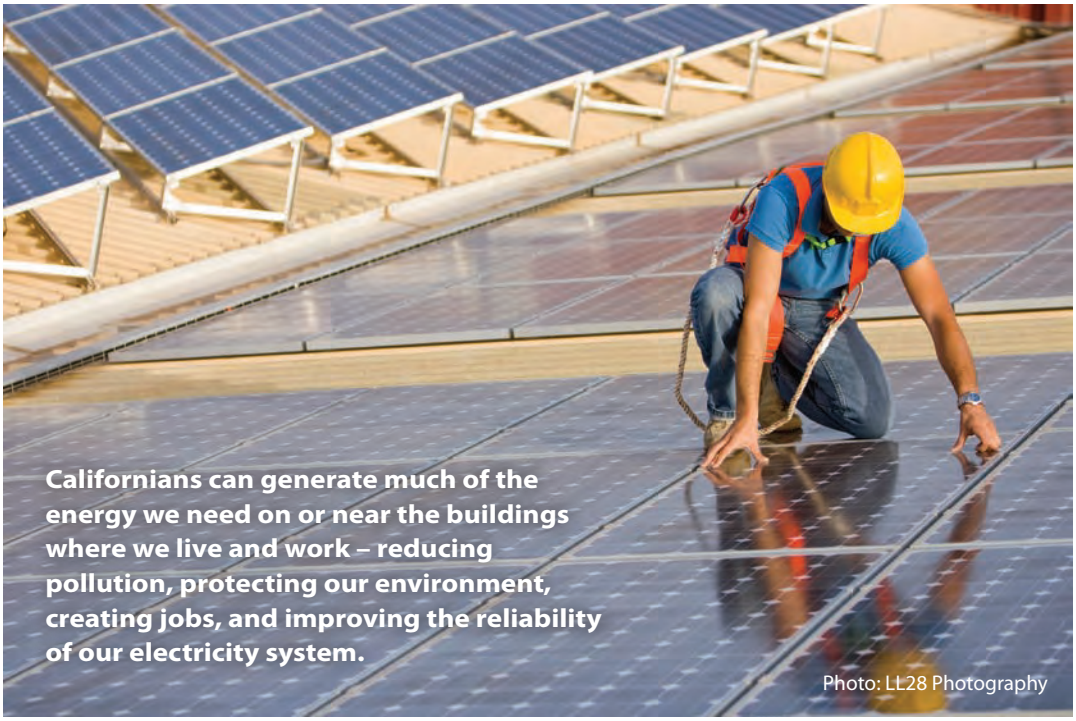
Clean, Localized, Renewable Energy Can Power California

Too much of our energy comes from dirty sources that harm our environment. By efficiently using the power of the sun, the wind and the earth, we can repower our lives with clean energy that never runs out. Moreover, we can generate much of the energy we need on or near the buildings where we live and work.



Californians can generate much of the energy we need on or near the buildings where we live and work – reducing pollution, protecting our environment, creating jobs, and improving the reliability of our electricity system.

Photo: LL28 Photography

Localized – or "distributed" – energy offers important benefits for society. Localized energy technology reduces the need to build large power plants, lessens the need to drill for oil and gas, reduces the need to upgrade transmission line infrastructure, and increases the overall efficiency of our electricity system. Localized energy systems can be installed much more quickly than traditional power stations and they can be tailored to suit the needs of individual buildings, institutions, or communities.

Recognizing these benefits, Governor Jerry Brown has proposed that California install a cumulative total of 12 gigawatts of clean, localized energy generation technology around the state by the end of the decade as part of a "Clean Energy Jobs Plan." Achieving this goal can help reduce air pollution in California, accelerate the rate of progress toward our goal of generating a third of our electricity from renewable sources of energy by 2020, create local jobs, and increase the resilience and reliability of our overall energy system.

California should adopt big, bold policies to accomplish this goal, greatly expanding the use of renewable sources of energy – including solar, wind, biomass and geothermal – and excluding technologies that rely on fossil fuels or exacerbate air pollution.

About These Factsheets

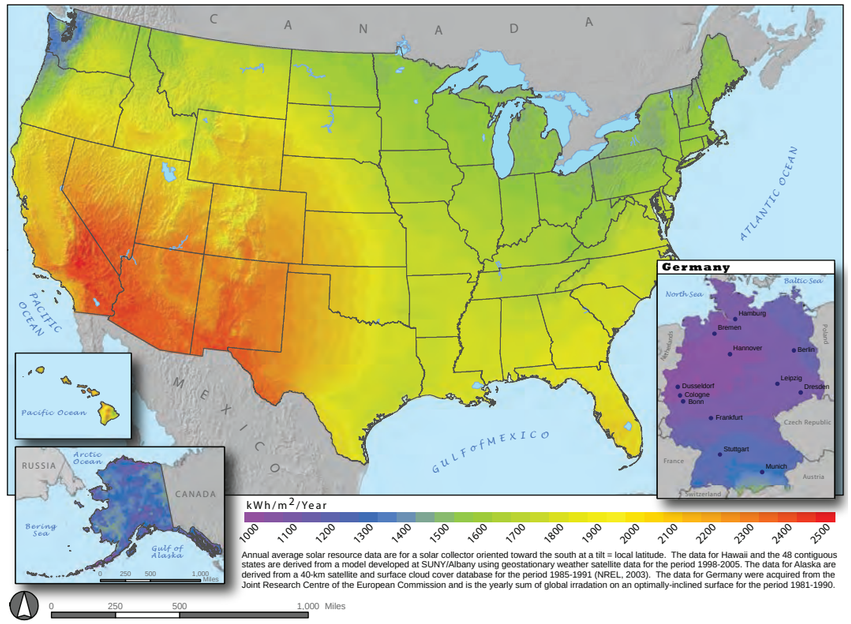
Environment California Research & Policy Center prepared this series of factsheets to provide information about local energy technologies that are well-suited to help California reduce its dependence on fossil fuels and achieve a clean energy future. Each factsheet describes technologies that use energy from the sun, the wind, the earth, or plant matter to generate heat or electricity on or near the buildings and factories where we live and work. The factsheets also provide examples of how these technologies are already contributing to California's clean energy goals. Finally, the factsheets provide recommendations for accelerating future clean energy progress. The full set of factsheets can be found online at www.environmentcaliforniacenter.org.

For more information, contact Michelle Kinman, Clean Energy Advocate, at (213) 251-3688 ext. 325, or michelle@environmentcalifornia.org.

Environment California
Research & Policy Center
3435 Wilshire Blvd., #385
Los Angeles, CA 90010

www.environmentcaliforniacenter.org

Credit: NREL



California's Solar Energy Resources Are Exceptional

California Can Install 12 Gigawatts of Local Clean Energy

Twelve gigawatts of power would meet the annual electricity needs of at least 3 million typical California homes.[1] That is a lot of power, but California has ample clean energy resources to meet the challenge. Germany – a country that has made a massive national commitment to solar power – installed almost 15 gigawatts of solar photovoltaic panels in just two years (2010 and 2011), and most of it was in the form of small-scale rooftop installations.[2] The sun shines on rooftops in California for far longer over the course of the year than it does in Germany, meaning that California should be able to exceed Germany when it comes to deploying local renewable energy.

