CFEE
CALIFORNIA FOUNDATION ON THE ENVIRONMENT AND THE ECONOMY

California Energy 101

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OVERVIEW | CALIFORNIA ENERGY

California's energy system is a complex network of conventional and renewable power plants, oil and gas production sites, and distribution infrastructure that collectively power the state's businesses, homes, and communities.

Detailed below is a brief background on the state's energy supply and the matrix of federal, state, and local entities – public and private – that oversee the system. This guide also includes a glossary of key terms and laws.

ENERGY SUPPLY

TRANSPORTATION

The majority of transportation vehicles in California – ranging from automobiles to airplanes and sea vessels – are powered by gasoline and diesel fuel with an increasing percentage coming from electricity, liquefied natural gas, biofuels, and hydrogen.

As the state's largest emitter, the transportation sector accounts for an estimated 41 percent of state greenhouse gas emissions (GHG). California has 135 different laws, regulations, and incentives to support the development of alternative and advanced vehicles.

ELECTRICITY

California continues to increase the percentage of renewable resources in its electricity mix. In 2018, renewable energy – including wind, solar, small hydropower, geothermal, and biomass – accounted for an estimated 34 percent of the state's electricity. Additional generation came from natural gas, predominantly, and from large hydro, nuclear, and unspecified sources of power. The electricity sector accounts for an estimated 15 percent of state GHG's.

KEY PUBLIC AGENCIES

FEDERAL

Federal Energy Regulatory Commission (FERC) is a five-member commission (appointed by the U.S. President) that regulates the interstate transmission of natural gas, oil, and electricity. It was formed in 1977 in response to the 1973 oil crisis and the effort to develop more energy resources domestically.

U.S. Environmental Protection Agency enforces federal environmental laws designed to safeguard natural resources, including air, water, and land. It is responsible for administering the Clean Air Act and the Endangered Species Act.

U.S. Department of Interior is comprised of numerous agencies tasked with managing federal lands. Sub agencies include the Bureau of Land Management and Bureau of Ocean Energy Management, which administer leases to produce energy on federal lands and oceans.

STATE

California Natural Resources Agency (CNRA) is the cabinet-level agency that oversees the policies and programs of fifteen different state agencies tasked with the stewardship of California's natural, cultural, and historic resources. Notable agencies and departments within CNRA include CAL FIRE, California Energy Commission, and the Geological Energy Management Divisions.

California Energy Commission (CEC) is a five-member agency (appointed by the Governor) that is responsible for energy policy and planning. The CEC, which was established in 1974, oversees the implementation of the Renewable Portfolios Standard (RPS), energy efficiency standards, investments in clean fuel technologies, and rooftop solar and electric vehicle mandates on new homes.

Geologic Energy Management Division (CalGEM) is a regulatory division within the Department of Conservation that oversees the drilling, operation, and closure of energy resource wells in California.

California Environmental Protection Agency (CalEPA) is a cabinet level agency established in 1991 that consolidated various agencies tasked with implementing California's environmental laws. One of its largest sub-agencies is the California Air Resources Board.

California Air Resource Board (CARB) was established in 1967 with the purpose of addressing air pollution. It is an agency within the California Environmental Protection Agency and has a 12-member Board (appointed by both the Governor and the Legislature). It has a critical role in regulating vehicle emissions, both criteria air pollutants and greenhouse gases

(GHG). It manages the state's cap and trade program that regulates GHG emissions from stationary sources.

California Public Utilities Commission (CPUC) is a five-member regulatory body (appointed by the Governor) responsible for regulating the energy, water, and telecommunications sectors. It was formed in 1911 with the initial responsibility of regulating the railroad industry.
The CPUC is responsible for regulating the energy rates set by the state's investor-owned energy utilities (IOU). The CPUC also exercises authority over power procurement, electricity and natural gas infrastructure, energy efficiency, public safety, and transportation network.
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State Leadership

Ana Matosantos, Energy Czar, Office of Governor Newsom

Wade Crowfoot, Secretary, CA Natural Resources Agency

David Hochschild, Chair, CEC *Janea Scott,* Vice-Chair, CEC

Jared Blumenfeld, Secretary, CA Environmental Protection Agency

Lianne Randolph, Chair, CARB
Sandra Berg, Vice-Chair, CARB

Alice Reynolds, President, CPUC

REGIONAL AND LOCAL – PUBLIC AND PRIVATE

Beyond the federal and state agencies that oversee California's energy system, there are numerous other entities – some private, some public – with varying responsibilities to deliver energy, manage infrastructure, and safeguard public safety and well-being.

