

California power summary

Californians, whose economic prosperity and quality of life are largely dependent on a reliable electric-power system, have become increasingly aware of the need for energy resources that are both efficient and environmentally friendly. The shortages and price spikes of 2000–2001 also brought home the value of locally controlled generation, renewable energy, and conservation. This chapter provides an overview of California's power system, including the electricity operations of Hetch Hetchy Water and Power and the Turlock and Modesto Irrigation Districts.

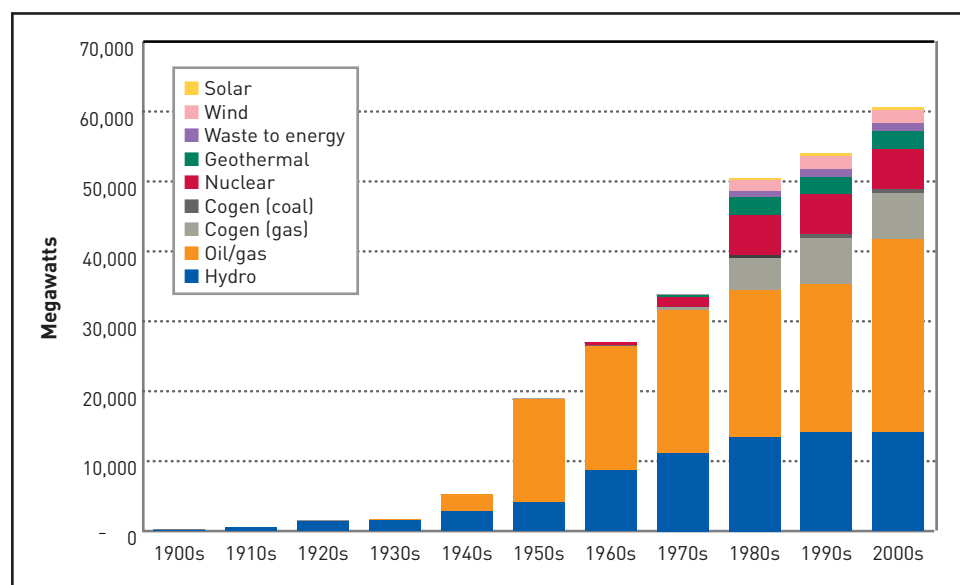
Overall system

California's electric-power system is comprised of an intricate grid of power plants, transmission lines, and distribution lines that were developed over the

past century by utilities in order to link sources of electrical energy (both in-state and out-of-state) to end users. California's grid is extensively interconnected with a much larger regional grid that encompasses parts of all 14 Western U.S. states, the Canadian province of British Columbia, and the Mexican state of Baja California. The routine exchange of energy with producers throughout western North America ensures a reliable supply of electricity for California's expanding population and growing business sector.

Figure 4-1 shows how the state's portfolio of generating resources has evolved since the early days of electrification. During the early and middle part of the 20th century, rivers were the main source of Californians' electricity. But in the last few decades, hydroelectric development has dropped significantly: few cost-

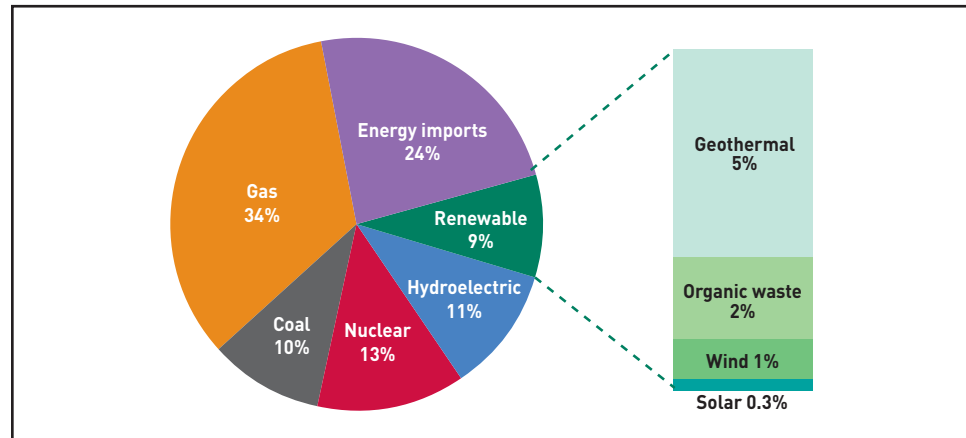
FIGURE 4-1
Cumulative generating capacity in California by decade and energy