California Has Ample Local Clean Energy Resources

California can generate local, clean electricity and heat using sunlight, the wind, the heat of the earth, and sustainably harvested crop wastes and other biomass resources.

- California's rooftops could hold enough solar panels to generate the equivalent of more than a third of the electricity we use in a year, statewide.[3] Solar panels adjacent to farmland, above parking lots or along highways could provide even more energy.
- Local-scale wind turbines at sites with low wind speeds could generate another third of California's annual electricity needs.[4]
- Experts estimate that full deployment of residential and commercial solar water heating systems could reduce statewide natural gas consumption by 1.2 billion therms per year, the equivalent of 24 percent of all gas used in California homes.[5]
- The natural heat of the earth could reduce the heating and cooling energy consumption of California buildings by about 40 percent.[6]
- Existing biomass energy resources, including crop and forestry wastes, and gas produced from food processing, could technically generate up to 13 percent of California's annual electricity needs.[7]

Photo: Gills Onions

Many Local Renewable Energy Technologies Can Contribute to a Clean Energy Future

Solar photovoltaic panels turn light into electricity. For example, solar panels help power four water treatment facilities for the Inland Empire Utilities Agency, generating more than 10 percent of the agency's annual electricity needs while preventing pollution equivalent to the emissions of 19,000 cars.

Solar thermal energy systems use solar energy to provide heating or cooling. For example, Sonoma Wine Company in Graton uses a hybrid electric-thermal solar energy system to meet about half of its hot water needs and 30 percent of its electricity.

Localized wind turbines turn the motion of the wind into electricity. For example, the Anheuser-Busch Brewery in Fairfield runs with the help of a large on-site wind turbine, and the Palmdale Sam's Club is partially powered by small turbines mounted on top of light poles in the parking lot. Together, these turbines annually prevent more global warming pollution than the emissions of more than 400 passenger vehicles.

Geothermal heat pumps use the constant temperature of the earth beneath our feet to provide heating or cooling for buildings – such as the Joint Use Facility at the City College of San Francisco's Ocean Campus.

Clean biomass power systems transform plant matter into electricity and/or heat. For example, Gills Onions in Oxnard powers its processing plant with electricity generated by fuel cells using gas produced from leftover onion scraps – saving the company more than $1 million per year on power and waste disposal costs while preventing as much global warming pollution as the annual emissions of nearly 3,000 passenger cars.

Photo: SunPower Corp.

Photo: Cogenra

Photo: Sam's Club

Photo: Bruce Damonte, ARCHITECTURE/vbn and Pfau-Long

Recommendations to Accelerate Local Clean Energy Development

California should adopt big, bold, market-transforming policies to drive the installation of 12 gigawatts of local clean energy generation capacity. The policies should include a broad range of renewable energy sources, including solar, wind, biomass and geothermal. Local clean energy programs should prioritize installations that are under 5 megawatts in size, and primarily generate electricity and/or heat for consumption on-site or nearby; and exclude technologies that rely on fossil fuels or would worsen California's air pollution problems. Specific steps include:

- Adopt a strong feed-in-tariff policy and expand net-metering programs to allow more Californians to benefit from local clean energy generation.
- Increase the use of solar and other local clean energy systems in new construction through a net-zero energy building code requirement.
- Simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation.
- Expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.

Photo: Foundation Windpower

[1] This value depends on both the specific technology deployed as well as the quantity of the energy resource available at a given location. For example, 12 gigawatts of solar PV in California would operate at an annual capacity factor of about 18 percent, producing about 19 billion kWh of electricity per year. That is enough to meet the annual needs of about 3 million typical California homes, per U.S. Department of Energy, Energy Information Administration, *Number of Retail Customers by State by Sector, Back to 1990 (Form EIA-861), and Retail Sales of Electricity by State by Sector by Provider, Back to 1990 (Form EIA-861),* downloaded from 205.254.135.7/electricity/data.cfm#sales on 7 March 2012. Including technologies with higher capacity factors would increase the amount of energy that 12 gigawatts of capacity could produce.

[2] German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, *Zeitreihen zur Entwicklung der Erneuerbaren Energien in Deutschland [Time Series of the Development of Renewable Energy in Germany],* 8 March 2012. Solar energy penetration in Germany is now higher than 3 percent of total annual electricity supply, compared to roughly 0.6 percent in California. See "German Solar Power Output up 60 Pct in 2011," *Reuters*, 29 December 2011.

[3] Beginning with 80GW of rooftop solar PV potential, per: J. Paidipati et al, Navigant Consulting, Inc. for the National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios,* Subcontract Report NREL/SR-581-42306, February 2008; and assuming that an average 1kW system generates more than 1,100 kWh of electricity per year, compared to California's annual usage of about 270 million MWh of electricity, per U.S. Energy Information Administration, *State Electricity Profiles: California,* DOE/EIA-0348(01)/2, April 2011. 80 GW of solar PV would cover more than half of statewide peak summer electricity demand. (Capacity credit of at least 50 percent, approximated based on Richard Perez & Thomas E. Hoff, Clean Power Research, *Energy and Capacity Valuation of Photovoltaic Power Generation in New York,* March 2008; vs. California statewide peak demand of about 65 GW, per California Energy Commission, *California Energy Demand 2010-2020, Adopted Forecast,* December 2009.

[4] The California Energy Commission estimated that wind turbines at 30m height on suitable land area in California with low wind speeds could technically generate more than 100 million MWh of electricity per year, per Dora Yen-Nakafuji, California Energy Commission, *California Wind Resources,* CEC-500-2005-071-D, Presented at Intra-state IEPR Workshop, Sacramento, CA, 9 May 2005; compared to California's annual usage of about 270 million MWh per note 3.

[5] Bernadette Del Chiaro and Timothy Telleen-Lawton, Environment California Research & Policy Center and Frontier Group, *Solar Water Heating: How California Can Reduce Its Dependence on Natural Gas*, April 2007.

[6] Mark Mizrahi, EnLink Geoenergy Services, Inc., "The Large Potential of Geothermal Heat Pump Systems," *CleanTechnica.com,* 3 December 2010.

[7] Bryan M. Jenkins et al, "Sustainable Use of California Biomass Resources Can Help Meet State and National Bioenergy Targets," *California Agriculture* 63(4):168-177, DOI: 10.3733/ca.v063n04p168, October-December 2009.

Solar Photovoltaic Electricity

California can build a clean energy future based on the efficient use of clean energy sources that do not pollute and will never run out, like the sun. Every bit of solar energy we capture reduces the need for dirty, unsafe energy sources like coal, gas or nuclear power.

Solar photovoltaic electricity will be a critical component of meeting Governor Brown's goal of installing 12 gigawatts of localized renewable energy generation. Solar technology is perfectly suited to generate pollution-free electricity on or near the buildings where we live and work.