California Independent System Operator (CAISO) is a non-government, independent body that manages 80 percent of California's high voltage electrical grid. Established in 1996 to steward a competitive wholesale market, CAISO operates the state's electricity markets and balances electricity supply and demand in real time, at all times. It is overseen by a 5-member Board, which is appointed by the Governor.

Investor-Owned Utilities (IOU) are private, regulated monopolies that serve the majority of the state's energy needs. IOU's own power plants, electrical lines and substations, and electric vehicle charging stations. In general, IOU's are responsible for maintaining grid infrastructure, forecasting long term and short term customer energy demands, and then procuring the needed energy to meet demand.
Examples include Pacific Gas & Electric Corporation, Southern California Edison, and San Diego Gas and Electric.

Publicly-Owned Utilities (POU) own local transmission and distribution assets and buy energy on behalf of the community they serve. In contrast to investor-owned utilities, municipal utilities set their energy rates through a locally-elected Board – not the CPUC. Further, POU's do not make a profit on their services. As public agencies, POU's can issue tax-exempt bonds to finance investments.
Examples include Los Angeles Department of Water and Power, Sacramento Municipal Utility District, and Turlock Irrigation District.

Community Choice Aggregation (CCA) are local government entities that buy power for their communities. In contrast to IOU's and POU's, CCA's do not own transmission and distribution infrastructure. CCA's can be established by local governing bodies, but only in IOU territory.
Examples include MCE, CleanPowerSF, and East Bay Community Energy.

Electrical Service Providers (ESP) are non-utility electricity providers that operate within an IOU territory. ESP's are most commonly used by companies with unique energy needs and prefer to tailor their resource planning. There is a limit on the amount of load that can be served by ESP's in California.
Examples include Constellation, CalPine Energy Solutions, and Liberty Power.

Air Pollution Control Districts (or Air Quality Management Districts) have regional jurisdictions to regulate air quality throughout the state. There are 35 such authorities that oversee planning, management, and emissions from stationary sources.

TERMINOLOGY

Demand Management

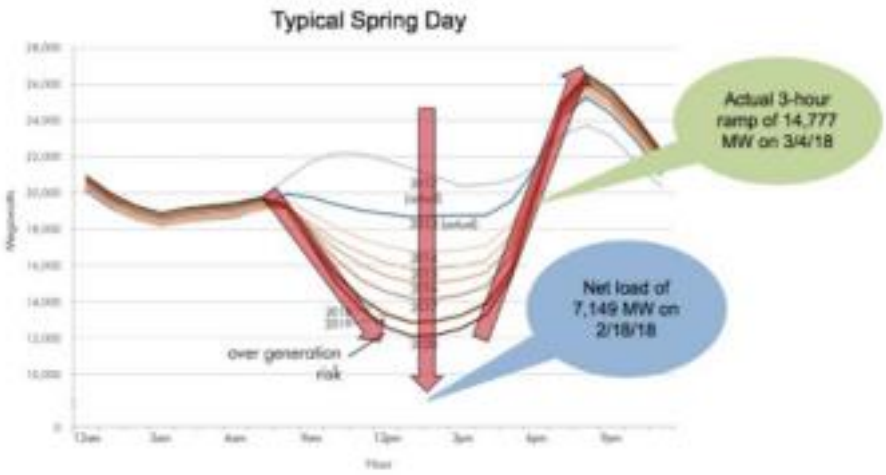
The practice of managing energy demand so that it better aligns with the available energy supply. This can be done with automated technologies or price signals to consumers.

Distributed Energy Resources (DER)

DER refers to electricity producing resources that are connected to a local distribution system. These resources tend to be smaller in size and produce less energy than utility-scale power plants. Rooftop solar, diesel generators, battery storage, and devices that modulate energy demand are examples of DER.

