SUBCHAPTER 3.2

ENERGY

3.2 ENERGY

3.2.1 REGULATORY SETTING

Federal and state agencies regulate energy use and consumption through various means and programs. On the federal level, the U.S. DOT, U.S. DOE, and U.S. EPA are three agencies with substantial influence over energy policies and programs. Generally, federal agencies influence transportation energy consumption through establishment and enforcement of fuel economy standards for automobiles and light trucks, through funding of energy related research and development projects, and through funding for transportation infrastructure projects. On the state level, the California Public Utilities Commission (CPUC) and California Energy Commission (CEC) are two agencies with authority over different aspects of energy. The CPUC regulates privately-owned utilities in the energy, rail, telecommunications, and water fields. The CEC collects and analyzes energy-related data, prepares state-wide energy policy recommendations and plans, promotes and funds energy efficiency programs, and regulates the power plant siting process. California is preempted under federal law from setting state fuel economy standards for new on-road motor vehicles. Some of the more relevant federal and state transportation-energy-related laws and plans are discussed below.

3.2.1.1 Federal Regulations

<u>Energy Policy and Conservation Act</u>

The Energy Policy and Conservation Act of 1975 sought to ensure that all vehicles sold in the U.S. would meet certain fuel economy goals. Through this Act, Congress established the first fuel economy standards for on-road motor vehicles in the U.S. Pursuant to the Act, the National Highway Traffic and Safety Administration, which is part of the U.S. DOT, is responsible for establishing additional vehicle standards and for revising existing standards. Since 1990, the fuel economy standard for new passenger cars has been 27.5 miles per gallon. Since 1996, the fuel economy standard for new light trucks (gross vehicle weight of 8,500 pounds or less) has been 20.7 miles per gallon. Heavy-duty vehicles (i.e., vehicles and trucks over 8,500 pounds gross vehicle weight) are not currently subject to fuel economy standards. Compliance with federal fuel economy standards is not determined for each individual vehicle model, but rather, compliance is determined on the basis of each manufacturer's average fuel economy for the portion of their vehicles produced for sale in the U.S. The Corporate Average Fuel Economy (CAFE) program, which is administered by U.S. EPA, was created to determine vehicle manufacturers' compliance with the fuel economy standards. The U.S. EPA calculates a CAFE value for each manufacturer based on city and highway fuel economy test results and vehicle sales. Based on the information generated under the CAFE program, the U.S. DOT is authorized to assess penalties for noncompliance.

Intermodal Surface Transportation Efficiency Act

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) promoted the development of inter-modal transportation systems to maximize mobility as well as address national and local interests in air quality and energy. ISTEA contained factors that Metropolitan Planning Organizations (MPOs), such as SCAG, were to address in developing transportation plans and programs, including some energy-related factors. To meet the new ISTEA requirements, MPOs adopted explicit policies defining the social, economic, energy, and environmental values that were to guide transportation decisions in that metropolitan area. The planning process for specific projects would then address these policies. Another requirement was to consider the consistency of transportation planning with federal, state, and local energy goals. Through this requirement, energy consumption was expected to become a decision criterion, along with cost and other values that determine the best transportation solution.

Transportation Equity Act for the 21st Century

The Transportation Equity Act for the 21^{st} Century (TEA-21) was signed into law in 1998 and builds upon the initiatives established in the ISTEA legislation, discussed above. TEA-21 authorizes highway, highway safety, transit, and other surface transportation programs for the next six years. TEA-21 continues the program structure established for highways and transit under ISTEA, such as flexibility in the use of funds, emphasis on measures to improve the environment, and focus on a strong planning process as the foundation of good transportation decisions. TEA-21 also provides for investment in research and its application to maximize the performance of the transportation system through, for example, deployment of Intelligent Transportation Systems, to help improve operations and management of transportation systems and vehicle safety.

Clean Cities Program

The U.S. DOE's Clean Cities Program promotes voluntary, locally-based government/industry partnerships for the purpose of expanding the use of alternatives to gasoline and diesel fuel by accelerating the deployment of alternative fuel vehicles (AFVs) and building a local AFV refueling infrastructure. The Clean Cities Program has created more than 70 partnerships in communities throughout the country. Six of these partnerships have been established in the southern California region: Coachella Valley, Lancaster, Long Beach, Los Angeles, Northwest Riverside, and one administered by SCAG (SCAG, 2001).