Credit: NREL

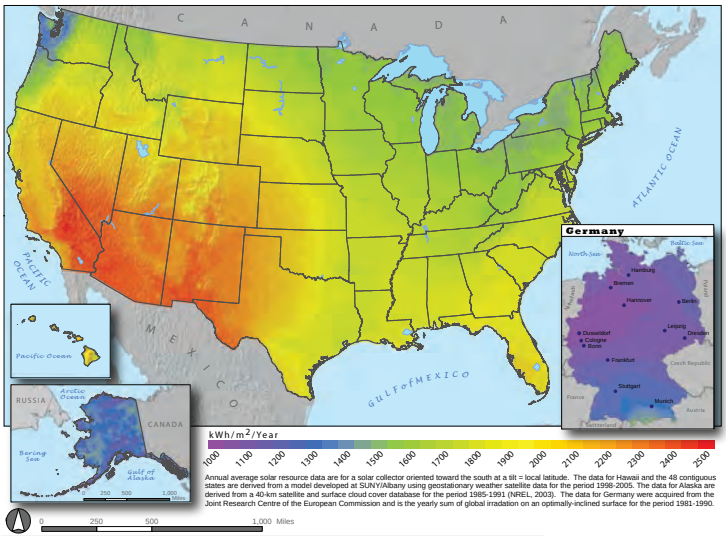


Figure 1: California's Solar Energy Resources Are Exceptional

Sunlight Is Virtually Limitless

Solar power makes sense for California. Solar energy takes advantage of a resource that is clean, safe and ubiquitous, and which California has in virtually limitless abundance: sunlight. (See Figure 1.) California's rooftops could hold enough solar panels to generate the equivalent of more than a third of the electricity we use in a year, statewide.[1] Despite the rapid growth of California's solar market, we have barely begun to tap into the state's vast potential for solar energy.

Kyocera Solar, Inc. installed solar panels on top of "solar trees" planted to cover the parking lot outside of its San Diego headquarters. The panels produce enough electricity to power more than 60 typical California homes for a year.[2]

Solar Photovoltaic Technology Turns Sunlight into Electricity

Solar photovoltaic (PV) panels capture the energy in sunlight and turn it into electricity. Solar PV technology is ideally suited for localized use. The panels are modular and can be installed anywhere with suitable exposure to sunlight. Rooftops make ideal locations, but solar panels can also be installed above parking lots, on utility poles, along highways, on top of water storage ponds, in brownfields, and in other locations. The solar industry is rapidly developing new innovations, including solar roofing shingles, solar siding, solar window lamination, and more.

During sunny weather, solar panels can serve local electricity needs or feed power to other nearby electricity users. During cloudy weather or at night, other sources of electricity generation take over. Since solar panels tend to produce their peak output during hot summer days when demand for electricity also tends to be the highest, they help increase the reliability of electricity service.

The Inland Empire Utilities Agency provides water for nearly a million Californians in San Bernardino County, with the help of solar panels at four of its water treatment facilities. The panels produce more than 10 percent of the agency's annual electricity needs while saving a half million dollars a year. At the same time, the panels prevent pollution – equivalent to the emissions of roughly 19,000 cars.[4]

SunWheel Energy Partners installed this solar energy system at Hayes Valley, a multi-family housing complex in San Francisco, in 2009. The panels generate enough electricity to power nearly 50 typical California homes and prevent global warming pollution at a level equivalent to using 16,000 fewer gallons of gasoline per year.[5]

Photo: SunWheel Energy Partners / McCormack Baron Salazar

California's Solar Industry Is Taking Off

California is building a strong and sustainable solar industry. In 2011, California was home to about 20 percent of all solar companies in the United States. More than 3,500 firms are active in California's solar industry, employing more than 25,000 people.[6] The addition of a million residential solar energy systems would add about $30 billion to the state economy and create more than 20,000 new jobs.[7]

Recommendations to Accelerate Local Clean Energy Development

California should adopt big, bold, market-transforming policies to drive the installation of 12 gigawatts of local clean energy generation capacity. The policies should include a broad range of renewable energy sources, including solar, wind, biomass and geothermal. Local clean energy programs should prioritize installations that are under 5 megawatts in size, and primarily generate electricity and/or heat for consumption on-site or nearby; and exclude technologies that rely on fossil fuels or would worsen California's air pollution problems. Specific steps include:

- Adopt a strong feed-in-tariff policy and expand net-metering programs to allow more Californians to benefit from local clean energy generation.
- Increase the use of solar and other local clean energy systems in new construction through a net-zero energy building code requirement.
- Simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation.
- Expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.

For more information, contact Michelle Kinman, Clean Energy Advocate, at (213) 251-3688 ext. 325, or michelle@environmentcalifornia.org.

Environment California Research & Policy Center
3435 Wilshire Blvd., #385, Los Angeles, CA 90010

www.environmentcaliforniacenter.org

San Ramon Valley Unified School District has installed solar photovoltaic panels at five campuses located in San Ramon and Danville – including the parking shade pictured here. Over the next 25 years, the school district will save an estimated $24.4 million by generating electricity locally, while also preventing more than 76 million pounds of global warming pollution.[3]

Photo: SunPower Corp.

---

[1] Beginning with 80GW of rooftop solar PV potential, per: J. Paidipati et al, Navigant Consulting, Inc. for the National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios,* Subcontract Report NREL/SR-581-42306, February 2008; and assuming that an average 1kW system generates more than 1,100 kWh of electricity per year, compared to California's annual usage of about 270 million MWh of electricity, per U.S. Energy Information Administration, *State Electricity Profiles: California,* DOE/EIA-0348(01)/2, April 2011.

[2] Kyocera Solar, Inc., *Success Stories: Solar Grove, San Diego, California,* downloaded from www.kyocerasolar.com/commercial-solutions/success-stories/?id=5 on 12 March 2012.

[3] SunPower Corp., *San Ramon Valley Unified School District Goes Solar to Save Big with SunPower* (factsheet), October 2011.

[4] SunPower Corp., *Inland Empire Utilities Agency Saves Approximately $500,000 in Annual Energy Costs with SunPower Solar Solution* (factsheet), April 2009.

[5] Sunwheel Energy, *Sample Projects,* downloaded from sunwheelenergy.com/projects.html on 17 April 2012. Converted kWh to home consumption by comparing reported annual generation with the average annual electricity usage of a residential customer in California per, U.S. Department of Energy, Energy Information Administration, *Number of Retail Customers by State by Sector, Back to 1990 (Form EIA-861), and Retail Sales of Electricity by State by Sector by Provider, Back to 1990 (Form EIA-861),* downloaded from 205.254.135.7/electricity/data.cfm#sales on 7 March 2012. Electricity generation converted to global warming emissions using the non-baseload emission rate for carbon dioxide pollution in California from 2007, per U.S. Environmental Protection Agency, *eGRID2010 Version 1.1,* 20 May 2011. Gasoline equivalency per U.S. Environmental Protection Agency, *Greenhouse Gas Equivalencies Calculator,* available at www.epa.gov/cleanenergy/energy-resources/calculator.html.

[6] The Solar Foundation, *National Solar Jobs Census 2011: A Review of the U.S. Solar Workforce,* October 2011.

[7] Alexander Quinn, Christine Safriet, and Christopher Clement, AECOM, *Economic and Fiscal Impact Analysis of Residential Solar Permitting Reform*, July 2011.

