



California ISO

Shaping a Renewed Future



COMPANY INFORMATION AND FACTS

California Independent System Operator Corporation

The California Independent System Operator Corporation

The ISO manages the flow of electricity across the high-voltage, long-distance power lines that make up 80 percent of California's power grid. The nonprofit public benefit corporation safeguards the economy and well-being of 30 million Californians by "keeping the lights" on 24/7.

As the impartial grid operator, the ISO opens access to the wholesale power market that is designed to diversify resources and lower prices. It also grants equal access to 25,865 circuit-miles of power lines and reduces barriers to diverse resources competing to bring power to customers.

Every five minutes, the ISO forecasts electrical demand, accounts for operating reserves and dispatches the lowest cost power plant unit to meet demand while ensuring enough transmission capacity is available to deliver the power.

The ISO opened its northern and southern California control centers in 1998 when the state restructured its wholesale electricity industry. While utilities still own transmission assets, the ISO acts as a traffic controller by routing electrons, maximizing the use of the transmission system and its generation resources, and supervising maintenance of the lines. As the nerve center for the California power grid, the ISO matches buyers and sellers of electricity, facilitating nearly 30,000 market transactions every day to ensure enough power is on hand to meet demand.

POWER FACT

The ISO keeps a pulse on an estimated **57,000 megawatts** of capacity from nearly **1,400 power plant** units connected to **25,865 circuit miles** of transmission lines serving the electricity needs of **30 million** Californians.

The **ROLE** of the California ISO

California's electricity industry includes traditional utilities, private power plant owners and state and federal agencies, each playing a unique role. The ISO is charged with ensuring the safe and reliable transportation of electricity on the "electron superhighway" we know as the power grid. As the impartial grid operator, it has no financial interest in any market segment and makes sure diverse resources have equal access to the transmission network and markets used to fine-tune the flow of electricity.

ISO Market Offers:

A **full network model** that analyzes generation and transmission schedules submitted a day in advance to better manage or avoid real-time bottlenecks.

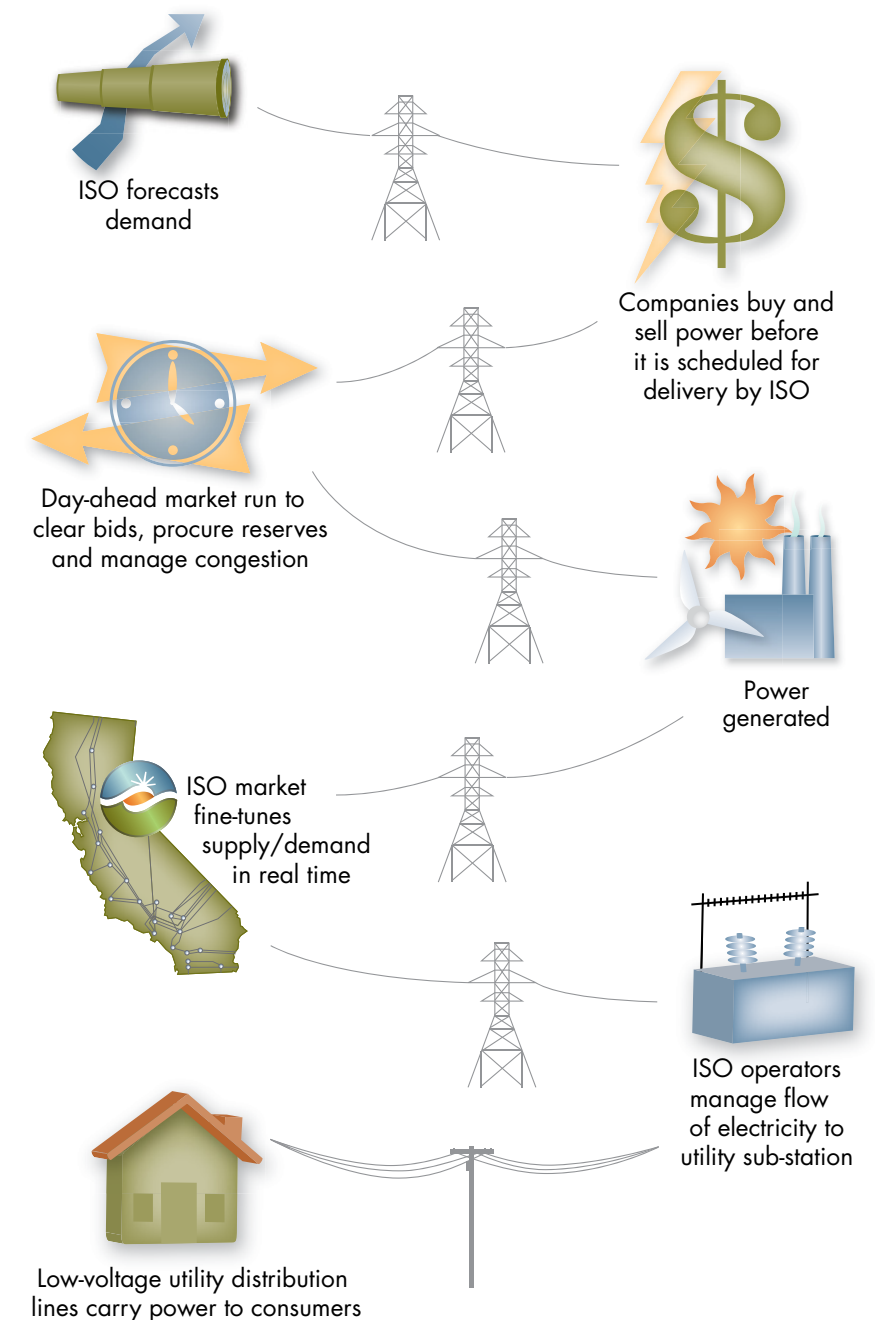
An **integrated forward market** that provides a one-stop shop for trading and analyzing the electricity bids, transmission capacity and reserves needed to keep the grid in balance.

