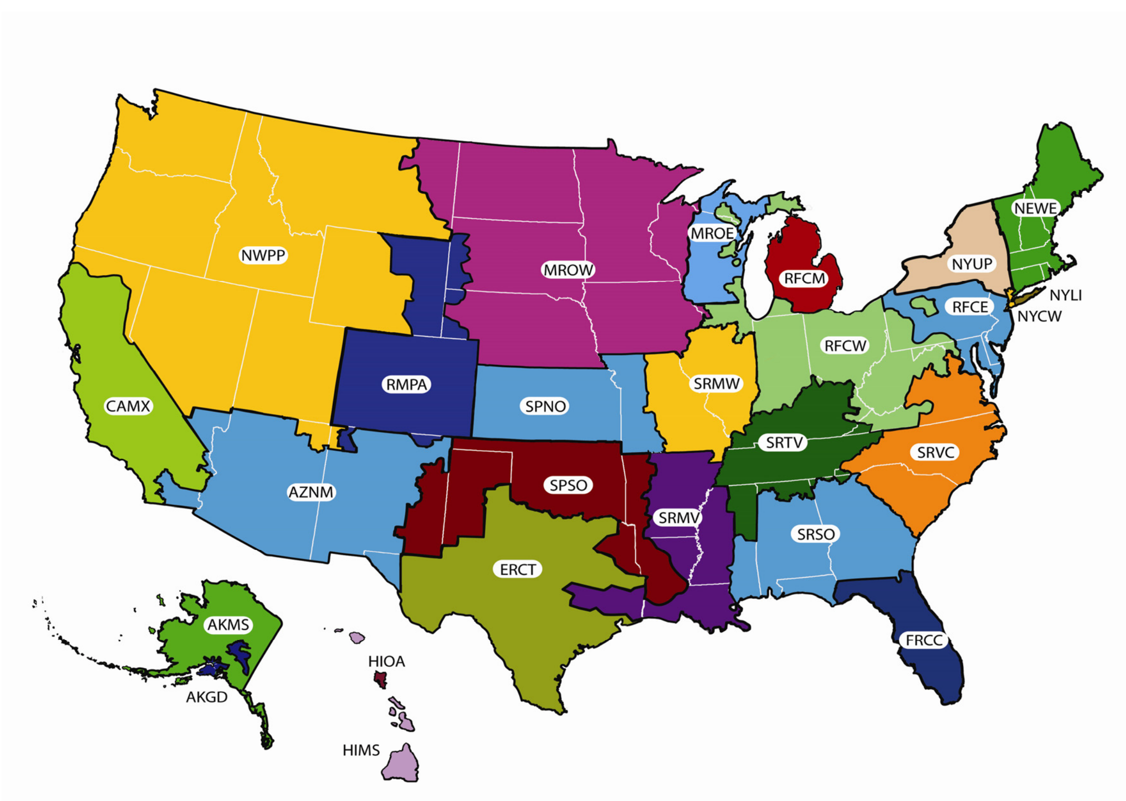
eGRID subregion acronym	eGRID subregion name	Nameplate capacity (MW)	Net generation (MWh)	Generation resource mix (percent)									
				Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal
AKGD	ASCC Alaska Grid	1,428	5,260,954	12.3	7.3	68.0	0.0	0.0	12.4	0.0	0.00	0.000	0.0
AKMS	ASCC Miscellaneous	635	1,265,757	0.0	28.8	3.6	0.0	0.7	66.9	0.0	0.00	0.000	0.0
AZNM	WECC Southwest	37,712	132,753,033	40.4	0.0	31.5	0.0	0.0	4.5	21.2	0.39	0.003	2.0
CAMX	WECC California	67,188	213,779,426	12.6	1.1	46.4	0.9	2.8	15.1	14.2	2.01	0.267	4.7
ERCT	ERCOT All	88,542	306,488,130	37.7	0.5	45.9	1.3	0.1	0.3	13.2	0.94	0.000	0.0
FRCC	FRCC All	56,126	201,982,118	26.4	18.3	36.5	0.3	2.0	0.0	15.5	0.00	0.000	0.0
HIMS	HICC Miscellaneous	841	3,079,854	3.6	77.2	4.1	0.0	4.9	3.0	0.0	0.24	0.000	6.9
HIOA	HICC Oahu	1,784	8,333,611	18.0	77.4	0.0	1.9	2.7	0.0	0.0	0.00	0.000	0.0
MROE	MRO East	7,646	29,431,172	71.3	2.4	5.2	0.1	3.7	3.9	13.2	0.14	0.000	0.0
MROW	MRO West	42,534	177,494,568	74.6	0.6	1.8	0.1	0.8	4.7	16.0	1.26	0.000	0.0
NEWE	NPCC New England	36,783	132,524,397	14.5	9.4	36.7	1.0	5.7	5.1	27.6	0.01	0.000	0.0
NWPP	WECC Northwest	59,994	250,231,026	34.4	0.3	10.6	0.1	1.2	49.0	3.6	0.49	0.000	0.3
NYCW	NPCC NYC/Westchester	11,749	33,470,521	0.0	20.4	29.8	0.3	0.8	0.0	48.6	0.00	0.000	0.0
NYLI	NPCC Long Island	5,505	14,321,157	0.0	58.2	35.5	1.8	4.5	0.0	0.0	0.00	0.000	0.0
NYUP	NPCC Upstate NY	24,158	89,924,573	25.4	6.6	13.2	0.3	1.3	26.0	27.1	0.11	0.000	0.0
RFCE	RFC East	76,512	273,924,233	44.9	3.5	9.6	0.7	1.3	1.6	38.4	0.10	0.000	0.0
RFCM	RFC Michigan	29,765	95,781,410	67.0	0.9	15.5	0.3	2.0	0.0	14.3	0.00	0.000	0.0
RFCW	RFC West	144,922	597,514,474	72.8	0.5	1.5	0.7	0.3	0.7	23.2	0.06	0.000	0.0
RMPA	WECC Rockies	18,408	81,742,789	80.6	0.0	13.5	0.0	0.0	5.3	0.0	0.46	0.000	0.0
SPNO	SPP North	18,363	66,514,000	78.1	1.3	4.6	0.1	0.0	0.1	15.2	0.54	0.000	0.0
SPSO	SPP South	41,190	137,772,165	58.8	0.2	34.1	0.3	1.7	4.2	0.0	0.61	0.000	0.0
SRMV	SERC Mississippi Valley	48,864	160,765,506	23.4	5.0	39.3	1.1	2.4	1.6	26.6	0.00	0.000	0.0
SRMW	SERC Midwest	31,186	135,519,573	84.7	0.3	2.0	0.1	0.1	1.2	11.7	0.00	0.000	0.0
SRSO	SERC South	68,200	251,944,380	64.0	0.6	10.1	0.1	3.5	3.1	18.6	0.00	0.000	0.0
SRTV	SERC Tennessee Valley	57,181	230,695,467	65.8	1.7	2.4	0.0	0.9	8.8	20.4	0.00	0.000	0.0
SRVC	SERC Virginia/Carolina	75,784	302,557,474	51.0	1.7	3.8	0.2	2.0	1.7	39.5	0.00	0.000	0.0
U.S.		**1,052,996**	**3,935,071,766**	**50.2**	**3.0**	**17.4**	**0.5**	**1.4**	**6.6**	**20.0**	**0.34**	**0.015**	**0.3**



Year 2004 eGRID Subregion Emission Rates

(Source: eGRID2006 Version 2.1, April 2007)