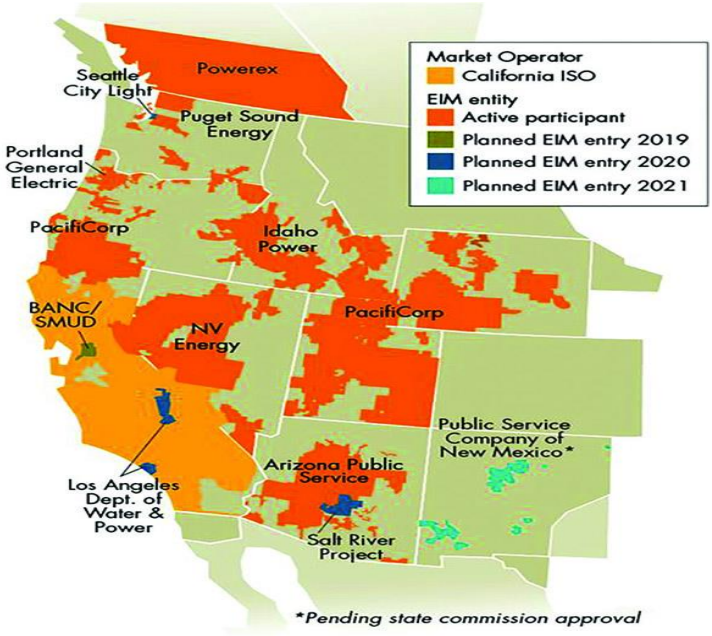
Duck Curve

The Duck Curve is a graphical representation of a side effect of increasing amounts of renewable energy on the electrical grid (see right). The graph shows that with increasing renewable energy, particularly solar power, during the middle of the day, there is less power needed from conventional baseload resources like natural gas (the "belly of the duck"). However, as the sun goes down and renewable generation declines, there is an increase in energy demand as people come home from work and turn on lights, make dinner, etc. (the "neck of the duck"). During this period of increasing energy demand, there is need to significantly increase the amount of energy generation from non-renewable resources that had been minimally used or idle throughout the day. This dynamic stresses grid operation and the commercial operation of baseload plants.



Energy Imbalance Market (EIM)

The California Independent System Operator's Energy Imbalance Market (EIM) is a real-time energy market, the first of its kind in the western U.S. EIM's advanced market systems automatically find low-cost energy to serve real-time consumer demand across a wide geographic area. In the beginning, resources were only being optimized across the CAISO and PacifiCorp balancing authority areas. But since that time, NV Energy, Arizona Public Service, Puget Sound Energy, Portland General Electric, Idaho Power, and Powerex have become participants in the EIM. The footprint now includes portions of Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, and Wyoming, even extending to the Canadian border.



Electrical Grid
The electrical grid (sometimes referred to as the energy system) is an electrical power system comprised of power plants, transmission lines, substations, distribution lines, and the end consumer. In general terms, electricity is generated and then processed at a substation that converts it into a form that can be transported over long distances. Once within a regional network, a grid operator (also known as a "balancing authority") manages and transmits it closer to the end point of consumption where another substation decreases the voltage so it can be delivered for use.

Flex Alert
When energy demand is projected to stress the available supply of energy, the grid operator (CAISO) will issue a voluntary call to consumers to reduce how much energy they use. Events that can trigger a Flex Alert include hot weather, unplanned power outages, and damage to transmission lines.

Load Serving Entity (LSE)
An LSE is an entity that provides electricity to consumers. Utility is the general term for an LSE. PG&E, LADWP, and MCE are all examples of an LSE.

Micro-grid
Micro-grids are self-sufficient energy systems that need not be connected to the larger electrical grid. Micro-grids have their own power generation, storage, and load management technologies to ensure that energy can be consumed when not connected to the grid (or when the grid is not capable of delivering energy).

Provider of Last Resort (POLR)
The Provider of Last Resort is the entity that would become your energy provider should your current provider cease operations for any reason. The POLR is a backstop to ensure your energy service is not interrupted.

Renewable Portfolio Standard (RPS)
The RPS is a regulatory mechanism designed to increase the percentage of renewable energy in the state's electricity mix. It requires load serving entities to procure a certain amount of their energy from eligible renewable resources by specific dates. The current RPS statutory mandate is to procure 33 percent renewable energy by 2020 and 60 percent by 2030.