Locational marginal pricing that creates a highly transparent system that prices electricity based on the cost of generating and delivering it.



FLOWS How power in California

The California ISO network is a long-distance, high-voltage transmission system that delivers wholesale electricity to local utilities for distribution to 30 million Californians. The ISO control area is one of the largest in the world, encompassing three quarters of the state and delivering approximately 200-billion kilowatt hours of electricity each year.



Competition brings TRANSPARENCY

More than one hundred electric transmission companies and generators participate in the ISO market, which is used to allocate transmission space, maintain operating reserves and match supply with demand.

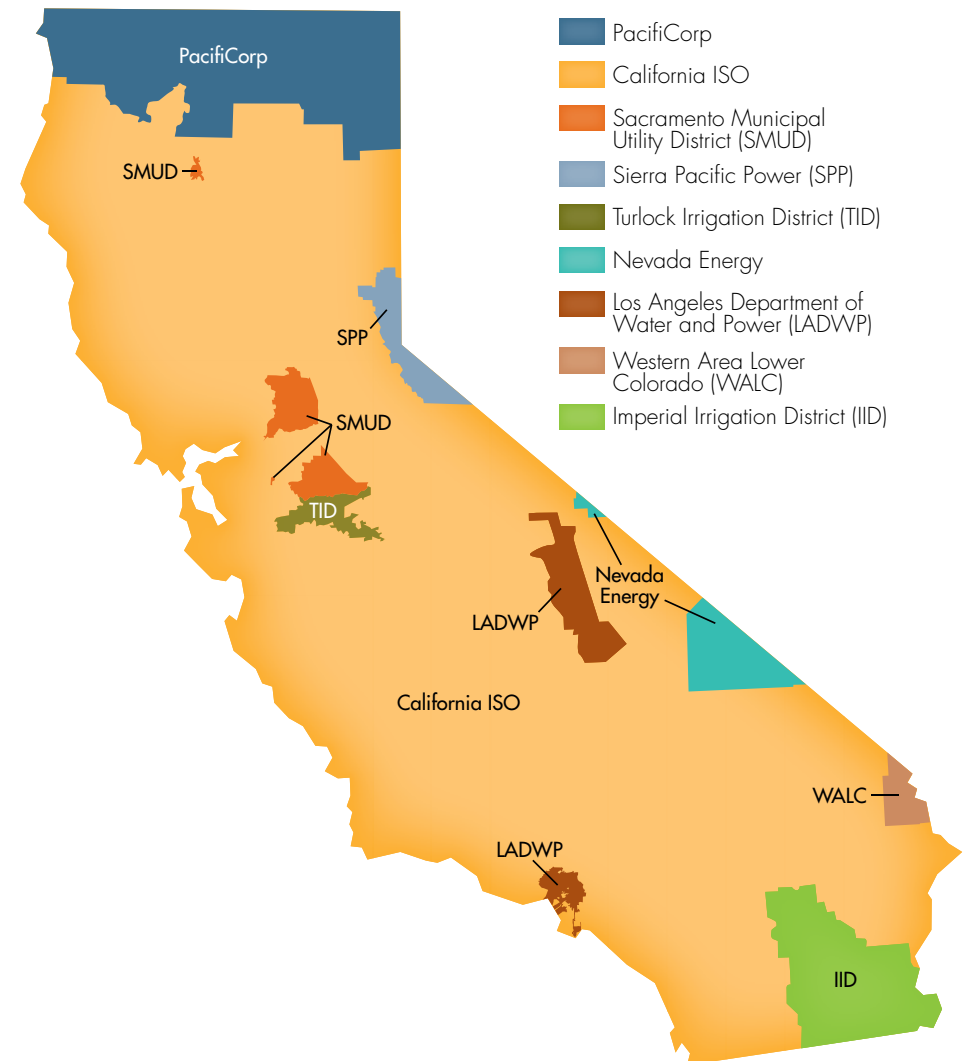
Another central function of the ISO is to provide transparent information about the state of the system and prices. This information helps market participants assess the economics and manage the risks of wholesale power transactions and supply options. Timely and accurate information about wholesale markets is the centerpiece of an effective and competitive marketplace. At the same time, economists within the ISO Department of Market Monitoring keep a close eye on market activity, monitoring wholesale prices and policing potential instances of market power abuse.