3.2.1.2 State Regulations

State of California Energy Plan

The CEC is responsible for preparing the State Energy Plan, which identifies emerging trends related to energy supply, demand, conservation, public health and safety, and the maintenance of a healthy economy. The plan calls for the state to assist in the transformation of the transportation system to improve air quality, reduce congestion, and increase the efficient use of fuel supplies with the least environmental and energy costs. To further this policy, the plan identifies a number of strategies, including assistance to public agencies and fleet operators in implementing incentive programs for ZEVs and addressing their infrastructure needs; and encouragement of urban designs that reduce vehicle miles traveled and accommodate pedestrian and bicycle access (SCAG, 2001).

<u>California Environmental Quality Act (CEQA)</u>

Appendix F of the CEQA Guidelines describes the types of information and analyses related to energy conservation that are to be included in EIRs that are prepared pursuant to the CEQA. In Appendix F of the CEQA Guidelines, energy conservation is described in terms of decreased per capita energy consumption, decreased reliance on natural gas and oil, and increased reliance on renewable energy sources. To assure that energy implications are considered in project decisions, EIRs must include a discussion of the potentially significant energy impacts of proposed projects, with particular emphasis on avoiding or reducing inefficient, wasteful and unnecessary consumption of energy.

3.2.2 ENERGY TRENDS IN GENERAL (STATEWIDE)

Figure 3.2-1 shows California's major sources of energy. In 2001, 49.4 percent of the petroleum came from in-state, with 21.3 percent coming from Alaska, and 29.3 percent being supplied by foreign sources. In 1999, 82 percent of the electricity came from in-state sources and 18 percent was imported into the state. The electricity imported totaled 49,486 gigawatt hours (gWh), with 25,629 gWh coming from the Pacific Northwest, 19,734 gWh from the Southwest, and 4,123 gWh coming from other sources. A gigawatt is equal to one million kilowatts. For natural gas in 1999, 46 percent came from the Southwest, 28 percent from Canada, 16 percent from in-state, and 10 percent from the Rockies.

3.2.2.1 Electricity

The electricity market in California was restructured under Assembly Bill 1890 (AB 1890), which was signed into law in 1996. Restructuring involved decentralizing the generation, transmission, distribution and customer services which had previously been integrated into individual privately-owned utilities, increasing competition in the power generation business, increasing customer choice through the Power Exchange (PX), and releasing of control by privately-owned utilities of their transmission lines to a central operator called the Independent System Operator (ISO). Publicly-owned utilities provide electric service to approximately one-quarter of the state's population, and although the changes instituted by AB 1890 do not apply to them to the same extent as to the privately-owned utilities, AB 1890 does state the Legislature's intention that the state's publicly- owned