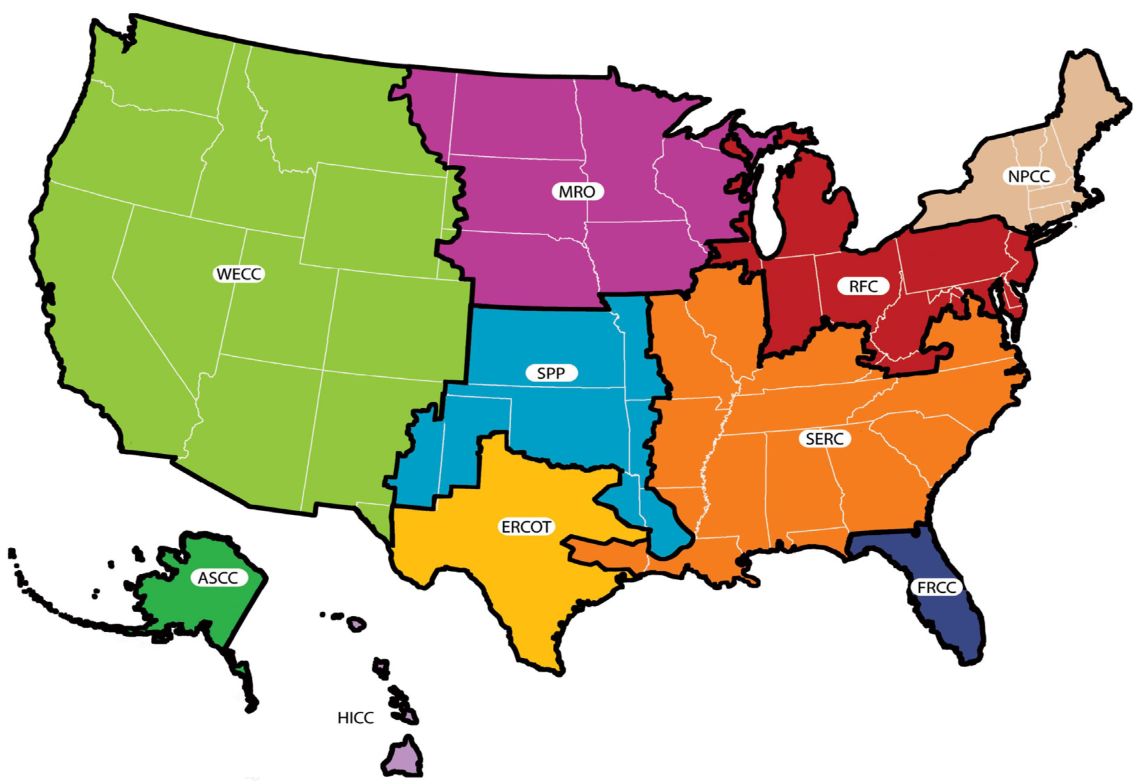
eGRID subregion acronym	eGRID subregion name	Output emission rate					Fossil fuel output emission rate					Non-baseload output emission rate				
		CO_2 (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	Hg (lb/GWh)	CO_2 (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	Hg (lb/GWh)	CO_2 (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	Hg (lb/GWh)
AKGD	ASCC Alaska Grid	1,257	1.329	2.993	3.138	0.0017	1,435	1.517	3.416	3.660	0.0020	1,436	2.468	2.998	3.004	0.0000
AKMS	ASCC Miscellaneous	480	0.677	6.532	7.210	N/A	1,390	1.960	18.915	18.956	N/A	1,442	2.054	19.775	19.720	N/A
AZNM	WECC Southwest	1,254	1.444	2.083	2.007	0.0254	1,743	2.007	2.894	2.738	0.0352	1,434	0.699	1.469	1.291	0.0090
CAMX	WECC California	879	0.559	0.759	0.722	0.0023	1,437	0.912	1.121	1.092	0.0020	1,279	0.322	0.534	0.451	0.0010
ERCT	ERCOT All	1,421	3.174	0.981	0.950	0.0291	1,673	3.766	1.161	1.108	0.0345	1,335	0.804	0.709	0.724	0.0040
FRCC	FRCC All	1,328	3.620	2.269	2.240	0.0091	1,447	4.013	2.388	2.363	0.0065	1,475	3.698	2.184	2.100	0.0040
HIMS	HICC Miscellaneous	1,456	5.992	6.994	7.232	N/A	1,628	6.699	7.813	7.957	N/A	1,625	5.338	9.693	9.645	N/A
HIOA	HICC Oahu	1,728	3.524	2.561	2.583	0.0160	1,775	3.690	2.387	2.404	N/A	1,730	4.346	3.017	3.048	0.0170
MROE	MRO East	1,859	7.500	3.254	3.015	0.0307	2,249	9.074	3.931	3.771	0.0371	2,088	9.055	4.183	4.362	0.0210
MROW	MRO West	1,814	5.877	3.814	3.675	0.0433	2,350	7.608	4.895	4.774	0.0552	2,217	8.107	5.259	5.066	0.0470
NEWE	NPCC New England	909	2.358	0.978	0.858	0.0085	1,431	3.646	1.161	0.968	0.0053	1,404	3.201	1.190	1.031	0.0050
NWPP	WECC Northwest	921	1.265	1.626	1.564	0.0097	2,032	2.746	3.531	3.539	0.0212	1,532	1.573	2.466	2.715	0.0130
NYCW	NPCC NYC/Westchester	922	0.705	0.896	0.860	0.0065	1,819	1.393	1.665	1.461	N/A	1,776	1.533	1.753	1.538	0.0060
NYLI	NPCC Long Island	1,412	5.370	1.831	1.569	0.0057	1,452	5.715	1.579	1.391	N/A	1,486	5.628	1.728	1.509	0.0010
NYUP	NPCC Upstate NY	820	4.196	0.995	0.907	0.0140	1,794	9.195	2.091	1.882	0.0257	1,706	9.176	2.259	2.188	0.0220
RFCE	RFC East	1,096	8.035	1.707	1.237	0.0413	1,687	12.573	2.544	1.796	0.0579	1,814	12.061	2.951	2.317	0.0460
RFCM	RFC Michigan	1,641	6.824	2.452	2.136	0.0329	1,765	7.316	2.572	2.242	0.0353	1,949	8.297	2.848	2.443	0.0390
RFCW	RFC West	1,556	10.199	2.841	1.796	0.0437	2,030	13.362	3.668	2.335	0.0572	2,084	14.787	3.805	2.850	0.0640
RMPA	WECC Rockies	2,036	2.033	3.123	3.103	0.0163	2,162	2.159	3.316	3.305	0.0173	1,698	2.041	2.283	2.383	0.0100
SPNO	SPP North	1,971	6.061	3.983	3.807	0.0273	2,344	7.206	4.735	4.484	0.0324	2,192	8.399	4.133	3.828	0.0310
SPSO	SPP South	1,761	3.948	2.551	2.421	0.0387	1,863	4.198	2.662	2.515	0.0329	1,506	2.192	2.205	2.026	0.0140
SRMV	SERC Mississippi Valley	1,135	2.290	1.461	1.505	0.0110	1,642	3.167	2.031	2.045	0.0164	1,411	2.122	1.936	1.884	0.0050
SRMW	SERC Midwest	1,844	6.955	2.529	1.538	0.0407	2,117	7.984	2.902	1.750	0.0467	2,150	9.656	3.164	1.943	0.0410
SRSO	SERC South	1,490	8.451	2.169	1.750	0.0349	1,949	10.991	2.788	2.182	0.0458	1,810	10.549	2.787	2.352	0.0310
SRTV	SERC Tennessee Valley	1,495	7.225	2.591	1.585	0.0253	2,126	10.254	3.669	2.195	0.0360	2,048	11.836	3.549	2.462	0.0390
SRVC	SERC Virginia/Carolina	1,146	5.886	1.865	1.333	0.0219	1,913	9.826	3.069	2.141	0.0362	1,917	11.013	3.077	2.375	0.0340
U.S.		**1,363**	**5.436**	**2.103**	**1.704**	**0.0269**	**1,869**	**7.473**	**2.831**	**2.268**	**0.0355**	**1,714**	**6.967**	**2.511**	**2.104**	**0.0260**



Year 2004 NERC Region Emissions

(Source: eGRID2006 Version 2.1, April 2007)

