

Geothermal Energy Potential

State of California

Power Generation

Geothermal energy is heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the shallow ground to steam, hot water, and hot rock accessed by drilling wells up to thousands of feet beneath the Earth's surface. The extremely high temperatures in the deeper geothermal reservoirs are used for the generation of electricity.

Most electricity in the U.S. is generated using steam. The high-pressure steam spins a turbine that rotates a generator, producing electricity. The largest source of carbon emissions in the U.S. are the many power plants still burning fossil fuels to boil water for steam. Geothermal power plants, however, do not burn fuels to heat water to steam. Instead, they use natural heat found below the Earth's surface to generate electricity.

New geothermal power plants produce near-zero CO₂ and emit very little air pollution.

And unlike solar or wind energy, geothermal energy is available around the clock.



BENEFITS



Jobs Boost. Geothermal power plants employ about 1.17 persons per MW. Adding related governmental, administrative, and technical jobs, the number increases to 2.13.



Economy Boost. Over the course of 30 to 50 years an average 20 MW facility will pay nearly \$6.3 to \$11 million dollars in property taxes plus \$12 to \$22 million in annual royalties. Seventy-five percent of these royalties (\$9.2 to \$16.6M) go directly back to the state and county.



Locally Produced. Geothermal power can offset electricity currently imported into the state, keeping jobs and benefits in state and local communities.



Near-Zero Carbon Emissions. Geothermal flash plants emit about 5% of the carbon dioxide, 1% of the sulfur dioxide, and less than 1% of the nitrous oxide emitted by a coal-fired plant of equal size, and binary geothermal plants – the most common – produce near-zero emissions.



Small Footprint. Geothermal has among the smallest surface land footprint per kilowatt (kW) of any power generation technology.



Reliable. Geothermal power can provide consistent electricity throughout the day and year - continuous baseload power *and* flexible power to support the needs of variable renewable energy resources, such as wind and solar.



Sustainable Investment. Energy resource decisions made now for sources of electric power have 40-50 year consequences, or longer. Using renewables like geothermal resources avoids "price spikes" inherent in fossil fuel resource markets. Geothermal energy is an investment in stable, predictable costs. Investing in geothermal power now pays off for decades to come.

Discover the geothermal power generation potential in your state.

California Geothermal Power Benefits

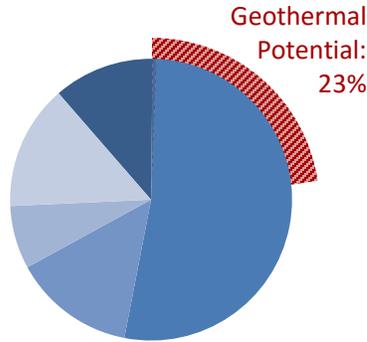


Reliable, baseload power:

16,740 MWe of geothermal potential

Current California Electricity Production

- Nuclear
- Other Fossil Fuels
- Natural Gas
- Hydro
- Geothermal
- Other Renewables



Total annual power consumption in California in 2013 was 487,000 GWh. Geothermal potential in the state is as much as 110,000 GWh – 23% of the state's power consumption, providing reliable baseload power.



Developing the available geothermal can create temporary and permanent jobs and revenue streams in California.

Job Creation:

Construction:

50,000 person-years

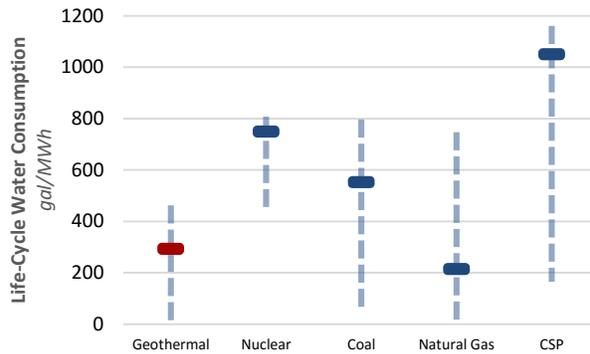
Operation:

19,000 full-time jobs



Water use reduction

Geothermal Power Represents Significant Water Savings



Geothermal power has substantially lower life-cycle water consumption than other types of baseload generation. In addition, geothermal plants normally use brackish water for cooling (when necessary) that would not be fit for human consumption or use.

Policies & Incentives

Federal and state policies and incentives helped catapult renewable energy technologies, such as wind and solar, into the billion dollar industries they are today.

State incentive programs that help developers reduce upfront risk and secure power purchase agreements can help to incentivize geothermal power development in the state.