Hydrogen provided most of California's energy supply in the early days of electrification. More recently, fossil-fired plants and nuclear energy have met most of the state's ever-growing demand for electricity, as the number of cost-effective hydroelectric sites has dwindled and public opposition to new dams has mounted.

Source: California Energy Commission

FIGURE 4-2
California electricity sources, 2002



California relies on a diverse portfolio of resources to meet its energy needs. Renewable energy sources such as geothermal, wind and solar power will increase as the state’s investor-owned utilities comply with a new law that requires them to obtain 20 percent of their supply from renewable sources by 2017. Source: California Energy Commission

effective hydroelectric sites remain, while public opposition to new dams has grown. Fossil-fuel-fired plants have met much of the state’s ever-growing demand since the 1950s, with newly built fossil-fuel facilities now using natural gas. Several large nuclear reactors came on line in the 1980s, but none have been developed (or proposed) since then. In the last quarter-century, over 5000 megawatts of renewable generation have been added to the state’s resource mix.

Today, California’s electricity portfolio includes a combination of natural gas, coal, hydropower, nuclear, and renewable-energy sources, as shown in Figure 4-2. Annual mixes vary dramatically from year to year, depending on factors such as precipitation and natural-gas prices. A significant recent development, which will shape the evolution of the state’s power supply, was the Legislature’s adoption of a renewable portfolio standard (RPS). Passed in 2002, SB1078 (Sher) requires that California’s investor-owned utilities, including Pacific Gas and Electric Company, purchase 20 percent of their electricity from renewable sources by 2017. Although municipal utilities,

including irrigation districts, are exempt from the RPS, some have undertaken voluntary efforts to increase their reliance on renewable energy.

Imported electricity accounts for a significant part of the resources for meeting the state’s electricity needs. Hydropower from the Northwest and coal-fired generation in the Southwest provide much of California’s imported energy, but interconnection with other Western states means that power from all types of sources can flow here from throughout the region. Ongoing construction of new gas-fired plants in the Mexican state of Baja California may add a new source of imports. In 2002, California imported approximately 62,859 million KWh, while power plants within the state generated approximately 209,650 million KWh.

Conservation and energy efficiency are playing an increasingly important role in balancing California’s electricity supply and demand. Since the 1970s, residents have invested in upgrading buildings and equipment so that electricity may be used more sparingly, and these investments have paid off. The

California Energy Commission (CEC) estimates that since 1977 Californians have shaved 6000 MW from peak demand, the equivalent of a dozen new natural-gas power plants.¹ Meanwhile, technological innovation continues to yield new efficiency-enhancing—and relatively low-cost—technologies.

Beyond the last three decades' impressive progress, the shortages and price spikes of 2000–2002 taught Californians that they could save even more energy. About 70 percent of the significant peak-load reduction that California realized during the summer of 2001 came from conservation—behavioral changes such as darkening empty rooms, shutting off idle equipment and turning down the air conditioning.² The rest of the savings came from new investments in energy-efficiency measures such as replacing incandescent light bulbs with compact fluorescent lamps, discarding old air conditioners in homes and offices in favor of newer and more efficient models, installing energy-

management systems, and even coating rooftops with reflective materials.