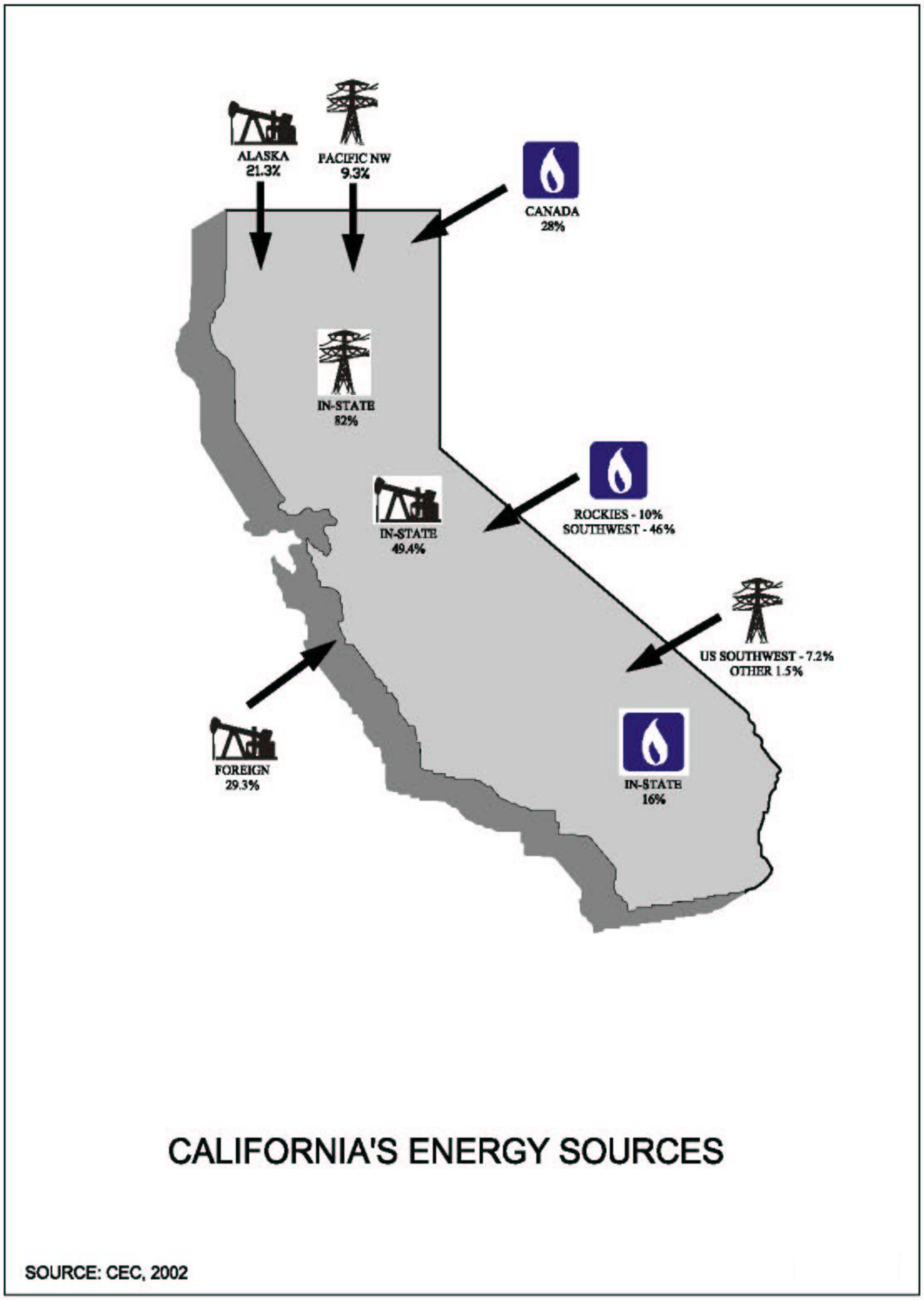

Figure 3.2-1
California's Major Sources of Energy

utilities voluntarily give control of their transmission facilities to the ISO, just as the privately-owned utilities are required to do. In-state power plants supply most of California's electricity demand, while hydroelectric power plants from the Pacific Northwest, and power plants in the southwestern U.S., provide California's out-of-state needs. The contribution between in-state and out-of-state power plants depends upon, among other factors, the precipitation that occurred in the previous year and the corresponding amount of hydroelectric power that is available. Two of the largest power plants in California are located in southern California at Alamitos and Redondo Beach. Both of these plants consume natural gas. San Onofre, the state's largest power plant in terms of net capability, is nuclear powered and is located just south of the District in San Diego County. Local electricity distribution service is provided to customers within the District by a small number of privately-owned utilities, such as Southern California Edison Company and San Diego Gas & Electric Company. Many public-owned utilities, such as the Los Angeles Department of Water and Power and the Imperial Irrigation District also provide service. Southern California Edison is the largest electricity utility in southern California with a service area that covers all or nearly all of Orange, San Bernardino, and Ventura counties, and most of Los Angeles and Riverside counties. Southern California Edison Company provides approximately 70 percent of the total electricity demand in the District. The San Diego Gas & Electric Company provides local distribution service to the southern portion of Orange County (SCAG, 2001).

The Los Angles Department of Water and Power is the largest of the public-owned electric utilities in southern California. Los Angeles Department of Water and Power provides electricity service to most customers located in the City of Los Angeles and provides approximately 20 percent of the total electricity demand in the District. Other cities that operate their own electric utilities in the region include Burbank, Glendale, Pasadena, Azusa, Vernon, Anaheim, Riverside, Banning, and Colton. Two water districts provide local electric service: Imperial Irrigation District and Southern California Water District. Imperial Irrigation District provides electricity to customers in Imperial County and the Coachella Valley portion of Riverside County. Southern California Water Company provides electric service to the community of Big Bear. Anza Electric Cooperative provides local distribution service to the Anza Valley area of southern Riverside County (SCAG, 2001).

Table 3.2-1 shows the amount of electricity delivered to residential and nonresidential entities in the counties in the South Coast Air Basin.