Key Identified Geothermal Resource Sites in California

- Salton Sea area, Imperial Co.
- The Geysers, Sonoma & Lake Co.
- Coso Geothermal, Inyo Co.
- Medicine Lake, Siskiyou Co.
- Imperial Valley, Imperial Co.
- Surprise Valley, Modoc Co.

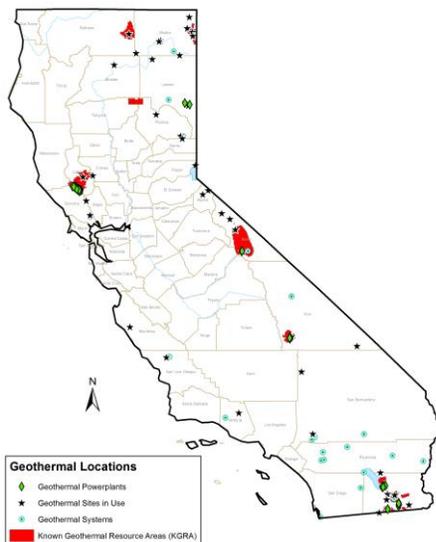


Locally produced power:

In-state electricity production

California's most promising Geothermal Resource Areas

Geothermal plants can operate for many decades providing stable jobs to local communities and revenue to state and municipal treasuries.



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<http://www.geo-energy.org>

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<http://www.geothermal.org>

Geothermal Exchange Organization
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Geothermal Energy Potential

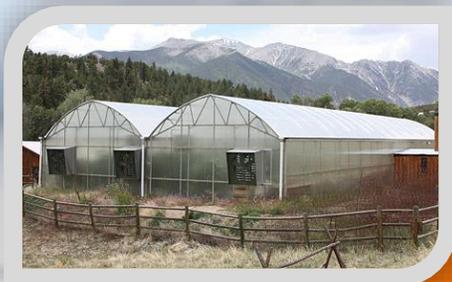
State of California

Direct Use

Geothermal energy is heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the shallow ground to hot water and hot rock accessed by drilling wells up to thousands of feet beneath the Earth's surface. The hottest reservoirs are used to produce electricity, and the more common moderately hot reservoirs are a ready source of natural heat, without burning fossil fuels.

Direct, or non-electric, use of geothermal energy refers to the use of the energy for both heating and cooling applications. Fluids with temperatures of $<300^{\circ}$ F, adequate for direct use, are available throughout much of the United States.

Direct use of geothermal energy in homes and commercial operations is much less expensive than using traditional fuels; savings can be as much as 80%! Furthermore, direct use applications such as fish farms, greenhouses, microbreweries, fruit and vegetable drying, spas, pulp and paper processing, and lumber drying offer attractive and innovative opportunities for local businesses and entrepreneurs.



BENEFITS



Jobs Boost. Direct-use geothermal energy projects leverage existing workforces and companies within the state. Their simple design and construction from off-the-shelf parts can utilize local engineering firms, geologists, drilling operators, construction trades, pipefitters, technicians, and welders. A rough prediction of potential job opportunities created by installing direct use systems may be 3 temporary jobs per MW_{th} during construction, with 1 full-time job per MW_{th} for ongoing operation.



Economy Boost. Geothermal heated facilities have the potential to stimulate economies through increased tax revenues, the creation of new businesses and local jobs, tourism, agriculture, and enhanced community involvement.



Locally Produced. Directly using geothermal energy in homes and commercial operations, such as food production from local agriculture, can offset imported energy, keeping jobs, dollars, and other benefits in local communities.



Carbon Emission Reduction. Geothermal direct use projects produce near-zero emissions. Depending on the existing heating fuels being offset, this may result in annual emissions reductions of anywhere between 1,700 tons (if offsetting natural gas) to 9,300 tons (if offsetting inefficient electricity) of CO_2 saved per MW_{th} of installed GDU capacity.



Flexible Heating Systems Applications of geothermal direct use may include district heating, snow melting, spas and pools, agriculture, food processing, and other uses. Within a single system these diverse applications can be "cascaded" and work together in the most efficient way possible to ensure the maximum benefit and lowest costs possible from direct use systems.



Reliable and Sustainable Heat Source. Geothermal heating projects last for decades—typically at least 25 years or more—providing reliable energy at a low, stable price. This can provide price certainty and insulate consumers (and the economy) from often unpredictable fluctuations in fossil fuel prices.

Discover the geothermal direct use potential in your state.