An especially important development is the installation of sophisticated new electricity meters for most of the state's large energy users. These devices will permit such customers to participate in “dynamic pricing” programs that provide incentives for them to cut power use during peak periods. Adding this demand-side flexibility means that fewer new power plants will be needed to accommodate the relatively few hours each year when energy demand is at its maximum level. According to CEC forecasts of the resources required to meet California's future energy needs, dynamic pricing could pare more than 2500 MW from system peak demand, avoiding the need for at least five new natural-gas powerplants.³

Although these advances are slowing the growth in demand for electricity, California still needs to develop new generating capacity to maintain adequate energy supplies. Power-plant construction in the state has recently followed a boom-bust pattern, partly in response to changing policies toward cost recovery and industry structure. The Legislature's enactment in 1996 of a law that radically restructured the electricity industry, AB1890, ended a 10-year lull in new construction and launched a rush to build new power plants. Although the new plants were not finished fast enough to prevent shortages and price spikes in 2000–2001, their steady arrival since then has brought supply and demand back into balance. Since 2001 over 8000 MW of new generating capacity has come on line in California, and the state currently enjoys an energy surplus. But the rate of new construction has once again slowed, and shortages may return in just a few years if the pace of development does not pick up.

Electricity units

Watt (W): Basic measurement for the rate of power output or use

Watt-hour(Wh): Basic measurement for energy output or use. For example, a 100-W light bulb that is on for 10 hours has used 1000 Wh of energy.

Kilowatt (KW)—1000 watts: Kilowatt-hours (KWh) is the usual basic unit on consumers' electric bills.

Megawatt (MW)—1,000,000 watts: is usually the unit used to measure power-plant capacity. Yearly output is sometimes measured in megawatt-hours.

The U.S. average residential monthly energy usage in 2002, according to the U.S. Department of Energy (DOE), was 907 KWh.

Net energy production in the United States in 2002, according to the DOE, was 3,858,452 million KWh.

Net energy production in California in 2002, according to the CEC, was 272,509 million KWh.

The current construction slowdown is happening mainly because private-sector power-plant developers cannot get financing for new projects. Skittish lenders are withholding funds, citing their uncertainty about the industry's future structure and regulatory environment as California legislators and regulators develop new policies to reconfigure the industry once again.

Policymakers have gone back to the drawing board because AB1890 is widely perceived as a failure, even though the bill's passage did help stimulate the recent wave of new construction. In particular, flaws in AB1890's market redesign have been blamed for creating conditions that allowed the Enron Corp. and other power marketers to exploit the tight market conditions of 2000-01, thereby driving electricity prices to astronomical levels and imperiling the financial health of the state's three big investor-owned utilities. Consequently, policymakers are revisiting critical questions, including who will be responsible for building new projects (utilities or independent merchant generators?) and how to assure developers' recovery of construction costs even as they are held accountable for unreasonable delays and excessive expenses.

California's many municipal utilities have not experienced the credit crunch, however, and have continued to build new plants even as private-sector construction has lagged. Although they must secure approval from state environmental regulators for new projects larger than 50 MW, municipal utilities such as the Turlock and Modesto Irrigation Districts are mostly unaffected by the regulatory changes now being considered. These changes will mainly affect investor-owned utilities, such as Pacific Gas and Electric Company, which serve over 80 percent of California's electricity demand.

Hydropower and California's rivers

Almost all of California's major river systems, including the Tuolumne, have been developed not only to supply water but also to produce hydropower. Over the past 20 years the proportion of California's energy provided by in-state hydroelectric facilities has varied from 9 percent to nearly 30 percent, depending on precipitation, the timing of spring snowmelt, and other factors. Hydropower produces no emissions of harmful air pollutants or global-warming gases, and production costs at existing facilities are typically low. Some hydroelectric plants also play an important role in maintaining a robust electric system by varying their energy output rapidly, in response to grid operators' signals, to assure the grid's stability. It should be noted, however, that California's new gas-fired plants share this operating flexibility, thereby reducing the need for hydroelectric facilities.