TABLE 3.2-1

California Utility Electricity Deliveries for 2000

	Residential		**Nonresidential**		**Total**	
County	**Number of Accounts**	**kWh[1] (million)**	**Number of Accounts**	**kWh (million)**	**Number of Accounts**	**kWh (million)**
Los Angeles	2,956,616	18,342	356,167	45,577	3,312,783	63,919
Orange	878,934	6,092	120,907	13,612	999,841	19,704
Riverside	500,171	4,396	157,503	6,425	657,674	10,821
San Bernardino	547,654	3,774	67,131	8,093	914,785	11,867

California Energy Commission (CEC), 2002d

[1] kilowatt-hour (kWh): The most commonly-used unit of measure telling the amount of electricity consumed over time. It means one kilowatt (1000 watts) of electricity supplied for one hour.

3.2.2.2 Natural Gas

Four regions supply California with natural gas. Three of them—the Southwestern U.S., the Rocky Mountains, and Canada—supply 85 percent of all the natural gas consumed in California. The remainder is produced in California. In 2000, approximately 35 percent of all the natural gas consumed in California was used to generate electricity. Residential consumption represented approximately one-fourth of California's natural gas use with the balance consumed by the industrial, resource extraction, and commercial sectors. Southern California Gas Company, a privately-owned utility company, provides natural gas service throughout the District, except for the City of Long Beach, the southern portion of Orange County, and portions of San Bernardino County. The service area for the Long Beach Gas & Electric Department, a municipal utility owned and operated by the City of Long Beach, includes the cities of Long Beach and Signal Hill, and sections of surrounding communities, including Lakewood, Bellflower, Compton, Seal Beach, Paramount, and Los Alamitos. San Diego Gas & Electric Company provides natural gas service to the southern portion of Orange County. In San Bernardino County, Southwest Gas Corporation provides natural gas service to Victorville, Big Bear, Barstow, and Needles (SCAG, 2001) (CEC, 2002a).

Table 3.2-2 provides the estimated use of natural gas in California by residential, commercial and industrial sectors. About 71 percent of the natural gas consumed in California is for industrial and electric generation purposes.

TABLE 3.2-2

California Natural Gas Consumption 2000
(Million Cubic Feet per Day – MMcfd)

Sector	Utility	Non-Utility	Total
Residential	1,381	--	1,381
Commercial	505	--	505
Industrial	1,327	1,044	2,371
Electric Generation	2,281	45	2,326
Total	**5,495**	**1,089**	**6,584**

Source: CEC, 2002b

3.2.2.3 Liquid Petroleum Fuels

California is the third largest oil-producing state in the U.S., behind Alaska and Texas (including Federal Offshore). In 2001, the total receipts to refineries of roughly 655 million barrels came from in-state oil production (49.4 percent), combined with oil from Alaska (21.3 percent) and foreign sources (29.3 percent) (CEC, 2002c).

California is a major refining center for West Coast petroleum markets with combined crude oil distillation capacity totaling more than 1.9 million barrels per day, ranking the state third highest in the nation. California ranks first in the U.S. in gasoline consumption and second in jet fuel consumption (CEC, 2002c).

A large network of crude oil pipelines connects producing areas with refineries that are located in the San Francisco Bay area, Los Angeles area and the Central Valley. Major ports in northern and southern California receive Alaska North Slope and foreign crude oil for processing in many of the state's 21 refineries (CEC, 2002c).

Most gasoline and diesel fuel sold in California for on-road motor vehicles is refined in California to meet state-specific formulations required by the CARB. Major petroleum refineries in California are concentrated in three counties: Contra Costa County in northern California, Kern County in central California, and Los Angeles County in southern California. In Los Angeles County, petroleum refineries are located mostly in the southern portion of the county. BP Arco, and ConocoPhillips operate refineries in Carson; Shell, Valero, and ConocoPhillips operate refineries in Wilmington; ExxonMobil operates a refinery in Torrance; and ChevronTexaco operates a refinery in El Segundo (SCAG, 2001).

The long-term oil supply outlook for California remains one of declining in-state and Alaska supplies leading to increasing dependence on foreign oil sources. Since 1980, the world has consumed more oil than has been discovered. Current data suggests that one new barrel of oil is being found for every four barrels being consumed (Hubbert, 1999).

Sometime between 2005 and 2025, world oil production will reach a peak and will begin a sharp decline. If this permanent oil shock begins near 2010 at 85 million barrels per day (MMBD), the future production is anticipated to drop to 35 MMBD in 2020 (60% decline in 10 years). More than half the world's oil (and 70 percent of the US oil) will be consumed during a single human lifetime. In the last fifty years, the human population has doubled, and the number of cars has grown tenfold from 50 to 500 million. As Americans continue to consume oil, oil demand will eventually outstrip oil supplies. By 2010, the world may be consuming as much as 90 million barrels per day, 20 percent more than it does now. By 2050, nine billion people will be consuming only as much oil as three billion did in 1950 (SCAG, 2001).