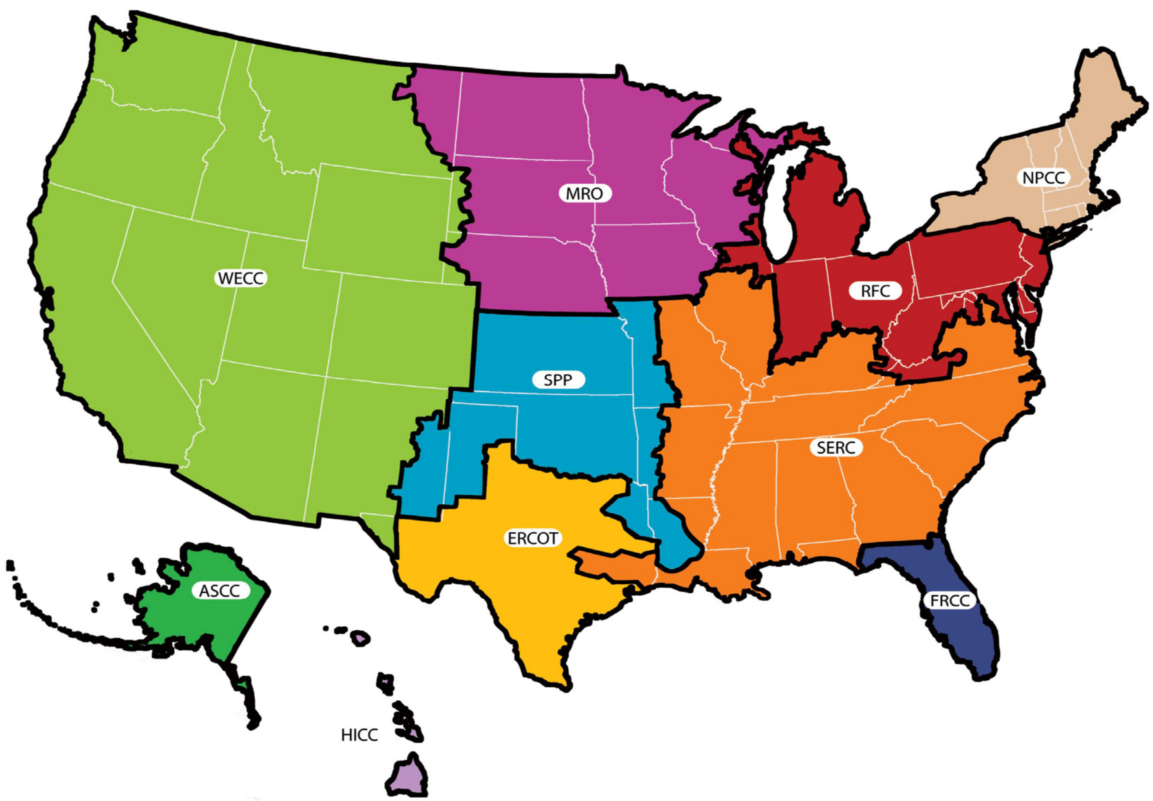
NERC region acronym	NERC region name	Carbon dioxide (CO_2)		Sulfur dioxide (SO_2)		Nitrogen oxides (NO_x)				Mercury (Hg)	
		Emissions (tons)	Output emission rate (lb/MWh)	Emissions (tons)	Output emission rate (lb/MWh)	Emissions (tons)	Output emission rate (lb/MWh)	Ozone season emissions (tons)	Ozone season output emission rate (lb/MWh)	Emissions (lbs)	Output emission rate (lb/GWh)
ASCC	Alaska Systems Coordinating Council	3,610,850	1,106	3,925	1.203	12,006	3.679	5,223	3.980	9.08	0.0014
ERCOT	Electric Reliability Council of Texas	217,692,276	1,421	486,348	3.174	150,320	0.981	68,132	0.950	8,918.75	0.0291
FRCC	Florida Reliability Coordinating Council	134,081,883	1,328	365,544	3.620	229,195	2.269	107,760	2.240	1,842.27	0.0091
HICC	Hawaiian Islands Coordinating Council	9,443,135	1,655	23,913	4.190	21,439	3.757	9,443	3.829	133.09	0.0117
MRO	Midwest Reliability Organization	188,322,861	1,820	631,898	6.107	386,326	3.734	155,808	3.578	8,584.10	0.0415
NPCC	Northeast Power Coordinating Council	122,626,436	908	395,136	2.924	137,658	1.019	53,192	0.915	2,682.39	0.0099
RFC	Reliability First Corporation	693,637,204	1,434	4,474,294	9.252	1,199,882	2.481	345,508	1.667	40,565.50	0.0419
SERC	SERC Reliability Corporation	749,844,741	1,387	3,443,824	6.369	1,143,087	2.114	368,430	1.537	28,533.36	0.0264
SPP	Southwest Power Pool	186,881,446	1,830	473,530	4.636	308,192	3.017	133,711	2.850	7,151.65	0.0350
WECC	Western Electricity Coordinating Council	375,612,971	1,107	397,034	1.170	550,377	1.622	234,342	1.560	7,620.42	0.0112
U.S.		**2,681,753,803**	**1,363**	**10,695,446**	**5.436**	**4,138,481**	**2.103**	**1,481,550**	**1.704**	**106,040.62**	**0.0269**



Year 2004 NERC Region Resource Mix

(Source: eGRID2006 Version 2.1, April 2007)

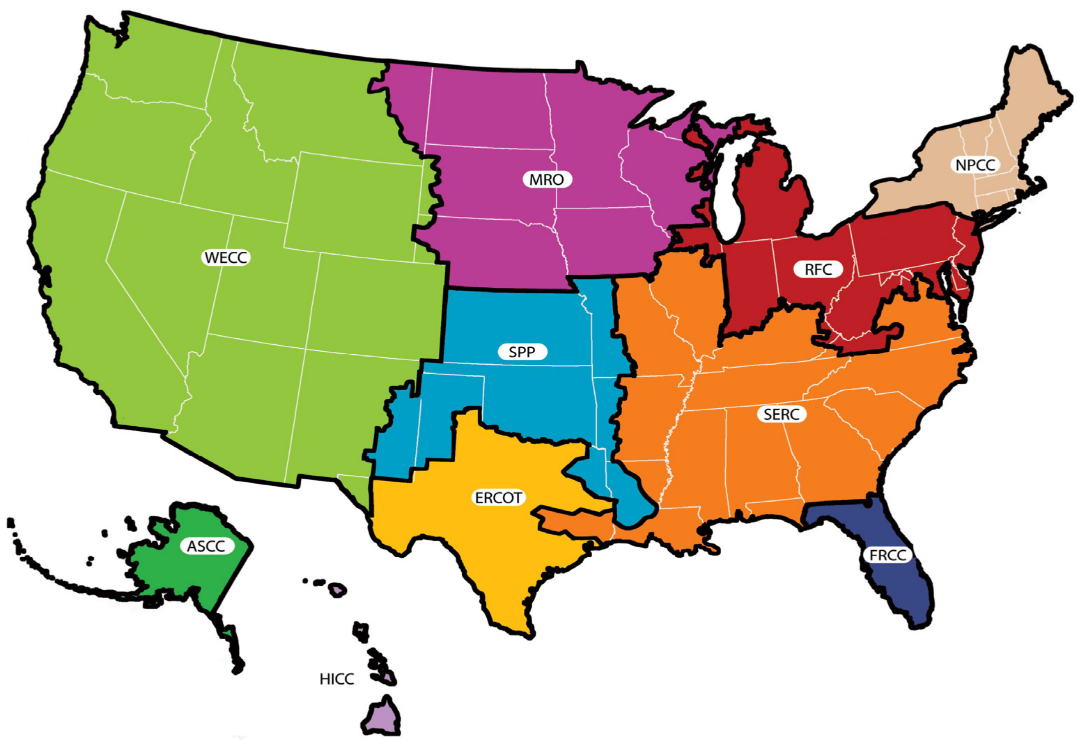
NERC region acronym	NERC region name	Nameplate capacity (MW)	Net generation (MWh)	Generation resource mix (percent)									
				Coal	Oil	Gas	Other fossil	Biomass	Hydro	Nuclear	Wind	Solar	Geo-thermal
ASCC	Alaska Systems Coordinating Council	2,063	6,526,711	9.9	11.5	55.5	0.0	0.1	23.0	0.0	0.00	0.000	0.0
ERCOT	Electric Reliability Council of Texas	88,542	306,488,130	37.7	0.5	45.9	1.3	0.1	0.3	13.2	0.94	0.000	0.0
FRCC	Florida Reliability Coordinating Council	56,126	201,982,118	26.4	18.3	36.5	0.3	2.0	0.0	15.5	0.00	0.000	0.0
HICC	Hawaiian Islands Coordinating Council	2,624	11,413,465	14.1	77.3	1.1	1.4	3.3	0.8	0.0	0.07	0.000	1.9
MRO	Midwest Reliability Organization	50,180	206,925,740	74.2	0.8	2.3	0.1	1.2	4.6	15.6	1.10	0.000	0.0
NPCC	Northeast Power Coordinating Council	78,194	270,240,647	15.6	12.4	28.0	0.7	3.6	11.1	28.6	0.04	0.000	0.0
RFC	Reliability First Corporation	251,199	967,220,117	64.4	1.4	5.2	0.7	0.8	0.9	26.6	0.06	0.000	0.0
SERC	SERC Reliability Corporation	281,215	1,081,482,400	57.3	1.8	10.0	0.3	1.9	3.5	25.2	0.00	0.000	0.0
SPP	Southwest Power Pool	59,553	204,286,164	65.1	0.5	24.5	0.2	1.1	2.9	5.0	0.59	0.000	0.0
WECC	Western Electricity Coordinating Council	183,302	678,506,273	34.2	0.5	26.3	0.3	1.3	24.3	9.9	0.95	0.085	2.0
U.S.		**1,052,996**	**3,935,071,766**	**50.2**	**3.0**	**17.4**	**0.5**	**1.4**	**6.6**	**20.0**	**0.34**	**0.015**	**0.3**