Localized Wind Power

ENVIRONMENT CALIFORNIA
RESEARCH & POLICY CENTER

California can build a clean energy future based on the efficient use of clean energy sources that do not pollute and will never run out, like the wind. Every gust of wind energy we capture reduces the need for dirty, unsafe energy sources like coal, gas or nuclear power.

Wind turbines will be an important component of meeting Governor Brown's goal of installing 12 gigawatts of localized renewable energy generation in California by 2020. Small wind turbines in particular are well-suited to generate electricity near the buildings where we live and work.

California Has Massive Potential for Local Wind Power

The wind blowing across California contains a large amount of energy. In 2005, the California Energy Commission estimated that smaller wind turbines at sites with low wind speeds could generate the equivalent of more than a third of the electricity we use in a year, statewide.[1]

Wind Turbines Generate Clean Electricity

Wind turbines transform wind energy into cheap and clean electricity. Local wind energy installations can range from very large turbines placed near a large electricity consumer, such as a factory, to small turbines placed near a home or a warehouse. Local wind turbines produce electricity that customers would otherwise have to buy from a utility at full retail prices, making them economically competitive sources of electricity in many regions of California.

Wind power produces pollution-free electricity. Moreover, every megawatt of small wind generation capacity installed creates approximately 50 full-time jobs in the United States, with at least 30 percent of the economic impact benefiting local small businesses.[2]

Photo: Sam's Club

These small wind turbines, perched on top of light posts in the Palmdale Sam's Club parking lot, generate clean, renewable electricity. The company estimates that the 17 turbines will produce enough electricity each year to power more than 11 typical California homes.[3]

Photo: Foundation Windpower

This large wind-turbine provides clean, renewable power for the Anheuser-Busch Brewery in Fairfield. On a net annual basis, the turbine produces about 20 percent of the electricity needed at the plant, on site.[4] If that electricity were instead purchased from the state electricity grid, it would produce nearly 3 million pounds of global warming pollution – the annual emissions of more than 400 passenger cars.[5]

Photo: Adobe Systems, Inc.

In 2010, Adobe Incorporated installed 20 Windspires to demonstrate on-site renewable electricity generation at its corporate headquarters in San Jose.[6] The aesthetic turbines rotate on a vertical axis when the wind blows, generating electricity for its three office towers. The company estimates that the 20 turbines will generate about 48,000 kilowatt-hours of electricity a year, or enough to power about 10 average California homes.[7]

Photo: NREL

Small wind turbines work at the backyard scale as well. For example, the City of Berkeley installed this wind turbine at its Shorebird Park Nature Center in 2007. The turbine captures wind from San Francisco Bay to power the center's Green Classroom, providing as much as 80 percent of the building's needs.[8]

Recommendations to Accelerate Local Clean Energy Development

California should adopt big, bold, market-transforming policies to drive the installation of 12 gigawatts of local clean energy generation capacity. The policies should include a broad range of renewable energy sources, including solar, wind, biomass and geothermal. Local clean energy programs should prioritize installations that are under 5 megawatts in size, and primarily generate electricity and/or heat for consumption on-site or nearby; and exclude technologies that rely on fossil fuels or would worsen California's air pollution problems. Specific steps include:

- Adopt a strong feed-in-tariff policy and expand net-metering programs to allow more Californians to benefit from local clean energy generation.
- Increase the use of solar and other local clean energy systems in new construction through a net-zero energy building code requirement.
- Simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation.
- Expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.

For more information, contact Michelle Kinman, Clean Energy Advocate, at (213) 251-3688 ext. 325, or michelle@environmentcalifornia.org.

Environment California Research & Policy Center
3435 Wilshire Blvd., #385, Los Angeles, CA 90010

www.environmentcaliforniacenter.org

[1] The California Energy Commission estimated that wind turbines at 30m height on suitable land area in California with low wind speeds could technically generate more than 100 million MWh of electricity per year, per Dora Yen-Nakafuji, California Energy Commission, *California Wind Resources,* CEC-500-2005-071-D, Presented at Intra-State IEPR Workshop, Sacramento, CA, 9 May 2005; compared to California's annual usage of about 270 million MWh of electricity, per U.S. Energy Information Administration, *State Electricity Profiles: California,* DOE/EIA-0348(01)/2, April 2011.

[2] American Wind Energy Association, *2010 U.S. Small Wind Turbine Market Report,* October 2011.

[3] Sam's Club, *Winds of Change Blowing at Sam's Club in Palmdale* (press release), 29 April 2010. More than 11 homes: comparing annual generation of the turbines (76,000 kWh) with the average annual electricity usage of a residential customer in California per, U.S. Department of Energy, Energy Information Administration, *Number of Retail Customers by State by Sector, Back to 1990 (Form EIA-861), and Retail Sales of Electricity by State by Sector by Provider, Back to 1990 (Form EIA-861),* downloaded from 205.254.135.7/electricity/data.cfm#sales on 7 March 2012.

[4] Barry Eberling, "Fairfield Brewery Gets Mammoth Wind Turbine to Power Plant," *Daily Republic,* 21 October 2011.

[5] Assuming a 33 percent capacity factor at the 950 kW turbine. Greenhouse gas equivalency per U.S. Environmental Protection Agency, *Greenhouse Gas Equivalencies Calculator,* available at www.epa.gov/cleanenergy/energy-resources/calculator.html.

[6] Adobe Incorporated, *20 Windspire Wind Turbines Create Renewable Energy at Silicon Valley Headquarters* (press release), 15 March 2010.

[7] Michael Kanellos, "Adobe: An Early Test Case for Manure, Fuel Cells and Small Wind," *Greentech Enterprise,* 6 January 2010.

[8] Interstate Renewable Energy Council, "City of Berkeley Installs its First Wind Turbine," *Small Wind Newsletter,* October 2007.

Geothermal Energy

California can build a clean energy future based on the efficient use of clean energy sources that do not pollute and will never run out, like the natural heat of the earth. Every bit of natural energy we capture reduces the need for dirty, unsafe energy sources like coal, gas or nuclear power.

At the local level, geothermal technology can be used to heat and cool buildings, helping to reduce California's overall demand for electricity as well as natural gas. Geothermal energy offers many of the same benefits as localized electricity generation, including reduced need for centralized power plants or transmission lines, less pollution, and less need to drill for natural gas.