Although hydropower is clean, it is not always green: hydropower facilities throughout California have had significant adverse impacts on aquatic ecosystems. Dams block fishes' access to spawning and rearing habitat (causing declines in many native fish populations), while diversions of water from natural riverbeds cause environmental degradation. Sudden changes in river flows can occur downstream of hydropower facilities when production is ramped up (i.e., to provide power during peak demand), further harming streamside and river ecosystems.⁴ A 1996 report by the University of California, Davis—the most ambitious compilation of research on the Sierra Nevada to date—deemed rivers and riparian ecosystems the “most endangered” habitats in the Sierra, and it identified dams and other hydropower facilities as their number-one threat.⁵

In many cases federal law provides an avenue to address these problems. The

Federal Energy Regulatory Commission (FERC) regulates private, state and local hydropower projects that are larger than 5 MW. In California there are 119 FERC-licensed dams, with 11,930 MW of generating capacity (85 percent of California’s total hydropower portfolio). Environmentally important operating parameters, such as provisions for fish passage and required flows in bypassed reaches, are specified in 30- to 50-year licenses granted by FERC.

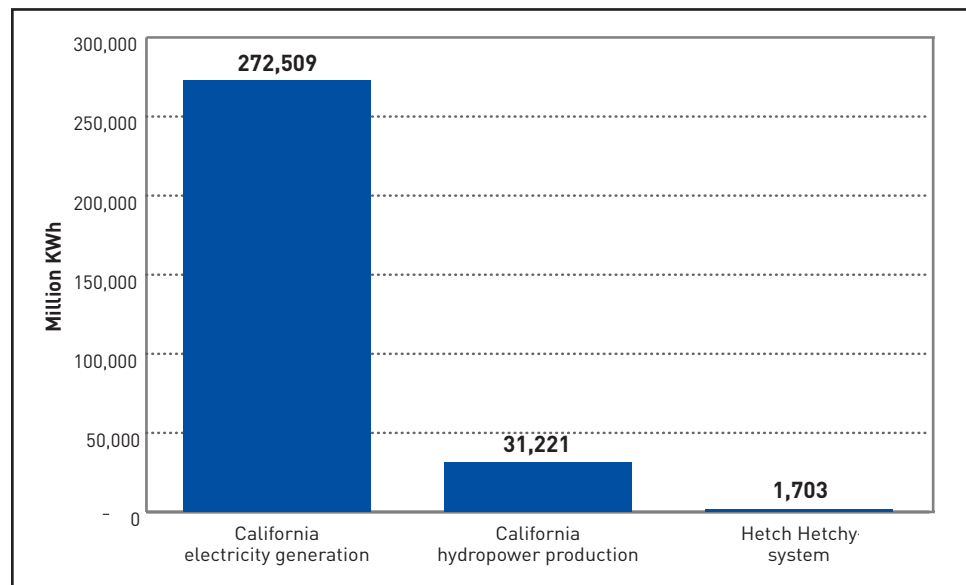
Most of California’s FERC-licensed plants came on-line more than 30 years ago, before the emergence of the modern environmental movement and the passage of today’s environmental laws. As these projects’ FERC licenses come up for renewal over the next two decades, Californians will have the opportunity not only to bring them into compliance with current regulations but to weigh their electricity benefits against their environmental costs in light of contemporary public policies and community values.

However, the Federal Power Act (section 29) stipulates that “nothing herein shall be held or construed to modify or appeal any of the provisions of the Act of Congress approved December 19, 1913 [the Raker Act],” granting certain rights of way to the City and County of San Francisco in the State of California. Consequently, FERC does not oversee San Francisco’s hydroelectric plants on the Tuolumne River.

Hetch Hetchy hydropower and its users

San Francisco operates three hydroelectric plants—the Kirkwood, Moccasin and Holm powerhouses—on the Tuolumne River (see Chapter 5). While they provide a significant amount of energy to the City of San Francisco and to Central Valley communities, these facilities account for only a tiny fraction of the electricity produced statewide. As illustrated in Figure 4-3, in 2002

FIGURE 4-3
Hetch Hetchy hydropower in perspective, 2002



The SFPUC’s hydroelectric plants play a minor role in meeting California’s energy needs. In 2002 they provided just 5.5 percent of statewide hydropower production and 0.6 percent of the state’s overall electricity supply.

Source: California Energy Commission and United States Department of Energy, Energy Information Administration

the three plants provided 0.6 percent of California's electricity supply and represented 5.5 percent of statewide hydropower production. Also, only the Moccasin and Kirkwood plants actually generate power using water stored behind O'Shaughnessy Dam.