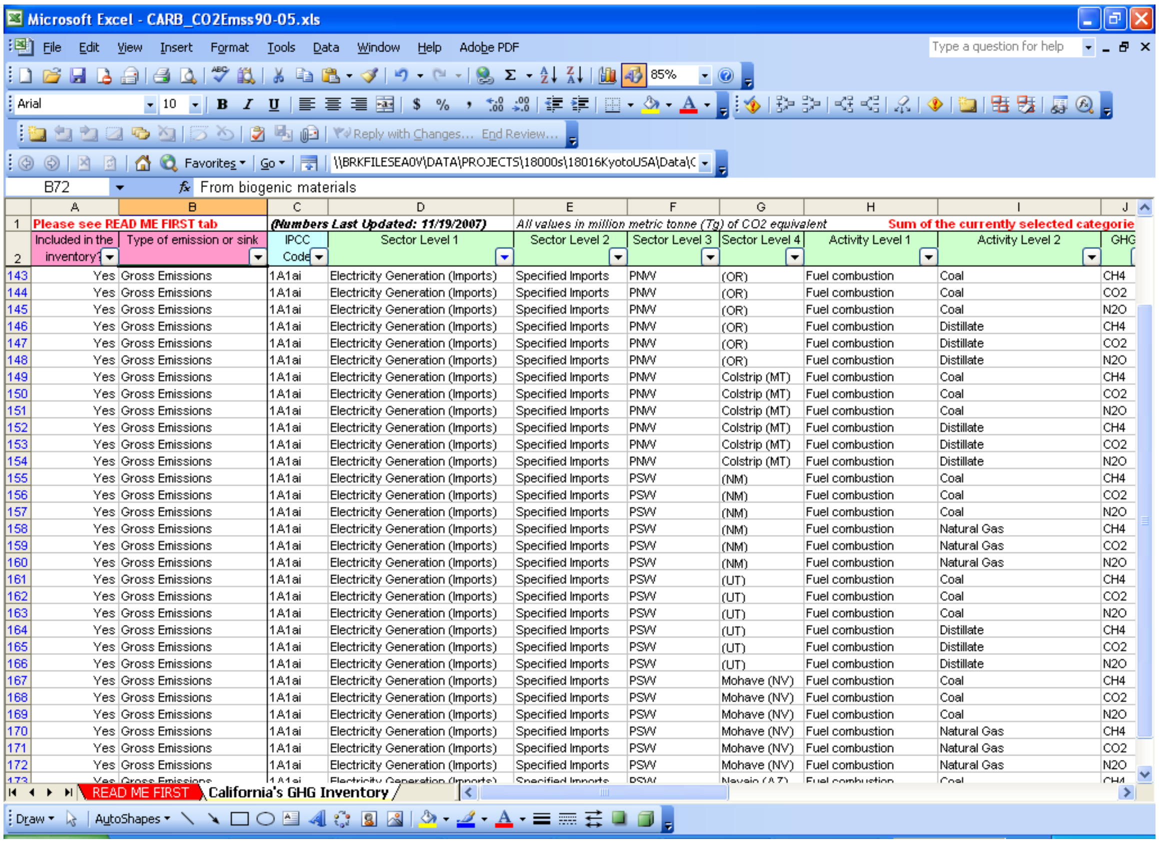
Year 2004 NERC Region Emission Rates

(Source: eGRID2006 Version 2.1, April 2007)

NERC region acronym	NERC region name	Output emission rate					Fossil fuel output emission rate					Non-baseload output emission rate				
		CO_2 (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	Hg (lb/GWh)	CO_2 (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	Hg (lb/GWh)	CO_2 (lb/MWh)	SO_2 (lb/MWh)	NO_x (lb/MWh)	Ozone season NO_x (lb/MWh)	Hg (lb/GWh)
ASCC	Alaska Systems Coordinating Council	1,106	1.203	3.679	3.980	0.0014	1,431	1.556	4.758	5.248	0.0018	1,437	2.399	5.802	5.749	0.0000
ERCOT	Electric Reliability Council of Texas	1,421	3.174	0.981	0.950	0.0291	1,673	3.766	1.161	1.108	0.0345	1,335	0.804	0.709	0.724	0.0040
FRCC	Florida Reliability Coordinating Council	1,328	3.620	2.269	2.240	0.0091	1,447	4.013	2.388	2.363	0.0065	1,475	3.698	2.184	2.100	0.0040
HICC	Hawaiian Islands Coordinating Council	1,655	4.190	3.757	3.829	0.0117	1,737	4.465	3.785	3.842	N/A	1,698	4.654	5.092	5.201	0.0120
MRO	Midwest Reliability Organization	1,820	6.107	3.734	3.578	0.0415	2,335	7.829	4.749	4.620	0.0525	2,192	8.292	5.049	4.941	0.0420
NPCC	Northeast Power Coordinating Council	908	2.924	1.019	0.915	0.0099	1,573	5.065	1.502	1.309	0.0097	1,539	4.401	1.563	1.391	0.0080
RFC	Reliability First Corporation	1,434	9.252	2.481	1.667	0.0419	1,914	12.423	3.260	2.188	0.0547	1,987	13.093	3.424	2.631	0.0550
SERC	SERC Reliability Corporation	1,387	6.369	2.114	1.537	0.0264	1,961	8.979	2.953	2.091	0.0374	1,842	9.179	2.898	2.250	0.0290
SPP	Southwest Power Pool	1,830	4.636	3.017	2.850	0.0350	2,008	5.109	3.289	3.084	0.0327	1,659	3.576	2.635	2.414	0.0170
WECC	Western Electricity Coordinating Council	1,107	1.170	1.622	1.560	0.0112	1,804	1.895	2.592	2.513	0.0177	1,411	0.823	1.318	1.310	0.0060
U.S.		**1,363**	**5.436**	**2.103**	**1.704**	**0.0269**	**1,869**	**7.473**	**2.831**	**2.268**	**0.0355**	**1,714**	**6.967**	**2.511**	**2.104**	**0.0260**



California Air Resources Board (CARB)
CARB has a detailed excel database which inventories CO2 emissions from 1990 through 2004, according to the Intergovernmental Panel on Climate Change (IPCC) The below illustrates the contents of this database.