Resiliency
Resiliency is the ability of infrastructure and communities to withstand extreme weather events, wildfires, earthquakes, and heavy usage.

Resource Adequacy (RA)
Resource adequacy refers to the requirement of load serving entities to contract for sufficient energy resources to ensure electrical system reliability. RA legislation was passed after the energy crisis in the early 2000's to ensure California had adequate resources to serve systemwide needs, address local capacity constraints, and respond to periods of the day when there is a continuous increase in energy demand (e.g. early to late evening). RA obligations, which are determined by the CPUC, are the primary planning mechanism for making sure there is enough supply to meet demand.

The Hype About Hydrogen

Energy carriers allow the transport of energy in a usable form from one place to another. Hydrogen, like electricity, is an energy carrier that must be produced from another substance. Hydrogen can be produced—separated—from a variety of sources including water, fossil fuels, or biomass and used as a source of energy or fuel. Hydrogen has the highest energy content of any common fuel by weight (about three times more than gasoline), but it has the lowest energy content by volume (about four times less than gasoline).
It takes more energy to produce hydrogen (by separating it from other elements in molecules) than hydrogen provides when it is converted to useful energy. However, hydrogen is useful as an energy source/fuel because it has a high energy content per unit of weight, which is why it is used as a rocket fuel and in fuel cells to produce electricity on some spacecraft. Hydrogen is not widely used as a fuel now, but it has the potential for greater use in the future.

The Hydrogen Color Spectrum

Green hydrogen, blue hydrogen, brown hydrogen and even yellow hydrogen, turquoise hydrogen and pink hydrogen. They're essentially color codes, or nicknames, used within the energy industry to differentiate between the types of hydrogen.
Depending on the type of production used, different colors are assigned to the hydrogen. But there is no universal naming convention and these color definitions may change over time, and even between countries.

Green Hydrogen

Green hydrogen is the one produced with no greenhouse gas emissions Green hydrogen is made by using clean electricity from surplus renewable energy sources, such as solar or wind power, to electrolyse water. Electrolysers use an electrochemical reaction to split water into its components of hydrogen and oxygen, emitting zero-carbon dioxide in the process.
Green hydrogen currently makes up a small percentage of the overall hydrogen, because production is expensive. Just as energy from wind power has reduced in price, green hydrogen will come down in price as it becomes more common.

Blue Hydrogen

Blue hydrogen is produced mainly from natural gas, using a process called steam reforming, which brings together natural gas and heated water in the form of steam. The output is hydrogen – but also carbon dioxide as a by-product. That mean carbon capture and storage (CCS) is essential to trap and store this carbon.
Blue hydrogen is sometimes described as 'low-carbon hydrogen' as the steam reforming process doesn't actually avoid the creation of greenhouse gases.

Gray Hydrogen

Currently, this is the most common form of hydrogen production. Gray hydrogen is created from natural gas, or methane, using steam methane reformation but without capturing the green house gases made in the process.

Black and Brown Hydrogen

Using black coal or lignite (brown coal) in the hydrogen-making process, these black and brown hydrogen are the absolute opposite of green hydrogen in the hydrogen spectrum and the most environmentally damaging.
Just to confuse things, any hydrogen made from fossil fuels through the process of 'gasification' is sometimes called black or brown hydrogen interchangeably.

Pink Hydrogen

Pink hydrogen is generated through electrolysis powered by nuclear energy. Nuclear-produced hydrogen can also be referred to as purple hydrogen or red hydrogen.

In addition, the very high temperatures from nuclear reactors could be used in other hydrogen productions by producing steam for more efficient electrolysis or fossil gas-based steam methane reforming.

Turquoise Hydrogen

This is a new entry in the hydrogen color charts and production has yet to be proven at scale. Turquoise hydrogen is made using a process called methane pyrolysis to produce hydrogen and solid carbon. In the future, turquoise hydrogen may be valued as a low-emission hydrogen, dependent on the thermal process being powered with renewable energy and the carbon being permanently stored or used.

Yellow Hydrogen

Yellow hydrogen is a relatively new phrase for hydrogen made through electrolysis using solar power.