The production in California's refineries has not been able to keep up with the demand in growth in recent years and the State has become a net importer of all categories of petroleum products, including finished gasoline, blend stocks, diesel and jet fuel. The state's shortfall is expected to increase significantly over the coming years. California receives limited supplies from refiners in nearby Washington, but California has to cover the bulk of its shortfall in petroleum products with imports from the U.S. Gulf Coast, the Canadian East Coast, the Caribbean, Europe, Asia and the Middle East. California currently imports about 300,000 barrels per day of petroleum products. Because of the large increase in imports, the volumes of products handled through the State's marine facilities have tripled since 1996. It is this sharp rise in import volumes coupled with stagnating infrastructure, which is in large part responsible for the current supply difficulties. Permitting restraints and technical limitations are expected to make it more difficult for refiners to continue to realize small gains in production capacity, which have averaged about 0.7 percent per year since 1995, when refineries first started to run at or near maximum sustainable operating rates (CEC, 2002).

CARB has enacted Reformulated Fuel Phase III requirements that includes the phase-out of methyl tertiary butyl ether (MTBE) from gasoline by December 2003. The removal of MTBE from gasoline is expected to cause a reduction in gasoline supplies by five to 10 percent. This shortfall will predominantly affect the southern California market (CEC, 2002) because no major increase in refining capacity has been proposed at southern California refineries. This makes the southern California area more vulnerable to supply shortages and more likely to be subjected to price fluctuations (CEC, 2002).

The increasing dependency on foreign imports represents significant exposure for the future capability to keep California supplied with gasoline because only a limited number of foreign refineries or refineries outside of California are willing or capable of producing fuels that comply with CARB requirements. The number of foreign refineries that can produce fuels in compliance with CARB Phase III requirements is expected to be even less (CEC, 2002).

The State of California is investigating measures to provide stability in the gasoline market that could include more streamlined permitting activities, the development of more storage capacity, and the development of a strategic fuels reserve to minimize the impact of a supply shortage (CEC, 2002).

3.2.3 ALTERNATIVE CLEAN TRANSPORTATION FUELS

The U.S. DOT currently recognizes the following as alternative fuels: methanol and denatured ethanol (alcohol mixtures that contain no less than 70 percent of the alcohol fuel), natural gas (compressed or liquefied), liquefied petroleum gas (LPG), hydrogen, coal derived liquid fuels, fuels derived from biological materials (i.e., biomass), and electricity. The liquid fuel referred to as Methanol (M85) consists of methanol and gasoline and is derived from natural gas, coal or woody biomass. The liquid fuel referred to as Ethanol (E85) consists of ethanol and gasoline and is derived from corn, grains or agricultural waste. Natural gas consists of a high percentage of methane (generally above 85 percent), and varying amounts of ethane, propane, butane, and inerts (typically nitrogen, carbon dioxide, and helium) and come from underground reserves. LPG consists mostly of propane and is a byproduct of petroleum refining or natural gas processing. Current technologies for electric vehicles include lead acid and nickel metal hydride batteries (SCAG, 2001).

3.2.4 RENEWABLE ENERGY

Assembly Bill 1890 (AB1890, Brulte, Chapter 854, Statutes of 1996) required California's three major investor-owned utilities to collect money from their ratepayers over a four-year period (1998 to 2002) to help support renewable electricity-generation technologies and develop a renewable market. As mandated by AB1890, the CEC submitted its *Policy Report on AB 1890 Renewables Funding (Policy Report)* to the Legislature in March 1997, with recommendations for allocating and distributing these funds. Senate Bill 90 (SB 90, Sher, Chapter 905, Statutes of 1997) subsequently established the Renewable Resource Trust Fund, placed $540 million into the fund, and directed the CEC to distribute the fund through four distinct accounts, which is consistent with the Policy Report. These accounts are as follows:

- Existing Renewable Resources Account
- New Renewable Resources Account
- Emerging Renewable Resources Account
- Customer-Side Renewable Resources Purchases Account:
  - Customer Credit Sub-account
  - Consumer Education Sub-account

The CEC will also have a role in implementing a portion of Senate Bill 1078 (SB 1078, Sher, Chapter 516, Statutes of 2002), signed by the Governor on September 12, 2002, which establishes a Renewable Portfolio Standard (RPS) in California. Senate Bill 1078 requires utilities to increase their procurement of renewable energy resources by at least one percent each year so that 20 percent of its retail sales are procured from eligible renewables by 2017. The CEC will develop eligibility requirements for certifying renewable facilities, create a system for tracking renewables purchases. The CEC will collaborate with the CPUC and other agencies as it prepares for implementing the RPS under SB 1078 (CEC, 2002g).