	A	B	C	D	E	F	G	H	I	J
1	Please see READ ME FIRST tab		(Numbers Last Updated: 11/19/2007)		All values in million metric tonne (Tg) of CO2 equivalent				Sum of the currently selected categorie	
2	Included in the inventory?	Type of emission or sink	IPCC Code	Sector Level 1	Sector Level 2	Sector Level 3	Sector Level 4	Activity Level 1	Activity Level 2	GHG
143	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	(OR)	Fuel combustion	Coal	CH4
144	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	(OR)	Fuel combustion	Coal	CO2
145	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	(OR)	Fuel combustion	Coal	N2O
146	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	(OR)	Fuel combustion	Distillate	CH4
147	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	(OR)	Fuel combustion	Distillate	CO2
148	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	(OR)	Fuel combustion	Distillate	N2O
149	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	Colstrip (MT)	Fuel combustion	Coal	CH4
150	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	Colstrip (MT)	Fuel combustion	Coal	CO2
151	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	Colstrip (MT)	Fuel combustion	Coal	N2O
152	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	Colstrip (MT)	Fuel combustion	Distillate	CH4
153	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	Colstrip (MT)	Fuel combustion	Distillate	CO2
154	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PNW	Colstrip (MT)	Fuel combustion	Distillate	N2O
155	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(NM)	Fuel combustion	Coal	CH4
156	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(NM)	Fuel combustion	Coal	CO2
157	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(NM)	Fuel combustion	Coal	N2O
158	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(NM)	Fuel combustion	Natural Gas	CH4
159	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(NM)	Fuel combustion	Natural Gas	CO2
160	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(NM)	Fuel combustion	Natural Gas	N2O
161	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(UT)	Fuel combustion	Coal	CH4
162	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(UT)	Fuel combustion	Coal	CO2
163	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(UT)	Fuel combustion	Coal	N2O
164	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(UT)	Fuel combustion	Distillate	CH4
165	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(UT)	Fuel combustion	Distillate	CO2
166	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	(UT)	Fuel combustion	Distillate	N2O
167	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	Mohave (NV)	Fuel combustion	Coal	CH4
168	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	Mohave (NV)	Fuel combustion	Coal	CO2
169	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	Mohave (NV)	Fuel combustion	Coal	N2O
170	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	Mohave (NV)	Fuel combustion	Natural Gas	CH4
171	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	Mohave (NV)	Fuel combustion	Natural Gas	CO2
172	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	Mohave (NV)	Fuel combustion	Natural Gas	N2O
173	Yes	Gross Emissions	1A1ai	Electricity Generation (Imports)	Specified Imports	PSW	Navajo (AZ)	Fuel combustion	Coal	CH4

Power Content Labels
The major utilities in California annually publish “Power Content Labels” which document the mix of fuel sources. Attached is an example of the power content labor from the Los Angeles Department of Water and Power.

POWER CONTENT LABEL

Annual Report of Actual Electricity Purchases for LADWP Calendar Year 2006

ENERGY RESOURCES	LADWP Power* ACTUAL MIX	LADWP Power PROJECTED MIX	LADWP Green Power** ACTUAL MIX	LADWP Green Power PROJECTED MIX	2006 CA POWER MIX*** (for comparison)
Eligible Renewable******	**7%**	**6%**	**100%**	**100%**	**5%**
-- Biomass & waste	1%	1%	<1%	<1%	<1%
-- Geothermal	1%	<1%	<1%	<1%	4%
-- Small hydroelectric	5%	4%	70%	<1%	<1%
-- Solar	<1%	<1%	<1%	<1%	<1%
-- Wind	<1%	1%	30%	100%	<1%
Coal	**47%**	**48%**	**-**	**-**	**29%**
Large Hydroelectric	**8%**	**6%**	**-**	**-**	**31%**
Natural Gas	**30%**	**30%**	**-**	**-**	**35%**
Nuclear	**8%**	**10%**	**-**	**-**	**0%**
Other	**<1%**	**<1%**	**-**	**-**	**0%**
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**

* 86% of **LADWP Power** is specifically purchased from individual suppliers.

** 100% of **LADWP Green Power** is specifically purchased from individual suppliers.

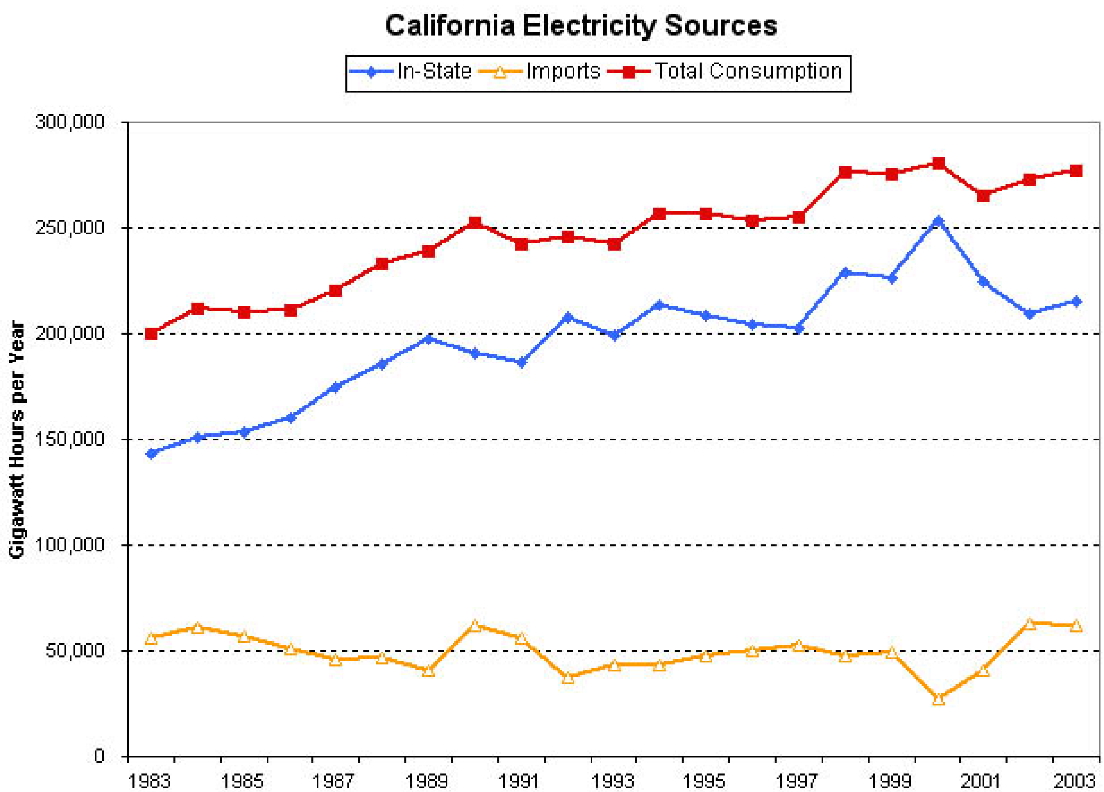
*** Percentages are estimated annually by the California Energy Commission based on electricity sold to California consumers during the previous year.

**** In accordance with Los Angeles City Council's action on 10-5-04 for File No. 03-2688 (RPS).

For specific information about this electricity product, contact

LADWP at 1-800-DIAL-DWP. For general information about the Power Content Label, contact the California Energy Commission at 1-800-555-7794 or www.energy.ca.gov/consumer.

California's Electricity Sources Figure.



State of California, "In-state Electricity Generation, Electricity Consumption and Apparent Net Import of Electricity to California."

III

Analysis of Local “Offset” Program Potential

ANALYSIS OF LOCAL "OFFSET" PROGRAM POTENTIAL

Introduction

This memo evaluates the basis for establishing a local **Community Climate Fund** to help facilitate the installation of renewable energy systems on schools and other facilities that serve a public purpose. It can be demonstrated that renewable energy systems, when combined with improved energy efficiencies and conservation, are affordable and can replace significant amounts of electricity produced by climate altering fossil fuels.

A common perception exists among the public that photovoltaic (PV) systems are still too expensive for individual homeowners, businesses, and local government including our school districts. While that view may be true for low and middle income homeowners with modest energy bills, the same cannot be said for public schools whose energy costs are often quite high and increasing at a remarkable rate.[1] Look closely at a school district's annual energy bills and the amortized cost of a PV system that provides all, or most, of the electricity a school needs, and you'll find that the cost difference is quite modest. A **Community Climate Fund** would provide the funding to a school district to eliminate that cost differential.

The **Community Climate Fund** is modeled on local fundraising organizations called Community Chests[2] that were established in the early 1900s to support community projects.

The City of Berkeley, along with numerous other stakeholders, is developing a comprehensive set of initiatives to implement Measure G, a voter supported resolution which directs the City to reduce its community-wide greenhouse gas (GHG) emissions by 80 percent by 2050. The **Community Climate Fund** is among the many initiatives being considered by stakeholders.

Loosely modeled on carbon emissions offset programs like TerraPass[3] and Native Energy[4] the **Community Climate Fund** is intended to offer an alternative to current national/international offset programs, by using local resident and business donations to fund local energy efficiency / renewable energy projects which will help achieve local GHG reductions and other tangible local economic, health, and environmental benefits. This approach brings the benefits of capturing dollars locally, using those dollars to fund local projects that are tangible and highly visible to donors and the community at large, reducing greenhouse gases in the process, and stimulating increased interest in further community GHG reduction activities.