Chapter 9 presents an analysis of how restoring Hetch Hetchy Valley would affect hydropower generation on the Tuolumne River.

Meanwhile, although the Hetch Hetchy Reservoir accounts for only a small part of California's overall electricity supply, it is an important and valuable resource to the people who use it. The remainder of this section discusses the role of Hetch Hetchy power in meeting the needs of electricity customers in San Francisco and in those parts of the Central Valley served by the Turlock and Modesto Irrigation Districts.

SAN FRANCISCO

Most homes and businesses located in San Francisco receive their electricity from Pacific Gas and Electric Company (PG&E). However, the electrical energy delivered to the airport, the Port of San Francisco and San Francisco General Hospital, and other City-owned facilities, are provided by the Hetch Hetchy Water and Power system; PG&E provides the transmission and distribution services that deliver power to these customers.

As a practical matter, electrons originating from San Francisco's Tuolumne River hydroelectric generators are commingled with those from the diverse array of resources that feed into the Western grid. However, for cost accounting and other purposes, power-market participants keep track of what they "pour into" the grid and what they draw out of it. Thus, PG&E delivers a mix of Hetch Hetchy and purchased power to City facilities while serving its own

retail customers in San Francisco with its own blend of purchased and self-generated energy.

Total electricity consumption in the City of San Francisco was 5,374 million KWh in 2002 and has been slowly rising in recent years (except for a dip during the energy shortages of 2000–2001).⁶ According to data reported annually by the San Francisco Public Utilities Commission (SFPUC) to state agencies, Hetch Hetchy energy supplied to public facilities has been approximately 900 million KWh per year in recent years.⁷ Although average generation from the SFPUC's Tuolumne powerhouses significantly exceeds the City's public-sector needs—as discussed in Chapter 5, the balance is sold to the Turlock Irrigation District, the Modesto Irrigation District, and other utilities and power marketers—it is less than a third of overall consumption in San Francisco. Even if all Hetch Hetchy energy were made available for all users in the City, considerable additional resources would be required.

San Francisco has developed an Electricity Resource Plan that sets ambitious environmental, economic and equity goals for meeting the City's electricity needs through 2012. In the short term, closing the highly polluting Hunters Point and Potrero plants will yield significant advances on all of these fronts (see *Clearing the Air in San Francisco*, page 28). For the longer term, the Plan calls for maximizing energy efficiency in City buildings and investing in renewable energy technologies such as wind and solar. In 2002, San Francisco joined other cities in setting the 2012 goal of greenhouse-gas emissions that are 20 percent below the 1990 levels; to meet this goal will require significantly increasing the share of renewable energy in the City's portfolio.

Clearing the air in San Francisco

Air pollution from aging power plants in low-income, predominantly non-white communities is a major environmental-justice issue in San Francisco. PG&E's Hunters Point power plant and the Potrero Unit 3 (operated by the Mirant Corporation) are among the oldest and dirtiest plants in the state; Hunters Point is the City's most significant stationary source of air pollution.

Plans to close these plants have been developed, but they are currently on hold. Standing in the way is the California Independent System Operator (CAISO), which controls the state's electricity grid and is responsible for assuring reliable service. The delay derives not from any shortage of replacement power but from a transmission bottleneck that limits the flow of power into San Francisco. Because almost all of the City's electricity supply is imported via a few transmission lines that run up the peninsula, the CAISO requires a City-based backup source of power should the peninsula suffer a transmission outage. Therefore the CAISO will not allow Hunters Point and Potrero to close until new transmission lines are built or enough new local generation is added to guarantee reliable service in the City.

In any case, efforts to restore Hetch Hetchy Valley would not be adversely affected by the closure of Hunters Point and Potrero. As discussed in Chapter 9, there are several options for developing new resources to replace the hydro-power that would be lost, and these supplies would most likely be imported into San Francisco, just as Hetch Hetchy energy is now. New generation or conservation resources developed locally to enable the closing of Hunters Point and Potrero might even hasten the valley's restoration.