POWER FACT

For consumers, the California ISO ensures **electrical demand is met around-the-clock**—and that reasonable wholesale costs are fostered. For energy companies, the **California ISO ensures equal access to the grid** and conducts open and fair markets used as a last resort to **balance the system**.

The California ISO manages the flow of electricity for about 80 percent of California, which encompasses all of the investor-owned utility territories and some municipal utility service areas. There are some pockets of California where local public power companies manage their own transmission systems.

The ISO is the largest of about 40 balancing authorities in the western interconnection, handling an estimated 35 percent of the electric load in the West. A balancing authority is an entity responsible for operating a transmission control area. It matches generation with load and maintains electric frequency of the grid.



Before the establishment of independent transmission operators, electricity was a matter of local concern and was regulated strictly at the state level. The technology simply wasn't there to move electricity over great distances, which required power plants to be located close to customers. For this reason, the industry operated for years as a monopoly with one local utility providing generation, transmission and distribution services for its area. When technology evolved to provide the ability to move electrons over many miles, plants could be located away from consumers and the introduction of competitive markets became viable.

POWER FACT

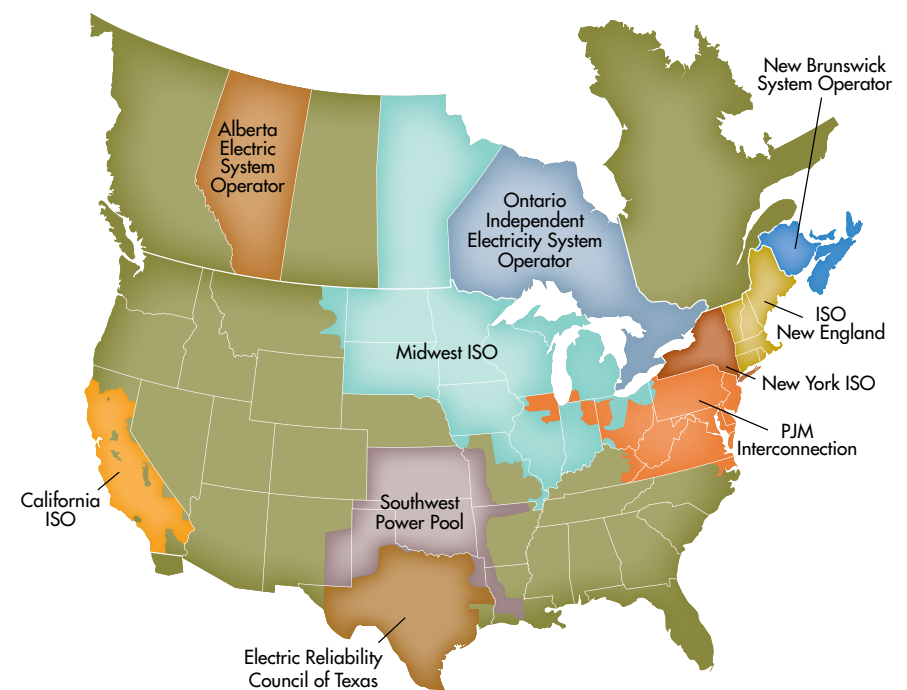
Today, **competitive wholesale power grids are managed** by entities called **Independent System Operators (ISOs)** or **Regional Transmission Organizations (RTOs)**.