This memo is intended to estimate the potential market "size" in terms of dollars that could be raised in Berkeley and the East Bay. The companion study conducted by Economic and Planning Systems (EPS) evaluates the economic and non-economic benefits of a 100 Kw photovoltaic solar system built on a local public school that was made possible, in part, by contributions from local

[1] " PG&E warns its bills could soar this winter", *San Francisco Chronicle*, July 25, 2008

[2] The **Community Chests** in the United States and Canada were fund-raising organizations that collected money from local businesses and workers and distributed it to community projects. The first Community Chest was founded in 1913 in Cleveland, Ohio. The number of Community Chest organizations increased from 39 to 353 between 1919 and 1929, and surpassed 1000 by 1948. By 1963, and after several name changes, the term "'United Way'" was adopted in the United States.

[3] http://www.terrapass.com/

[4] http://www.nativeenergy.com/

residents. The EPS study attempts to quantify the economic and environmental benefits that accrue to a city and its residents, as well as the health benefits for those whose health is affected by the generation of electricity from fossil fuels.

Assumptions and Limiting Conditions

The following assumptions and limiting conditions apply to this memorandum:

- This memorandum was produced by Berkeley-based KyotoUSA, a sponsored project of the Sequoia Foundation, a non-profit organization based in La Jolla, California, and as such, reflects this organization's direction and input.
- This memorandum should be considered as an initial overview of potential program benefits. It is not intended to be a comprehensive discussion of offset issues and solutions, nor a complete analysis of economic and non-economic costs and benefits to the community.

Overview of Carbon Offset Credits

According to Terrapass, one of many providers of carbon offsets, a carbon offset is "a certificate representing the reduction of one metric ton (roughly 2,200 lbs.) of carbon dioxide." [5] Although in the U.S., mandatory GHG emission limits have not yet been imposed, numerous firms, governments, institutions, and residents have voluntarily purchased carbon offsets as one means of reducing the GHG emissions for which they are responsible. A common way of conceptualizing this type of market demand is that if a firm or individual household desires to reduce its carbon responsibility or achieve carbon neutrality, the entity should first calculate its carbon "footprint" (e.g., tons of GHG emissions for which it is responsible), take action to reduce these emissions by conservation, improved efficiencies, and changed behaviors and/or practices, and then offset any remaining emissions through the purchase of offset credits, used to fund GHG reduction projects elsewhere in the world. This logic flow makes sense from a global warming perspective, because greenhouse gases and their impact on climate are a global process.

Currently, there is a growing number of national and international carbon offset retailers offering credits to U.S. residents, businesses, and institutions. These "retailers" serve as intermediaries, arranging for the sale of offsets in small quantities, and facilitating the transfer of dollars raised to actual GHG reduction or sequestration projects. Offset retailers typically sell credits that fund projects focused on renewable energy generation, energy conservation improvements, or carbon sequestration through tree planting. Because the North American offset market is **voluntary** and funds are priced based on the mitigating project, prices for an offset credit vary greatly. As of July 2008, offset prices for a one ton reduction ranged from about $4.00 to $99.00, with prices hovering around $15.00 per ton.[6]

One of the keys to creating a viable and credible voluntary offset program is to ensure that the dollars raised are used to fund high quality, verifiable GHG reduction projects. A rapidly growing industry is evolving throughout the world to verify (Voluntary Emissions Reductions - VER) and in some cases, certify (Certified Emissions Reductions = CER) carbon offset credits[7] offered by

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[5] http://terrapass.com/about/how-carbon-offsets-work.html

[6] http://www.ecobusinesslinks.com/carbon_offset_wind_credits_carbon_reduction.htm

[7] See definitions for VERs and CERs at: Correct Carbon - http://www.correctcarbon.co.uk/offsetting-overview.asp

retailers. In general, the following criteria have evolved, and are recommended by Clear Air/Cool Planet as an approach to determining the quality of the offset offered by an offset retailer:[8]

- **Additionality -** Offset revenues make a project happen that otherwise would not have happened, or help to overcome financial barriers that would prevent the project from happening.
- **Baseline Determination and Benefit Quantification** - This refers to establishing a baseline of emissions before the project, and then measuring the reduction in GHG emissions compared to the baseline so that the reduction can be quantified.
- **Permanence -** Benefits of the project are not reversible (one example of a GHG reduction project that may not have permanence is tree planting, with the potential for trees dying and the benefits disappearing).
- **Ownership and Registration -** This set of criteria would require creating a paper trail of ownership and registration, so that multiple buyers are not purchasing the same offset credits.
- **Monitoring and Verification -** Offset projects should be monitored and verified over time by a credible third party.

Each of these criteria, while seemingly straightforward, has posed challenges to various environmental organizations seeking to clarify the process and avoid charges of "greenwashing." In particular, the concept of "additionality," poses conceptual problems to those projects which are underway, or will soon be mandated by law or regulation, therefore making the idea of determining whether the project would have happened without the offset funding more difficult to demonstrate.

One way for a U.S. based project to ensure the quality of the offset it plans to produce is to obtain verification. This process varies, with several different standards and verification protocols now in effect. In general, obtaining "verification" can be expensive (e.g., $5,000 to $10,000 or more), a concern in the case of small, local offset projects such as the installation of solar (PV) to generate energy for a school or affordable housing project.

In the absence of a certificate for an offset project, there are alternative viewpoints as to how to ensure GHG reduction project quality and thereby establish a credible local offset program. For example, a local offset program in Berkeley could be initially offered based on the more traditional model of a charitable, tax deductible donation to a credible and trusted non-profit, who in turn would manage the program, has accountability to its board of directors and the public, and communicates its expenditures through local, tangible projects for all to visit. In some ways, the concept of a local offset program may indeed bypass some of the criteria and expensive certification that has evolved to address quality criteria, because the actual project would be local and tangible rather than in a distant location.

Should a small project like HELiOS decide to forego the expense of the formal verification process, it could bundle and sell the solar renewable energy credits (SRECs) that are produced by the generation of renewable energy. One SREC represents the environmental attributes of one Megawatt hour (MwH) of renewable energy generation. There is a growing SREC market in the U.S. and prices for high quality SRECs produced in areas served by Pacific Gas and Electric are still

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[8] Clean Air, Cool Planet. *A Consumer's Guide to Retail Carbon Offset Providers.* December, 2006. Page 3.

modest ($0.01-$0.02 per kilowatt hour or $10-$20 per MWh)[9], but their sale could provide an additional source of income to a school district or its partner that could be used to supplement donations to the **Community Climate Fund**.

Opportunities for a Local Offset Program

Rather than sending local dollars to other states and countries to fund emission reduction projects, a local offset program would both reduce emissions and create local community development benefits. Local carbon offset dollars remain within the community, reducing emissions locally and creating employment opportunities. In this way, the process of reducing emissions through offset actions would become a local, visible process, so that the donor would experience tangible outcomes of his or her contribution. This approach would bring additional benefits to the climate change equation, including additional funding streams for much-needed local investments in capital improvements to increase energy efficiency. The localization of the process would also demonstrate keeping Berkeley's dollars within the local economy, providing non-economic benefits, including educational opportunities, health benefits in areas where electricity generation plants are located, and creating a groundbreaking model for local climate change action.

Two potential funding streams could make the "Community Climate Fund" an important source of revenue for a local climate response:

1. Tax deductible donations tied to individual or business carbon emissions. Calculation of emissions and suggested donations directed to a local project would be provided by a calculation tool developed for emissions from residents of a specific city or region.
2. Larger institutions or businesses that have established voluntary GHG reduction targets[10] may consider the purchase of offsets or SRECs after implementing conservation, efficiency measures, and renewable energy projects.

Each of these "market segments" may desire different characteristics to attract their investment dollars. For example, while individuals may appreciate the local investment feature, larger institutions may require additional accountability through the use of a third-party verification standard (e.g., the Gold Standard, Environmental Resources Trust, Center for Resource Solutions, etc.). However, as third- party verification can be costly relative to the modest funds that will likely result from a locally marketed offset, local offset programs may decide to start out less formally, accepting donations loosely tied to emissions reductions. Under this scenario, the program would still choose projects that measurably reduce emissions but could forego expensive verification procedures.