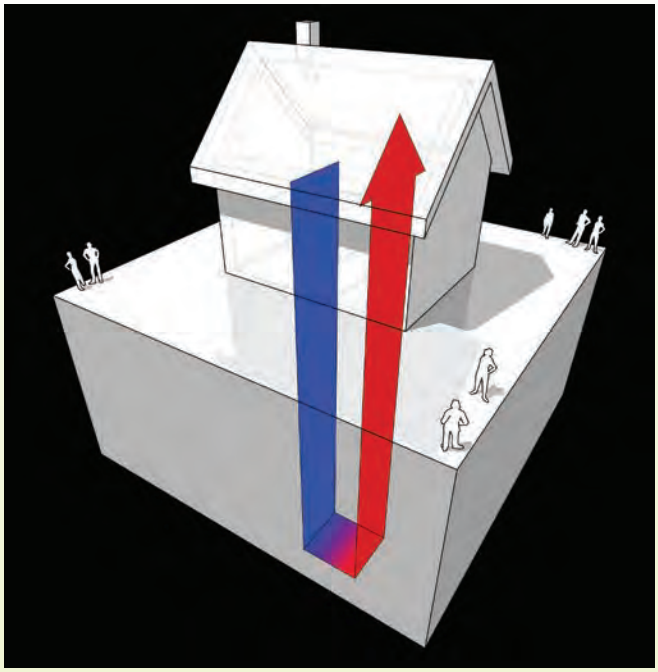
Photo: Bruce Damonte, ARCHITECTURE/vbn and Pfau-Long

Geothermal heat pumps provide renewable energy for homes and institutional buildings across California. For example, the City College of San Francisco and San Francisco State University incorporated a geothermal heat pump system beneath the Joint-Use Facility on its Ocean Campus in 2009 (see photo). The system heats and cools more than 300,000 square feet of building space. The heat pump is so effective that engineers did not plan any natural gas lines to the building.[4]

California Has Massive Geothermal Energy Resources

The ground beneath our feet contains an extraordinary amount of heat energy. Buildings anywhere in California can use that energy to maintain a comfortable indoor temperature or provide hot water using geothermal heat pump technology. A geothermal heat pump system in a typical building could reduce local consumption of electricity and natural gas by 40 percent or more.[1]

Geothermal heat pump technology could become an important part of California's energy supply. Equipping two million homes with geothermal heat pump systems would provide about the same amount of useful energy as one of the massive nuclear reactors at San Onofre.[2] Heat pump technology has been available for more than 50 years, but U.S. installations currently make up just 1 percent of the national heating and cooling market.[3]



Geothermal heat pumps take natural heat from the earth and use it to heat air or water inside a building, or cool the air inside a building by depositing excess heat in the ground.

Credit: Slavomir Valigursky

Geothermal Technologies Save Electricity and Natural Gas

The temperature of the earth just beneath our feet is constant at around 50 to 55 degrees, year round. Geothermal heat pumps use the natural temperature of the earth to warm homes when it is cold and cool them when it is warm, or to heat water. Geothermal heat replaces electricity or gas typically required for these tasks, reducing the need to supply power from far-off power plants as well as reducing the need to drill for natural gas.

Photo: City of Sacramento Planning Department

In Sacramento, developer Jeremy Drucker used geothermal heat pump technology within a nine-unit green housing project called Nine on F, which won recognition by the U.S. Green Building Council. The heat pump system contributes to dramatically reduced energy bills for local residents – on the order of 75 percent lower than conventional homes. Genevieve Shiroma, director of the Sacramento Municipal Utilities District, told the **Sacramento Bee** ***that local clean energy technologies like those deployed at Nine on F "mean we don't have to build new power plants that run on fossil fuel."[5] And that means better public health and a more stable environment.***

Recommendations to Accelerate Local Clean Energy Development

California should adopt big, bold, market-transforming policies to drive the installation of 12 gigawatts of local clean energy generation capacity. The policies should include a broad range of renewable energy sources, including solar, wind, biomass and geothermal. Local clean energy programs should prioritize installations that are under 5 megawatts in size, and primarily generate electricity and/or heat for consumption on-site or nearby; and exclude technologies that rely on fossil fuels or would worsen California's air pollution problems. Specific steps include:

- Adopt a strong feed-in-tariff policy and expand net-metering programs to allow more Californians to benefit from local clean energy generation.
- Increase the use of solar and other local clean energy systems in new construction through a net-zero energy building code requirement.
- Simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation.
- Expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.

For more information, contact Michelle Kinman, Clean Energy Advocate, at (213) 251-3688 ext. 325, or michelle@environmentcalifornia.org.

Environment California Research & Policy Center
3435 Wilshire Blvd., #385, Los Angeles, CA 90010

www.environmentcaliforniacenter.org

[1] Mark Mizrahi, The Large Potential of Geothermal Heat Pump Systems, *CleanTechnica.com,* 10 December 2010.

[2] Retrofitting a single home with a geothermal heat pump system would save on average about 35 million BTU of source energy. (Calculated based on Xiaobing Lu, Oak Ridge National Laboratory, *Assessment of National Benefits from Retrofitting Existing Single-Family Homes with Ground Source Heat Pump Systems*, ORNL/TM-2010/122, June 2010, which identified 661 trillion BTU of technical savings potential and about 18 million eligible homes in the western census division). One of the 1,127 MW reactors at San Onofre, operating at 83 percent capacity, would produce about 78 trillion BTU over the course of a year at a heat rate of 9,940 BTU per kWh (per Tetra Tech, *California's Coastal Power Plants: Alternative Cooling System Analysis,* Chapter 7N – San Onofre Nuclear Generating Station, March 2008.

[3] Pike Research, *Geothermal Heat Pump Shipments to Double in Volume to 326,000 Units Annually in the United States by 2017* (press release), 26 July 2011.

[4] Meline Energy, City College of San Francisco: *Geothermal Ground Heat Exchanger: Third Party Design Review & Construction Oversight* (factsheet), downloaded from www.meline.com/city_college.htm on 12 March 2012.

[5] Mary Lynne Vellinga, "Environmental Houses Hailed in Downtown Sacramento," *Sacramento Bee*, 9 March 2008.

Solar Thermal Power

ENVIRONMENT CALIFORNIA
RESEARCH & POLICY CENTER

California can build a clean energy future based on the efficient use of clean energy sources that do not pollute and will never run out, like the sun. Every bit of solar energy we capture reduces the need for dirty, unsafe energy sources like coal, gas or nuclear power.

Solar thermal power technology can create both heat and electricity, helping to increase the amount of local, clean energy generation in California. Solar thermal energy systems placed on or near the buildings where we live and work can reduce the need for fossil-fueled power plants and gas drilling rigs, while helping to cut emissions of global warming and smog-forming pollution.

Sunlight Is Virtually Limitless

Solar power makes sense for California. Solar technology takes advantage of a resource that is clean, safe and ubiquitous, and which California has in virtually limitless abundance: sunlight. (See Figure 1.) In fact, the sunlight falling on California every year contains more than enough energy to meet America's entire electricity needs.[1] Experts estimate that full deployment of residential and commercial solar water heating systems could reduce statewide natural gas consumption by 1.2 billion therms per year, the equivalent of 24 percent of all gas used in California homes.[2]

Solar Thermal Technology Can Deliver Both Heat and Electricity

Photovoltaic panels are not the only way buildings can put solar energy to work. In contrast, solar thermal technology directly captures the energy of the sun in the form of heat. Collected heat can be used to provide hot water, space heating, air conditioning, and electricity for buildings.

Solar heat energy collectors are the workhorse of solar technology, efficiently capturing as much as 87 percent of the energy in sunlight.[4] Solar heat collectors can be as simple as a series of black tubes, or they can incorporate special mirrors that track the sun throughout the day, focusing and concentrating solar energy. Some new designs even mix solar thermal and solar photovoltaic technology to produce electricity and useful heat at the same time.