Independent System Operators and Regional Transmission Organizations, virtually unknown to most, were created following the 1992 passage of the Federal Energy Policy Act, which introduced competition to the wholesale side of the electricity business.

Upon implementing the act, federal policymakers recognized the need for an independent entity without a stake in the outcome to manage the power grid and make sure competitive generation flows to customers.

ISOs and RTOs are often compared to air traffic controllers. It would be grossly unfair for air traffic controllers to represent one airline and profit from allowing that company's planes to go through before others. In the same way, ISOs and RTOs operate independently—managing the electron traffic on a power grid they do not own—making sure electricity is safely delivered to utilities and consumers on time and reliably.

The California ISO is one of 10 independent system operators in North America. Collectively, they deliver 2.2 million gigawatt-hours of electricity annually and oversee more than 270,000 miles of high-voltage power lines. Two-thirds of the United States is served by these independent grid operators.



Studies confirm that organized wholesale competitive energy markets improve grid reliability, optimize use of the transmission system, lower wholesale prices, improve power plant availability, and reduce market barriers for clean energy resources and demand response providers.

CONTROL

center

Grid reliability is a 24-hour-a-day job requiring California ISO operators to assess the status of the transmission system at all times. The ISO operates two control centers, with the main headquarters in Folsom and a second control room in Alhambra. The new Folsom headquarters houses one of the most modern control centers in the world. The second center in Southern California is a fully-functioning facility that is ready to assume control of the grid within minutes.

Advanced grid technology is now at the fingertips of ISO operators as they manage the transmission system and the competitive power market that supports operations. Robust systems provide increased reliability and efficiency, readying the ISO to respond to the most challenging conditions including sudden changes in electrical demand, power plant disruptions or fast-moving fires and other natural disasters. The ISO main control center hosts the first renewables dispatch desk in the country, showing the commitment the ISO is making to integrating green power reliably and efficiently.



HIGH-TECH

control centers

High-tech visual displays dominate the control centers in Folsom and Alhambra. These video display systems allow operators to assimilate large volumes of information at a glance:

- **Advanced features** include enhanced visualization capabilities, high-tech work consoles, a modern computerized energy management system and synchrophasor technology that takes a pulse of the power grid every 33 milliseconds rather than using the former industry standard of every four seconds.
- **High-Tech Tools** focus on fast start up of power plants, voltage stability, renewable forecasting, congestion management and reliability. Computer systems provide this information with pictures rather than thousands of individual data points.
- **The Energy Management System (EMS)** is the most advanced in the industry, providing the latest application software on the newest server hardware. This increases performance, capacity, and automation functions.
- **Ten visualization screens** display information from Google Earth and other applications spanning across an 80' wide x 6.5' high video wall at the Folsom headquarters. These screens serve a crucial need as the ISO integrates thousands of megawatts of green power onto the grid. The enhanced visibility improves wind and solar performance forecasting as well as advance weather prediction to anticipate consumer demand on the grid.



1 Enhanced Reliability

Because they span large geographic areas, regional markets optimize the power grid by promoting efficiency through resource sharing. These organized markets are designed so that an area that has surplus electricity can benefit by sharing megawatts with another region within the open market. This allows them to see the big picture when it comes to dispatching electricity as efficiently as possible. By maximizing megawatts as the demand for electricity increases, ISOs/RTOs help “keep the lights on” during peak periods.

2 Efficient Grid Dispatch

Through the use of advanced technologies and market-driven incentives, the performance of power plants within regional markets tends to be better than in areas under monopoly control. Evidence indicates there are lower power plant outage rates within competitive market regions because generation owners are motivated to keep plants on line, especially during peak periods, to maximize their revenues.