Should a local offset program determine that it is cost effective to have the emission credits verified – especially if individual projects can be aggregated under one umbrella – the sale of verified credits or SRECs to institutions, such as UC Berkeley that have a GHG reduction goal and interest in achieving and maintaining good relations with its host community, could be an attractive alternative.

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[9] The State of New Jersey pays some solar customers up to $475 per SREC as part of its Clean Energy Program. The payment for the SRECs helps to pay off renewable energy system loans for that are also provided through the local utility, Public Service Electric and Gas (PSE&G) of New Jersey.

[10] UC Berkeley Climate Action Partnership (Cal-CAP): Emission Targets and Feasibility. See, http://sustainability.berkeley.edu/calcap/feasibility-target.html

Beneficiaries envisioned for the local offset program currently include the Berkeley Unified School District. Future projects could include local non-profit housing developers, and other local non-profits that are engaged in energy programs or urban and rural reforestation programs.

Identifying Local Projects

In order to capture local residents' carbon offset dollars, the program should consider projects that aim to meet the minimum requirements of an offset program[11], as well as local residents' values. Nevertheless, local projects that provide local benefits should not be dismissed because they fail to meet the highly technical definition of "additionality" established under the Kyoto Protocol.[12] There are several means for identifying local projects.

First, there is a direct strategic GHG reduction-based approach, where local projects arise during the implementation phase of the City's Climate Action Plan. Such projects could include capital improvements leading to the net carbon neutrality of local public buildings, transportation projects that encourage biking and walking, or projects that otherwise result in Berkeley meeting its stated GHG reduction goals. Depending on forthcoming City implementation actions, the establishment of a local voluntary offset program may serve to assist this process, supplying a funding source to augment other financing strategies. Funding provided from the **Community Climate Fund** should supplement, but not replace, resources provided by the City or other funding source.

A needs assessment approach would complement other stated public policies, like meeting the needs of low-income households. Under this approach, the program operator issues Requests for Proposals to identify projects that meet offset and social justice requirements and hopeful recipients compete for offset funds. The City of San Francisco's local offset program that is currently under development is planning to follow this model.

Finally, in Berkeley, KyotoUSA is leading the way with its HELiOS solar schools program, which has obtained local donations to provide the gap financing required to install solar panels on Washington Elementary. Aside from providing gap financing to schools for solar installation, this method could translate into other gap financing opportunities, such as assisting local affordable housing developers with green affordable housing.

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[11] Additionality, verifiability, and measurability.

[12] Native Energy, http://www.nativeenergy.com/pages/additionality/38.php Project-specific additionality standards have their detractors. The principal concern is that strict insistence on the literal use of these standards can itself be a barrier to the rapid and widespread implementation of CO2 mitigation projects – conducting an additionality assessment using these tests, on a project-by-project basis, can be time consuming and costly, and in some cases can make the offset investment impossible. The question then becomes whether to use alternative standards that also serve the goal of rapid and widespread implementation of CO2 mitigation projects?

The tension at work in answering this question involves arriving at an optimum balance. The stringency of project-specific additionality standards produces inefficiencies that can prevent implementation of projects that would in fact meet the standards, but relaxing or departing from those standards necessarily results in crediting as additional some CO2 mitigation projects that are in fact, business as usual.

Voluntary Offset Market Size

Our analysis uses national per capita offset expenditures to estimate the potential local offset market's size.

The Ecosystems Marketplace report, *Foraging a Frontier*: *State of the Voluntary Carbon Markets 2008* estimates the global voluntary offset market at roughly $331million in 2007, based on an online survey of suppliers, brokers, and carbon credit accounting registries in the voluntary credit market. The U.S. share of those transactions was approximately 34% ($112 million) [13] or approximately $0.37 per capita current demand. However, offsets are a new concept in the U.S., and could grow rapidly as people and businesses become familiar with the process and want to offset their carbon emissions voluntarily. The Ecosystems Marketplace report estimates that the global voluntary offset market will grow to nearly 10 times its current size by 2012, to approximately $3.34 billion. Should the U.S. share of the market remain at 34%, it would result in $1.14 billion in transactions or a future per capita demand of $3.62 at current prices.[14]

In Berkeley, it is very likely that current purchases of offset credits are higher than the US average, but current information demonstrating local demand is not available. This likely strong local demand for voluntary carbon offsets could be demonstrated by the creation of a statistically significant survey of residents and business owners, and is recommended as a step in business planning for the program.

In the absence of primary data, this memorandum assumes that Berkeley resident demand matches U.S. averages; thus, current demand is estimated at roughly $38,800,[15] and 2012 demand would grow to at least $390,000.[16] Since Berkeley residents tend to be more oriented towards "green" issues, and also are more affluent than national norms,[17] using a national average to estimate the extent of the local offset demand may be too conservative. For example, assuming that Berkeley households would purchase credits at twice the national average rate, these estimates could increase to $77,600 today, and $780,000 by 2012. In addition, if the program was open to benefiting local non profits in the entire East Bay, local residents could demand up to $248,000 in offset purchases today. As emissions reduction is a regional problem, a regional program would increase both the potential market size, as well as the potential for emissions reduction. To better estimate the local market's potential, the City might consider surveying local residents and commercial and institutional buyers to determine their propensities for purchasing offsets and the importance of each offset criterion. The Table below shows the potential market sizes for a local offset program in 2007 and 2012.

[13] Ecosystems Marketplace. Foraging a Frontier: State of the Voluntary Carbon Markets 2008. May 8, 2008, page 14. Equals total voluntary market value ($331 million) times U.S.' share of market (34 percent).

[14] Determining the future value of the voluntary carbon offset market is a very imprecise exercise and should be approached cautiously. In 2006, the U.S. share of the global market was estimated to be 68%; in 2007, it fell to 34%. Once the U.S. signs an international climate agreement and/or the various States develop a cap and trade system, the value of voluntary carbon offsets will be affected by the introduction of a formal carbon market.

[15] City of Berkeley 2006 population from ABAG (104,895) times $0.37 per capita offset value.

[16] ABAG projected City of Berkeley 2012 population (107,950) times projected $3.62 per capita offset value.

[17] 2006 median household income in the U.S. was $48,201 (U.S. Census), compared to $51,256 in the City of Berkeley (U.S. Census)

However, providing that the program meets the additionality, verifiability, permanence, and measurability requirements that institutional and commercial buyers require, the local offset program's market size could be considerably higher. Institutional and commercial buyers represent 80 percent of the U.S. carbon offset market.[18] Since the University of California is committed to reducing its carbon emissions, and will likely purchase offset credits or RECs to meet its reduction goals, it represents a potentially extraordinary market demand source.

It should be noted that attracting local dollars to a local offset fund will mean competing with the myriad of national and international offset options. Because a local offset program would provide visible results and keep dollars within the local economy, this analysis assumes that the local program can capture the entire local market identified in the Table.

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[18] Ecosystems Marketplace. *Foraging a Frontier: State of the Voluntary Carbon Markets 2008.* May 8, 2008

Voluntary Carbon Offset Market Size, 2007 and 2012 (Projection)

	2007	2012
Total Transaction Volume – voluntary carbon credits (a)	65.1 MMT	551 MMT
Total Value of Global Voluntary Carbon Market (a)	$331,000,000	$3,342,000,000
U.S. Share of Voluntary Carbon Market's Value (b)	34%	34%
Value of U.S. Voluntary Carbon Market	$112,540,000	$1,136,280,000
U.S. Population (c)	301,621,151	314,281,098
Per Capita Offset Expenditures (d)	$0.37	$3.62
City of Berkeley Population (e)	104,895	107,735
Conservative Estimate of Berkeley's Share of Offset Market Value	$38,811	$390,000
Value Optimistic Estimate of Berkeley's Share (f)	$77,622	$780,000
East Bay Market Area (e), (g)	670,475	699,056
Conservative Estimate of East Bay's Share of Offset Market Value	$248,076	$2,530,583
Value: Optimistic Estimate of East Bay's Share (f)	$496,151	$5,061,165

Notes:

(a) Ecosystems Marketplace, 2008.

(b) According to Ecosystems Marketplace, U.S. offset purchases represent 34 percent of total OTC offset purchases in the global voluntary market.