California Geothermal Direct Use Benefits

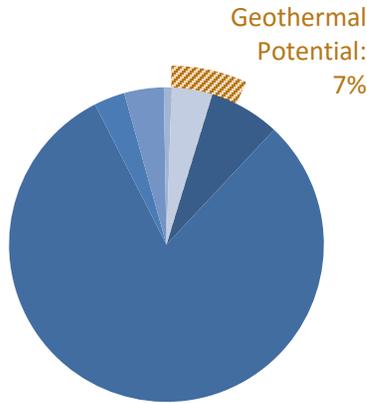


Reliable, stable heat:

54 Trillion BTU

Current California Heating Fuel Mix

- Electricity
- Natural Gas
- Propane/LPG
- District Heating
- Other
- Coal



The total estimated annual heat consumption in California is 749 Trillion BTU. Developing the hydrothermal direct-use resources in California – as much as 54 Trillion BTU - could supply a third of California's heating needs with clean, renewable geothermal heat.



Tilapia fingerlings on geothermal fish farm
Photo Credit: Robb Williamson

Geothermal Direct-Use Projects in California

There are many fish farms clustered around the Salton Sea. Some of these farms use geothermal fluids to control the temperature of the fish culture facilities, so as to produce larger fish in a shorter period of time and to permit winter production which would otherwise not be possible.

Policies & Incentives

Federal and state policies and incentives helped catapult renewable energy technologies, such as wind and solar, into the billion dollar industries they are today.

State incentive programs that help developers reduce upfront risk can help to incentivize geothermal direct-use development in the state.

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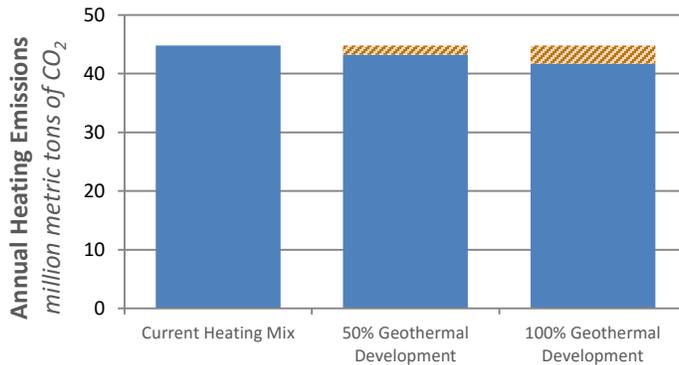
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Carbon emissions reduction:

3 Million metric tons



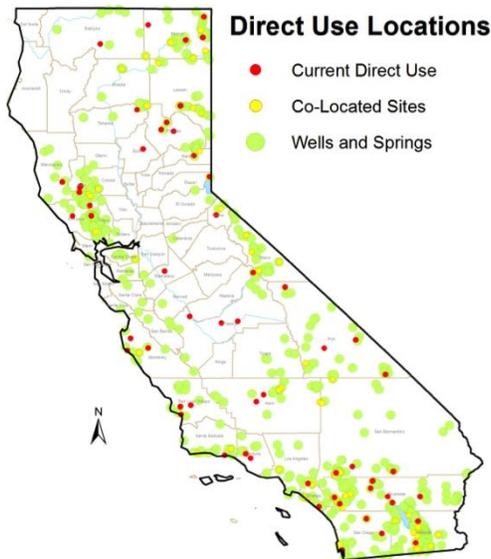
California's CO₂ emissions from heating is nearly 45 MMtCO₂ per year. Developing geothermal direct-use in the state can reduce emission by as much as 3 MMtCO₂, while providing reliable energy at a low, stable price.



Locally produced energy

Direct-Use Hydrothermal Sites in California

Low-temperature hydrothermal potential exists throughout most of the state of California with several hundred locations identified by the USGS as having potential for development.



Geothermal Energy Potential

State of California

Heat Pumps

Geothermal energy is heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the shallow ground to hot water and hot rock accessed by drilling wells up to thousands of feet beneath the Earth's surface. Geothermal heat pumps use the natural insulating properties of the earth from just a few feet underground to as much as several hundred feet deep, offering a unique and highly efficient renewable energy technology for heating and cooling.

Most work by circulating water in a closed system through a "loop field" installed horizontally or vertically in the ground adjacent to or even beneath a building. Heat is taken from the building and transferred to the ground in the summer. The system is reversible, and heat is taken from the ground and used in the building in the winter. The system only moves heat, which is much more efficient than using energy to generate heat.

Geothermal heat pumps can support space heating and cooling needs in almost any part of the country.



BENEFITS



Economic. On average, a typical home of 2000 square feet will require 4 tons of heating and cooling capacity with an average system installation cost between \$5,000 and \$7,500 per ton.