Solar thermal collectors can be mounted almost anywhere with good exposure to sunlight, whether on top of a roof or on the ground. Many solar thermal technologies are modular, and their size can be tailored precisely to localized needs. The heat that comes from solar thermal collectors can be stored in an insulated tank, and used even after the sun goes down or when clouds pass overhead, making solar thermal technology a potentially effective complement to other types of distributed renewable energy, like wind or solar photovoltaic power.

Credit: Sopogy

Southern California Gas Company uses solar thermal energy to air condition its Energy Resource Center building in Downey. The company is testing two kinds of solar thermal air conditioning systems, which heat water to nearly 200° F, feed the hot water through an absorption chiller, and then run the resulting cool water through the building's fans.[5] The systems replace electricity or gas that would otherwise provide air conditioning.

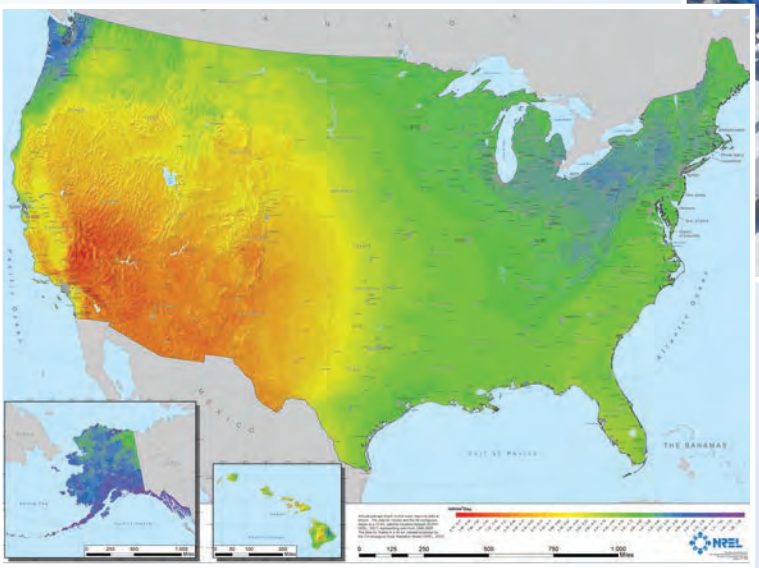


Figure 1: California Has Exceptional Solar Thermal Energy Resources[3]

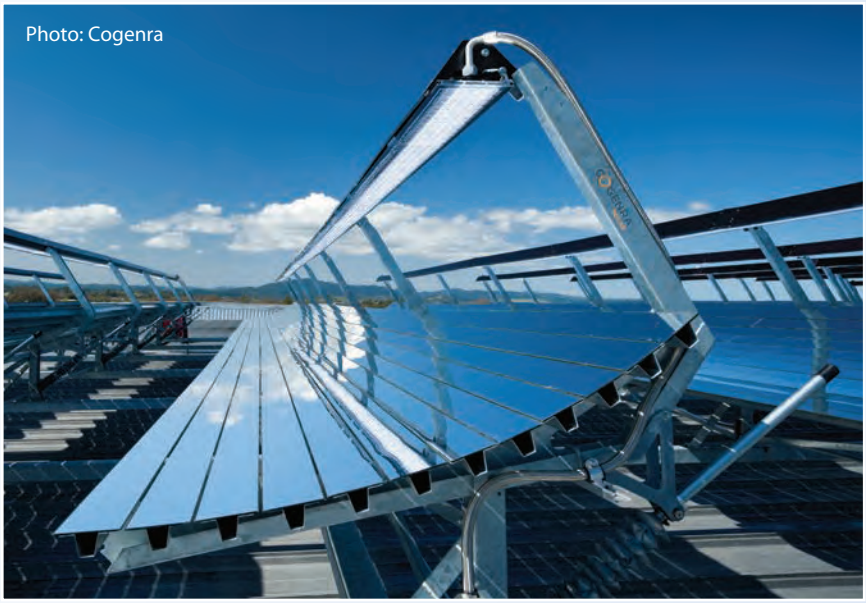


Photo: Cogenra

Sonoma Wine Company in Graton, CA installed a hybrid solar photovoltaic / solar thermal energy system in 2010, with support from the California Solar Initiative.[6] The system supplies about 40 to 60 percent of the winery's hot water needs, and 30 percent of its electrical requirements, assisting with the production of 4 million cases of wine annually.[7] Facebook is installing a similar system on the roof of the gymnasium at its new corporate headquarters in Menlo Park.[8] The California-based company that invented the hybrid solar thermal technology, Cogenra, calculates that the technology produces five times more energy, prevents three times as much global warming pollution, and delivers double the financial savings as a standard photovoltaic system.[9]

Recommendations to Accelerate Local Clean Energy Development

California should adopt big, bold, market-transforming policies to drive the installation of 12 gigawatts of local clean energy generation capacity. The policies should include a broad range of renewable energy sources, including solar, wind, biomass and geothermal. Local clean energy programs should prioritize installations that are under 5 megawatts in size, and primarily generate electricity and/or heat for consumption on-site or nearby; and exclude technologies that rely on fossil fuels or would worsen California's air pollution problems. Specific steps include:

- Adopt a strong feed-in-tariff policy and expand net-metering programs to allow more Californians to benefit from local clean energy generation.
- Increase the use of solar and other local clean energy systems in new construction through a net-zero energy building code requirement.
- Simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation.
- Expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.


Photo: NREL

These San Diego homes use the sun to provide both hot water and electricity. The single rectangles that look like skylights are solar water heating systems. The larger array of panels behind is a photovoltaic system.

For more information, contact Michelle Kinman, Clean Energy Advocate, at (213) 251-3688 ext. 325, or michelle@environmentcalifornia.org.

Environment California Research & Policy Center
3435 Wilshire Blvd., #385, Los Angeles, CA 90010

www.environmentcaliforniacenter.org

[1] The sunlight falling on a 100 mile by 100 mile patch of southeastern California desert would be enough. Bernadette Del Chiaro, Tony Dutzik and Sarah Payne, Environment America Research & Policy Center, *On the Rise: Solar Thermal Power and the Fight Against Global Warming,* Spring 2008.

[2] Bernadette Del Chiaro and Timothy Telleen-Lawton, Environment California Research & Policy Center and Frontier Group, *Solar Water Heating: How California Can Reduce Its Dependence on Natural Gas,* April 2007.

[3] U.S. Department of Energy, National Renewable Energy Laboratory, *Concentrating Solar Resource: Direct Normal, Annual,* February 2009, available at www.nrel.gov/gis/images/map_csp_us_10km_annual_feb2009.jpg.

[4] See note 2.

[5] Nathan Olivarez-Giles, "ENERGY: Using Solar Heat to Power Air Conditioning," *Los Angeles Times,* 20 August 2009.

[6] Cogenra, *Cogenra Awarded $1.5 Million from the California Solar Initiative RD&D Program* (press release), 6 October 2010.

[7] N. Sheree Saunders, "Award - Energy: Cogenra Solar Hybrid System Creates More Power via Heat, Electricity Combo," *San Jose Business Journal,* 17 February 2012.

[8] David Baker, "Cogenra Solar Delivers Hot Water Along with Power," *San Francisco Chronicle,* 2 November 2011.