3 Better Price Transparency

ISOs/RTOs are better equipped to identify transmission bottlenecks, analyze reliability and evaluate the economic benefits of investing in additional transmission in an unbiased manner. In monopoly-controlled markets, consumers and investors are faced with a “black box” regarding information about prices and locational value of transmission, which inhibits investment in the power grid. In contrast, competitive markets have seen billions spent to strengthen the power grid.

4 Ease of Entry and Private Investment

ISOs/RTOs develop standardized non-discriminatory rules for grid interconnection and provide important price signals for new investment. As grid planners, they provide the mechanisms for identifying the most economic solutions to transmission issues across a large footprint. ISOs/RTOs provide greater access to the infrastructure investment necessary to keep up with the growing demand for electricity in the United States.

5 Green Power Added to Grid

ISOs/RTOs level the playing field for diverse types of power plants to compete to bring the lowest cost electricity to consumers. Whether it is ensuring non-discriminatory access to high-voltage power lines or creating markets that open doors to renewable power, ISOs/RTOs are seeing robust investment in environmentally-friendly power generation in their regions.

6 Market Monitoring Benefits

ISO/RTO market monitors play an important role in enhancing the performance of competitive wholesale electric markets. Competitive markets benefit customers by assuring that prices properly reflect supply and demand conditions. Market monitors identify ineffective market rules and tariff provisions, identify potential anticompetitive behavior by market participants and provide the comprehensive market analysis critical for informed policy decision-making.

7 Market Flexibility

Organized markets offer diverse power products and services that can be used to hedge against price risks. Because average real-time energy prices correlate to short-term forward bilateral prices, ISO/RTO markets foster forward contracting that can stabilize prices. More and better price transparency means better contract pricing.

8 Liquidity in the Marketplace

ISO/RTO markets have more buyers and sellers than non-competitive markets. For instance, hundreds of companies are now vying for customers. Prior to restructuring, only a handful of companies were competing to bring the lowest cost power to consumers.

9 Market Diversity

Regions with organized wholesale markets have numerous buyers and sellers, but generator ownership is more concentrated in non-competitive regions. Formalized markets are able to monitor for the exercise of market power abuse and address market power through mitigation rules, recommending new operating procedures or proposing market structure changes.

10 Demand Response Development

ISOs/RTOs provide more information. And because grid and market data is available publicly, anyone can see it. As a result, more companies are encouraged to participate in energy markets—even companies that are paid to reduce demand on the grid. Demand response bids are very important during peak periods of electricity usage because reducing demand is just as effective as increasing supply—and often it is cleaner and more economical.

The ISO conducts an annual transmission planning process that uses engineering analysis to identify any grid expansions necessary to maintain reliability, lower costs or meet future infrastructure needs based on public policies.

ISO engineers design, run and analyze complex formulas and models that simulate grid use under wide-ranging scenarios, such as high demand days coupled with wildfires. This process includes evaluating power plant proposals submitted for study into our interconnection queue to determine viability and impact to the grid.

The long-term comprehensive transmission plan is the culmination of 15 months of hard work. It takes into account future growth in electricity demand and the need to meet state energy and environmental goals that require the ISO grid to connect to renewable-rich, but remote areas of the California landscape.



Open-market grid welcomes diverse resources

The ISO market makes it easier for resources to compete to bring power to consumers. The key to reliably integrating renewable generation is to maintain a broad power mix with traditional generators and advanced technologies that can quickly respond to fluctuations in wind and solar production. California’s natural resources provide a vast array of “fuel” for an energy landscape as diverse as its people and its climates.

POWER FACT

By reducing barriers to renewable energy sources, such as **wind and solar power**, the California ISO is helping **move the state toward reaching its renewable goal** of increasing the **environmentally friendly** portion of California’s energy mix to an ambitious **33 percent**.



With advancements in automation and smart technology, consumers are becoming sellers, not just buyers of electricity. Customers who enroll in demand response programs provide electricity curtailments to help balance system needs.

The ISO is creating market mechanisms that enable demand response, either through utility programs or aggregated by third-party entities, to bid into the wholesale market and be dispatched similar to a generator. The powerful combination of a competitive wholesale marketplace and operational flexibility is the foundation for modernizing a power delivery system that is more than 100 years old.