Energy Efficient. Geothermal heat pumps use 25% to 50% less energy than conventional heating or cooling systems.



Carbon Emissions Reduction. One ton (12,000 BTU/hr) of GHP capacity over a 20 year operating cycle avoids 21 metric tons of CO₂ emissions. So a typical home system can avoid 80-100 metric tons of CO₂ emissions.



Improved Indoor Air Quality & Safety. There is no combustion in a geothermal heat pump; therefore there is no chance of carbon-monoxide poisoning. By adding high-efficiency air cleaners with geothermal, these systems can improve inside air quality.



Locally Produced. Everywhere. Unlike other geothermal technologies, heat pumps are not limited by geography or geology. They can be installed in almost any location in any of the 50 states or territories of the U.S.



Sustainable Investment. The lifespan of a geothermal system is usually greater than 24 years. A conventional furnace will last 7-10 years with regular maintenance. The ground loop of the geothermal system has a warranty of 50 years. These loops are made up of high-density polyethylene pipe, the same pipe which is used in city gas lines.



Quiet Operation. Unlike air conditioners, there is no outdoor unit. Geothermal units are very smooth and quiet in operation.

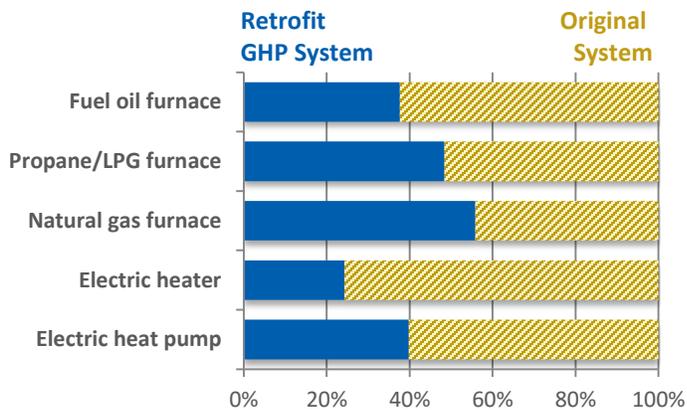
Discover the geothermal heat pump potential in your state.

California Geothermal Heat Pump Benefits



Carbon emissions reduction:

Over 50% for most systems



Percentage reduction of CO₂ emission from a geothermal heat pump (GHP) retrofit for a typical home in the Western United States. For example, a retrofitting a fuel oil furnace with a GHP system will reduce CO₂ emissions by 62%.



The Buck Institute

Geothermal Heat Pumps in California

Geothermal heat pumps are effective for all sizes of buildings from small homes to large buildings. A prominent San Francisco Bay Area research lab, the Buck Institute in Novato, uses a massive geothermal heating and cooling system. Wells 400 feet deep use the constant temperature of the earth to cool buildings at their facilities.

Policies & Incentives

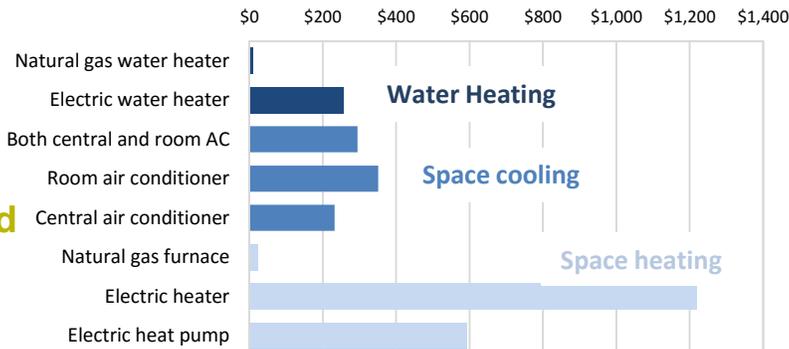
Federal and state policies and incentives helped catapult renewable energy technologies, such as wind and solar, into the billion dollar industries they are today.

States can use tax incentives, including property and sales tax incentives, and tax credits to provide an incremental motivation for geothermal development.



Household cost savings:

\$100s in cost savings each year



Average annual savings when replacing a household system with a geothermal heat pump. When multiple systems are replaced (e.g. space heating and cooling and water heating), savings are additive.



Public & commercial buildings savings



Public and commercial buildings, such as schools, universities, prisons and hospitals, can be retrofitted with geothermal heat pumps and provide cost-savings to the state's – and other utility rate payer's – energy bills. The picture above is an example of a commercial size vertical loop system. These systems are quiet, last for several decades, and reduce the state's dependence on fossil fuels for heating and cooling needs.

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