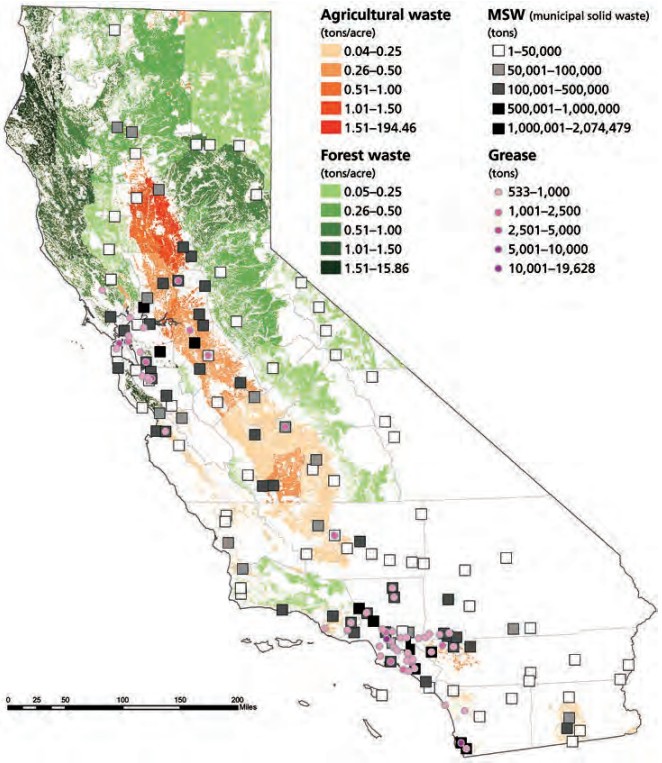
[9] Cogenra Solar, *Cogenra Solar Receives Top Honor in Greenbang 2011 Efficiency Awards* (press release), 5 December 2011.

Biomass Power

Plant matter and animal waste contain energy that can be harnessed to produce localized renewable energy and reduce the need for more polluting energy sources like coal or natural gas. Biomass energy technology can help to meet Governor Brown's goal of installing 12 gigawatts of localized renewable energy generation and reduce the state's contribution to global warming. At the same time, biomass energy can help to extend the life of the state's landfills.

Not all types of biomass are created equal, however. California should focus on the cleanest biomass technologies with the lowest life-cycle contribution to global warming as the most appropriate energy tools. The best types of biomass energy technologies use low-impact fuel sources and avoid combustion-related pollution. Inappropriate kinds of biomass energy technologies can actually worsen California's air quality, increase public exposure to toxic chemicals, and disrupt ecosystems.

Figure 1: Potential Biomass Energy Resources in California[3]



California Has Large Biomass Energy Resources

California already generates more than 2 percent of its electricity supply from biomass energy sources, including gas emitted from landfills, gas produced from livestock waste, and solid agricultural waste.[1] Using additional resources, biomass could produce 13 percent or more of the state's annual electricity needs. According to researchers at the University of California at Davis, the state could sustainably harvest more than 8 million tons of agricultural wastes, 1.2 million tons of food processing waste, 9 million tons of municipal biomass waste, and 14 million tons of forestry waste per year (see Figure 1). Additional energy could come from gas derived from landfills or municipal water treatment plants where biomass energy technology is not already deployed, or by specifically growing energy crops such as switchgrass on marginal farmlands.[2]

Biomass Energy Sources Can Have Tradeoffs

Care must be taken to avoid unintended consequences with biomass energy sources. Thinning forests can harm local ecosystems. Burning solid or gaseous biomass can increase our exposure to unhealthy soot and smog pollution. Growing crops for energy could come into conflict with other important uses of the state's available land and water supplies. If fuel production competes with food production, biomass energy can drive up food prices. And some types of biomass energy production – like corn ethanol – might not actually deliver global warming benefits on a life-cycle basis. Additionally, municipal solid waste incineration can create deadly air pollution, and should not play a role in meeting state goals for clean, local energy.

Promote the Best Biomass Energy Technologies

Decision-makers should take care to promote the best kinds of distributed biomass energy technology. For example, Gills Onions, a family-owned onion grower in Oxnard, CA, uses its own crop waste to generate local power. The company installed two fuel cells that it powers with biogas derived from


Photo: Gills Onions

up to 300,000 pounds of onion peels generated daily at its processing plant (see photos). The system, completed in 2009, produces 60 percent of the plant's annual electricity needs, saving the company about $700,000 per year in avoided

Photo: Gills Onions

electricity costs. By preventing truck trips to haul onion waste off site, the biomass energy system also saves the company another $400,000 in avoided waste disposal costs. Gills Onions expects the savings to fully cover the cost of the system within 6 years, generating a strong return on its investment. At the same time, the system prevents 14,500 metric tons of carbon dioxide pollution per year, helping California reduce its contribution to global warming.[4]

Similar energy systems could be based on biogas produced by digestion of food waste. For example, the University of California at Davis operates a demonstration biogas plant that can process up to 10 tons of food waste per day, providing enough electricity to power 10 typical California homes.[5] Food waste makes up 15 percent of California's municipal solid waste stream.[6] None of that material should be going to a landfill.

Recommendations to Accelerate Local Clean Energy Development

California should adopt big, bold, market-transforming policies to drive the installation of 12 gigawatts of local clean energy generation capacity. The policies should include a broad range of renewable energy sources, including solar, wind, biomass and geothermal. Local clean energy programs should prioritize installations that are under 5 megawatts in size, and primarily generate electricity and/or heat for consumption on-site or nearby; and exclude technologies that rely on fossil fuels or would worsen California's air pollution problems. Specific steps include:

- Adopt a strong feed-in-tariff policy and expand net-metering programs to allow more Californians to benefit from local clean energy generation.
- Increase the use of solar and other local clean energy systems in new construction through a net-zero energy building code requirement.
- Simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation.
- Expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.

[1] Bryan M. Jenkins et al, "Sustainable Use of California Biomass Resources Can Help Meet State and National Bioenergy Targets," *California Agriculture* 63(4):168-177, DOI: 10.3733/ca.v063n04p168, October-December 2009.

[2] Ibid.

[3] Ibid.

[4] Gills Onions, *Gills Onions Sustainability: Waste-to-Energy: The Advanced Energy Recovery System (AERS)* (factsheet), 2010.

[5] Edie Lau, "Power Lunch: Bacteria Turn Leftovers to Energy," *Sacramento Bee,* 24 October 2006.

[6] California Integrated Waste Management Board, *California 2008 Statewide Waste Characterization Study,* August 2009.

For more information, contact Michelle Kinman, Clean Energy Advocate, at (213) 251-3688 ext. 325, or michelle@environmentcalifornia.org.

Environment California Research & Policy Center
3435 Wilshire Blvd., #385, Los Angeles, CA 90010

www.environmentcaliforniacenter.org

California's Local Clean Energy Effort Should Exclude Fossil Fuels

ENVIRONMENT CALIFORNIA
RESEARCH & POLICY CENTER

Some types of localized energy generation technologies that run on fossil fuels can help California reduce overall levels of air pollution. In particular, high-efficiency combined heat and power systems and fuel cells that run on natural gas can generate electricity or heat locally with fewer polluting emissions than diesel generators or electricity from California's grid.