TURLOCK IRRIGATION DISTRICT
Organized in 1887, the Turlock Irrigation District (TID) is the oldest irrigation district in California and was the first in the state to sell electricity on a retail basis.⁸ TID provides water to 5,800 growers in Stanislaus and Merced Counties and electricity service to over 77,500 retail accounts. In addition, TID currently sells surplus energy at a profit when opportunities arise: from 1998 to 2002, the district's annual wholesale power sales ranged from 148 to 1,002 million KWh. Major objectives for TID's power supply operations are minimizing power procurement costs, maximizing the extent of local decision-making, and maintaining independence from outside control.

While most of TID's energy needs are met with purchased power, the district also owns two 49-MW natural-gas-fired power plants and it has financial interests in hydroelectric plants

whose capacity totals 152 MW. With a two-thirds ownership share in the Don Pedro Dam, TID takes the lead in managing that facility's hydropower operations, as well as its flood-control, recreation, and water-supply operations. A new 250-MW gas-fired plant, expected to enter service in 2006, is currently under construction in the City of Turlock. TID also has holdings in transmission capacity and generation resources elsewhere in California and the Northwest through its membership in public-power consortiums and long-term power-purchase contracts.

Hetch Hetchy energy has generally accounted for about 10-15 percent of TID's supply. Until recently, TID bought power from San Francisco under a 1987 contract that provided for purchases of firm power, as well as the surplus, to which the Raker Act entitles the District. San Francisco terminated the contract early in February 2004, but

TID continues to dispute whether the termination was valid.

MODESTO IRRIGATION DISTRICT

The Modesto Irrigation District (MID) provides electricity to over 100,000 retail accounts in rapidly growing parts of Stanislaus County. From 1998 to 2002, MID also sold between 385 and 1,047 Million KWh annually to wholesale customers. MID seeks to maintain a balanced portfolio of energy sources, including hydropower, natural gas, geothermal energy and coal. In 2002, nearly 90 percent of the energy that MID distributed to its customers was purchased, mostly through long-term contracts.

MID's principal sources of purchased power are the Hetch Hetchy system and the M-S-R Public Power Agency, through which it owns a portion of the energy produced by the San Juan coal-fired plant in New Mexico. MID also buys energy from the federal Central Valley Project and others, under various agreements, and it purchases a limited amount of energy on the short-term "spot market." MID's own generating resources include the 49-MW Woodland Avenue and 112-MW McClure natural-gas-fired plants and an approximately one-third interest in the Don Pedro Dam's hydroelectric generation. In 2002, purchases of Hetch Hetchy energy accounted for about one-fifth of MID's supply.

According to its 2002 Annual Report, MID intends to reduce its dependence on the state grid through more investments in local generation sources. Current projects include additions and upgrades to MID's existing facilities, and plans to build a new 90-MW gas-fired plant. MID is also exploring options to expand

its resource base by acquiring additional interests in hydroelectric and coal facilities, entering new long-term power purchase contracts, and investing in conservation and renewable energy.

MID and its customers recognize the value of investing in energy efficiency. MID already operates several programs, including an air-conditioner cycling project, to shave summer peak loads. In a 2002 survey of 800 MID residential and commercial customers, 75 percent ranked energy conservation as "important" or "very important."⁹

Moving water

In the present study (on which this report is based), a number of alternatives to storing water in Hetch Hetchy Reservoir are being considered that may require transporting water to another storage site. But water is heavy. Excepting cases where it can be moved via gravity, significant energy is required to move and pump water. California's rugged landscape, moreover, makes the transport of water from sources to population centers especially energy-intensive, using an average of 1,955 KWh per acre-foot—almost twice the average power needed for this purpose in most other states.¹⁰

Pumping is the single largest cost category for the State Water Project, which transports water from the Sacramento-San Joaquin Delta more than 300 miles south over the Tehachapi Mountains to the L.A. Basin.¹¹ Approximately 3,200 KWh per acre-foot are required to deliver water from the Edmonston pumping plant to the Devil Canyon Power Plant Afterbay, a net lift of 1,924 feet.