OUR MISSION

For the benefit of our customers, we:

- Operate the grid reliably and efficiently
- Provide fair and open transmission access
- Promote environmental stewardship
- Facilitate effective markets and promote infrastructure development

All through the provision of timely and accurate information

OUR VISION

California ISO strives to be a world-class electric transmission organization built around a globally-recognized and inspired team providing cost-effective and reliable service, well-balanced and transparent energy market mechanisms, and high-quality information for the benefit of our customers.

THE CORNERSTONES



CORE VALUES

Integrity

We are honest, ethical and trustworthy with each other and stakeholders in all business dealings, reflecting the highest professional standards.

Teamwork

We strive for one common vision and are inspired by working together, with clear points of accountability, to be a world-class organization in meeting corporate objectives and serving our customers.

Excellence

Internal and external excellence—we earn customer trust based on our quality, competence and discipline in our business dealings.

People-Focused

We value diversity, promote employee development, support work/life balance and foster an invigorating and fulfilling work environment.

Open Communication

We seek out diverse ideas and opinions, value transparency, promote “thought leadership” and openly share information both internally and externally.

UNDERSTANDING

electricity

A GUIDE TO INDUSTRY TERMINOLOGY

What's a Watt?

A watt is a measure of electricity. If you have ten 100-watt bulbs on at the same time, the “demand” or instantaneous measure of the power required for the job is 1,000 watts, also called one kilowatt or kW. If you keep them lit for one full hour, you have used 1,000 watt hours of electricity, also called a kilowatt-hour or kWh. The typical American home uses about 840 kWh per month.

Megawatt

One megawatt equals one million watts or 1,000 kilowatts, roughly enough electricity for the instantaneous demand of 750 homes at once. That number fluctuates because electrical demand changes based on the season, the time of day and other factors.

Voltage

Just as it takes pressure to move water through a pipe, it takes voltage to move electricity across a wire. The high-voltage transmission lines operated by the ISO carry power at 500, 230, 115 and 70 kV. It is “stepped down” into lower voltage by transformers at utility-operated substations and then to 12 or 21 kV for delivery to homes and businesses. Final delivery by the utilities is at 220 volts; most household plugs deliver power at 110 volts.

Capacity

The amount of electricity an electrical facility can carry or generate; usually applied to generators, transmission lines, substation equipment and distribution lines.

Energy vs. Capacity

If you're filling up a bucket with water from a garden hose, the amount of water moving through the hose is the “energy” or wattage, and the water pressure inside the hose is the voltage. The size of the hose is the capacity.

The Electrical Grid

Continuing the water analogy, envision the electrical grid as a big pressurized water system with hundreds of devices (generators) pumping water into the system through long pipes (transmission lines), and literally millions of customers sucking water out through smaller straws (utility distribution systems). There are hundreds of places (substations) where valves and adapters (switches and transformers) are used to break the

large volumes of water down into smaller units under less pressure for delivery through straws. The ISO job is to make sure that the high-pressure system, the water pressure (voltage) and the pump output (frequency) remain constant even though inflow and outflow (measured in wattage) are changing minute by minute.

Frequency

Much like radio signals, electric generators can be “tuned” to produce power that vibrates at different frequencies. In the United States, virtually all electricity is generated and transmitted at 60-hertz or 60 cycles per second (cps). If the frequency fluctuates, it can damage all manner of electrical equipment. Frequency can be affected by a variety of factors and must be monitored closely by the ISO to make sure it remains very close to the 60 cps target.

Load

Load is the energy use; the ISO refers to utilities as load serving entities (LSEs) because that's what they do, serve load. Load is frequently confused with demand, which is actually how much power the load requires.

Demand

The number of kilowatts or megawatts delivered to the load at a given instant.

Market Participant

Any entity that buys, sells, trades, transmits or distributes electricity in the California ISO control area. This includes utilities, generating companies, transmission owners, energy-trading companies and Scheduling Coordinators (SCs).

Scheduling Coordinators

Entities that buy or sell power through the California ISO have to do so through a SC that is specifically authorized by the ISO to handle this type of transaction. SCs may be a subsidiary of the company they represent or hired as agents for the company.

Investor-Owned Utility (IOU)

The term investor-owned utility or IOU refers to the fact that these are private companies, owned by stockholders, as opposed to municipal utilities that are owned by the customers they serve. The three largest utilities in California are: Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E).



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