However, while these technologies can play a near-term role in California's transition toward a clean energy future, they are ultimately not renewable sources of energy, and therefore cannot help the state to achieve its goal of obtaining 33 percent of its electricity from renewable sources by 2020. California should continue to support accelerated deployment of fossil-fired combined heat and power and fuel cells as part of the effort to rapidly reduce pollution, albeit independently of the effort to install 12 gigawatts of local, renewable power by the end of the decade.

Combined Heat and Power

Typical local gas-fired electricity generators are inherently inefficient, wasting half or more of the energy in their fuel. In contrast, combined heat and power (CHP) systems capture the waste heat from electricity generation and put it to work for space heating, cooling, or industrial processes. CHP systems also enable local electricity generation, which reduces power losses during transmission and distribution. As a result, CHP can help to reduce global warming pollution.

California has the potential to expand its use of CHP systems. A 2008 study by Oak Ridge National Laboratory (ORNL) concluded that economically beneficial CHP could account for 20 percent of electricity generating capacity nationwide by 2030.[2]

Fuel Cells

Fuel cells can also reduce air pollution. Because fuel cells extract energy from fuel without combustion, they produce far less smog-forming pollution than an internal combustion engine or gas turbine generator.


Photo: Adobe Systems Inc.

Fuel cells operate much like giant batteries, harnessing a chemical reaction to deliver power. They have no moving parts and can be very reliable sources of local power generation. For example, Adobe Systems Incorporated generates 30 percent of the electricity needed at its San Jose headquarters through 12 "Energy Servers," each containing thousands of individual cells fueled by natural gas. The units were manufactured and installed by Sunnyvale-based Bloom Energy in 2010.[3]

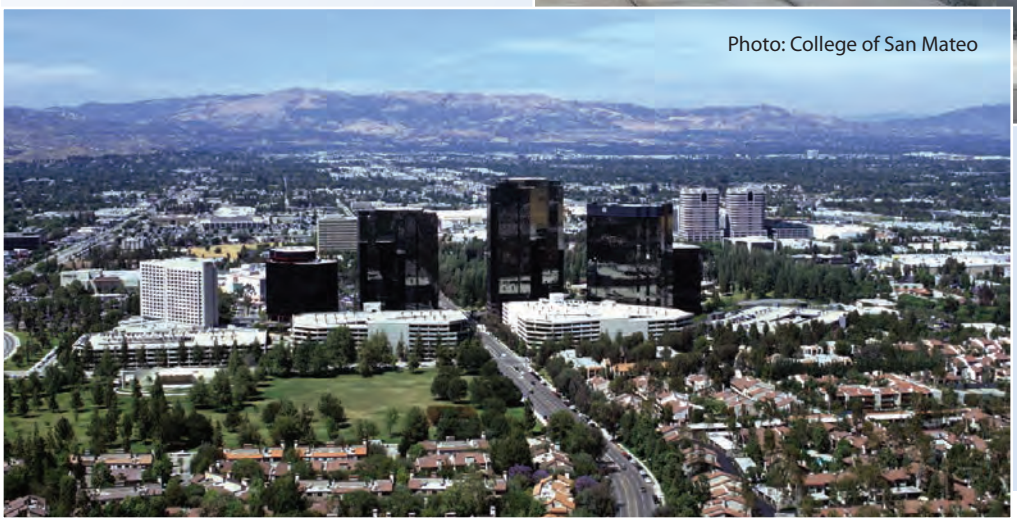


Photo: College of San Mateo

San Mateo Community College District has installed two CHP generators at its campus, providing up to half of the facility's peak electricity needs as well as building heat. Along with other efficiency improvements, the campus cut its overall energy use by 56 percent, saving $1 million per year on energy costs, and reducing global warming emissions by 6.4 million pounds per year.[1]

However, the global warming impact of a fuel cell depends on where the fuel comes from. If the fuel cell runs on gas produced from agricultural waste or other biomass, it can have zero net global warming impact. If the fuel cell runs on natural gas mined from deep in the ground, the fuel cell will have a global warming impact similar to a standard natural gas-fired generator – although this impact can be reduced through the use of combined heat and power technology, which captures waste heat from the fuel cell and puts it to use in heating or cooling building space or providing hot water.

Photo: LL28 Photography

California's effort to increase local clean energy generation should focus on technologies that do not use fossil fuels.

Fossil Fuel Technologies Should Not Be Included in California's Effort to Install 12 Gigawatts of Local Clean Energy Generation

The use of fossil fuels can lead to a wide range of negative environmental impacts. Drilling for gas can harm landscapes and create air and water pollution. Burning fossil fuels in an engine or combustion turbine contributes to California's unhealthy air quality and creates global warming pollution.[4] Moreover, using fossil fuels leaves California dependent on other states and nations for its energy supply and thus more vulnerable to supply disruptions.

To reduce the impacts of fossil energy, California policy should prioritize accelerating the transformation of its economy to run on completely renewable sources of energy.

Combined heat and power and fuel cell technologies running on fossil fuels can help to achieve near-term pollution reduction goals, and deserve policy support. However, California's effort to increase local clean energy generation should focus on technologies that do not use fossil fuels.

Recommendations to Accelerate Local Clean Energy Development

California should adopt big, bold, market-transforming policies to drive the installation of 12 gigawatts of local clean energy generation capacity. The policies should include a broad range of renewable energy sources, including solar, wind, biomass and geothermal. Local clean energy programs should prioritize installations that are under 5 megawatts in size, and primarily generate electricity and/or heat for consumption on-site or nearby; and exclude technologies that rely on fossil fuels or would worsen California's air pollution problems. Specific steps include:

- Adopt a strong feed-in-tariff policy and expand net-metering programs to allow more Californians to benefit from local clean energy generation.
- Increase the use of solar and other local clean energy systems in new construction through a net-zero energy building code requirement.
- Simplify and standardize permitting and interconnection rules, to make it as easy and affordable as possible for Californians to participate in the clean energy transformation.
- Expand opportunities to help California families, communities, businesses and institutions invest in clean, local energy systems.

For more information, contact Michelle Kinman, Clean Energy Advocate, at (213) 251-3688 ext. 325, or michelle@environmentcalifornia.org.

Environment California Research & Policy Center
3435 Wilshire Blvd., #385, Los Angeles, CA 90010

www.environmentcaliforniacenter.org

[1] Travis Madsen and Bernadette Del Chiaro, Environment California Research & Policy Center, *Greening The Bottom Line: California Companies Save Money by Reducing Global Warming Pollution,* August 2006.

[2] Anna Shipley, Anne Hampson, Bruce Hedman, Patti Garland, and Paul Bautista, Oak Ridge National Laboratory, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future,* 1 December 2008.

[3] Todd Woody, "Short on Roof Space? Adobe Plants Fuel Cells," *New York Times Green Blog,* 28 September 2010; Adobe Inc., *Environmental Sustainability*, downloaded from www.adobe.com/corporateresponsibility/environmental.html on 28 March 2012.

[4] Nate Berg, "Why Does California's Central Valley Have Such Bad Air Pollution?," *The Atlantic,* 28 September 2011. Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* 2007.