(c) 2007 U.S. Census estimate and 2012 projection. Includes 50 states, District of Columbia, and Puerto Rico.

(d) Total value of residential users share of offset market divided by 2007 national population.

(e) 2006 population estimates and 2012 projections from ABAG.

(f) Based on local residents spending twice as much as the national average per capita.

(g) East Bay Market Area consists of residents from the following cities: Albany, Berkeley, Emeryville, Oakland, El Cerrito, and Richmond.

Sources: *Foraging a Frontier: State of the Voluntary Carbon Market, 2008* Ecosystems Marketplace, May, 2008; U.S. Census, 2007; ABAG, 2007; Bay Area Economics, 2007.

IV

Jobs, Emissions, Health Calculator

Key to cells:
Input information here
Key calculation

		Input
1. About the Renewable System	Cost of System	$1,000,000
	Size of Renewable System (MW)	0.1
	Efficiency Factor	20%
	Conversion to MWh / year	175

	Labor Type	**Amt. of System Costs to Labor**	**Overhead Portion**	**Type of Wage Effect** Direct	Indirect	Induced	Total
				1.00	*1.13*	*1.22*	
2. Portion of Expenditure to Local Wages	Mounting	13%	55%	$58,500	$0	$0	$58,500
	Electrical	13%	55%	$58,500	$0	$0	$58,500
	Design	3%	55%	$13,500	$0	$0	$13,500
	Wages related to supply purchases and employee purchases			$0	$16,965	$28,710	$45,675
	Total (One-time, wages)			**$130,500**	**$16,965**	**$28,710**	**$176,175**

	Labor Type	**Type of Employment Effect** Direct	Indirect	Induced	Total
		1.26	*0.2*	*0.4*	
3. Employment Impacts	Mounting	0.74	0.15	0.29	1.18
	Electrical	0.74	0.15	0.29	1.18
	Design	0.17	0.03	0.07	0.27
	Total (Job-years)	**1.64**	**0.33**	**0.66**	**2.63**

		Coal	**Natural Gas**	**Petroleum**	**Nuclear**	**Hydro-power**	**Other**	**Renew-ables**	**Total**
4. Sample Fuel Mix	National	49%	20%	2%	20%	7%	0%	2%	100%
	Selected States								
	California	16%	41%	0%	13%	19%	0%	11%	100%
	Colorado	75%	22%	0%	0%	2%	0%	1%	100%
	Indiana	95%	2%	0%	0%	0%	3%	0%	100%
	West Virginia	97%	0%	0%	2%	0%	0%	0%	100%
	Selected California Utilities								
	Southern California Edison (2007)	9%	48%	0%	21%	6%	0%	16%	100%
	Pacific Gas & Electric (2007)	2%	44%	0%	23%	17%	1%	13%	100%
	Sacramento Municipal Utility District (2007)	4%	60%	0%	1%	21%	0%	14%	100%
	LA Dept of Water and Power (2007)	47%	29%	0%	9%	7%	0%	8%	100%

			Coal	Natural Gas	Petroleum	Nuclear	Hydro-power	Other	Renew-ables		Total
5. MWh/ Year Reduced	Geography Grid Fuel Mix	LADPW	47%	29%	0%	9%	7%	0%	8%		100%
	MWh/ year reduced, by source		82	51	0	16	12	0	14		175

	Emission		**Coal**	**Natural Gas**	**Petroleum**	**Nuclear**	**Hydro-power**	**Other**	**Renew-ables**		
6. Emissions Factors: Pounds per MWh Reduction	CO_2		2,155	1,042	1,980	See note 1.					
	NO_x		7.75	1.9	4.9	See note 1.					
	SO_2		46.6	0	14.9	See note 1.					
Pounds per Gigawatt	Hg (Mercury)		0.105	0.001	0.005	See note 1.					

	Emission		**Coal**	**Natural Gas**	**Petroleum**	**Nuclear**	**Hydro-power**	**Other**	**Renew-ables**		**Total**
7. Emissions in Pounds Reduced per Year, due to Renewable System	**CO_2**		**177,451**	**52,942**	**0**						**230,393**
	NO_x		**638**	**99**	**0**						**737**
	SO_2		**3,837**	**0**	**0**						**3,837**
Pounds per Gigawatt	**Hg (Mercury)**		**0.008605**	**0.000051**	**0.000000**						**0.009**

		Per Megawatt	**Total for System**
8. Health Impacts	**<u>Cases Reduced per Year</u>**		
	Mortality	0.004	0.0003
	Chronic Bronchitis	0.003	0.0002
	Heart Attacks	0.007	0.0005
	Hospital Admissions - Respiratory	0.002	0.0002
	Hospital Admissions - Cardiovascular	0.002	0.0001
	Emergency room visits, Asthma	0.005	0.0004
	Acute Bronchitis	0.007	0.0005
	Lower Respiratory Symptons	0.079	0.0060
	Upper Respiratory Symptons	0.064	0.0048
	Work Loss Days	0.508	0.0386
	Minor Restricted Activity Days	3.488	0.2651

[1] Despite emitting no GHGs or air pollutants, Power Scorecard assigned Nuclear energy the highest environmental impact score of all power sources because its solid waste storage requirement is estimated to be 10,000 years.

	Notes to Calculator
1. About the Renewable System	Description Input information about the system in the highlighted cells. Key calculation in section is the total megawatt hours per year projected from the system.
2. Portion of Expenditure to Local Wages	Description Based on the total cost of the system, calculates amount of wages to local labor. References "System Costs to Labor" sourced from: U.S. Department of Energy, "Energy Efficiency and Renewable Energy Solar Energy Technologies Multi-Year Technical Plan, 2003-2007 and Beyond" document Wage effect relies on county-level data from IMPLAN (Minnesota IMPLAN Group); Mounting, Electrical, and Design assumed to be local labor
3. Employment Impacts	Description Calculates the total number of estimated one-time, local jobs.
4. Sample Fuel Mix	Description Reflects fuel mix for selected utilities shown. May use the fuel mix selected, or may shown 100% of one fuel-type being dispaced by the system. Our findings indicate that Natural Gas is the most likely type of fuel to be displaced, due to its cost and use during peak energy usage events.
5. MWh/ Year Reduced	Description Calculates megawatt hours of each fuel displaced, due to the system.
6. Emissions Factors: Pounds per MWh Reduction	Description Average emissions from the various fuel sources. References Power Scorecard is the primary source of information for the emissions estimates. More information here: http://www.powerscorecard.org/ See Methodology publication, September 22, 2000 revised February 1, 2005.
7. Emissions in Pounds Reduced per Year, due to Renewable System	Description Calculation results, pounds reduced of pollutants.
8. Health Impacts	Description Avoided health impacts due to the displacement of fossil fuel electricity sources with PV solar. The calculation is based on a study which reviewed emissions from electricity generated 75% from Natural Gas and 25% from Coal. More coal-heavy fuel mixtures will have greater health impacts than those calculated here while mixtures with more Natural Gas will have less of a health impact than that estimated here. References See the National Renwable Energy Laboratory's August 2007 publication: "Energy, Economic, and Environmental Benefits of the Solar America Initiative"

Geographies Database for Calculator

Do not erase:	Column #	1	2	3	4	5	6	7	8	9
				Coal	Natural Gas	Petroleum	Nuclear	Hydro-power	Other	Renew-ables
		California		16%	41%	0%	13%	19%	0%	11%
		Colorado		75%	22%	0%	0%	2%	0%	1%
		Free A		0%	0%	0%	0%	0%	0%	0%
		Free B		0%	0%	0%	0%	0%	0%	0%
		Free C		0%	0%	0%	0%	0%	0%	0%
Must be in Alpha.		Free D		0%	0%	0%	0%	0%	0%	0%
Order to Function		Indiana		95%	2%	0%	0%	0%	3%	0%
Properly		LADPW		47%	29%	0%	9%	7%	0%	8%
		National Ave.		49%	20%	2%	20%	7%	0%	2%
		PG&E		2%	44%	0%	23%	17%	1%	13%
		SMUD		4%	60%	0%	1%	21%	0%	14%
		SoCal Edison		9%	48%	0%	21%	6%	0%	16%
		West Virginia		97%	0%	0%	2%	0%	0%	0%