Renewable energy resources are naturally replenishable, but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Some (such as geothermal and biomass) may be stock-limited in that stocks are depleted by use, but on a time scale of decades, or perhaps centuries, they can probably be replenished. Renewable energy resources include: biomass, hydro, geothermal, solar, and wind. In the future they could also include the use of ocean thermal, wave, and tidal action technologies. Utility renewable resource applications include bulk electricity generation, on-site electricity generation, distributed electricity generation, non-grid-connected generation, and demand-reduction (energy efficiency) technologies (CEC, 2002f).

The CEC continues to make progress in implementing the initial Renewable Energy Program. The program responded to California's recent energy challenges by hastening the development of new renewables projects and continuing to develop consumer demand for renewable energy. Over the last two years, customer interest in rebates for emerging renewable technologies, especially for solar photovoltaic (PV) and wind energy systems, has increased tenfold (CEC, 2002).

During the last four years the Renewable Energy Program brought over 240 megawatts of new renewables online, which could eventually total 1,300 megawatts of new renewable capacity for California's electric grid. A total of 274 facilities were able to keep 4,400 megawatts of existing renewables operative and supported over 200,000 customer purchases of electricity generated by renewable energy. By the end of 2002, rebates will have been provided for installing 7,500 on-site systems representing over 21 megawatts of solar and wind energy capacity. The program continues to help consumers learn about the benefits of renewable energy and how they can support renewables in today's markerplace (CEC, 2002).

Table 3.2-1 shows the amount and percentage of gross electricity produced, to include renewables, in California during 2001.

3.2.4.1 Hydroelectric Power

Hydroelectric power is a major source of electricity for California, and the nation. About 23 percent of the total electricity in California is hydroelectric – 20 percent from large hydroelectric plants, and about three percent from small hydroelectric facilities (30 megawatts or less). Nationally, hydroelectricity accounts for about 10 percent of the country's total electricity production – about 77,000 megawatts.

The U.S. Bureau of Reclamation, and the State of California's Department of Water Resources operate large hydroelectric plants, located on dams in California, such as Shasta, Folsom, Oroville, etc. Smaller plants in the state are operated by utilities; mainly Pacific Gas and Electric Company and Sacramento Municipal Utility District. Licensing of hydroelectric plants is done by the Federal Energy Regulatory Commission, with input from state and federal energy, environmental protection, fish and wildlife, and water quality agencies.

Hydroelectric power, a renewable resource, is generated when hydraulic turbines are turned by the force of moving water as it flows through a turbine. The water typically flows from a higher to a lower elevation. These turbines are connected to electrical generators, which produce the power. The efficiency of such systems can be close to 90 percent (CEC, 2002h).

Hydroelectric power is generated in the District, but is a smaller percentage of overall generation as compared to the rest of the state. Hydroelectric power is supplied to the District by investor-owned utilities, water districts, and municipalities (CEC, 2002i).

3.2.4.2 Geothermal Energy

Geothermal energy is produced by the heat of the earth and is often associated with volcanic and seismically active regions. California has 25 known geothermal resource areas, 14 of which have underground water temperatures of 300 degrees Fahrenheit (149 degrees Celsius) or greater.

Hot water and, in some instances, steam can be used to make electricity in large power plants. Hot water can also be put to direct use, such as heating greenhouses or other buildings. The constant temperature below ground can also be tapped to warm or cool homes through a ground-source heat pump.

Forty-six of California's 58 counties have lower temperature resources for direct-use geothermal. The City of San Bernardino has developed the largest number of geothermal direct-use projects in North America, heating at least three dozen buildings – including a 15-story high-rise and government facilities – with fluids distributed through 15 miles of pipelines (CEC, 2002h).

When added together, California's 47 geothermal power plants produce about 40 percent of the world's geothermally-generated electricity. The power plants have a dependable installed capacity of about 2,626 megawatts and produced 4.9 percent of California's total electricity in 1999 (12,786 gigawatt/hours).

The most developed of the high-temperature resource areas of the state is the Geysers. North of San Francisco, the Geysers was first tapped as a geothermal resource to generate electricity in 1960. It is one of only two locations in the world where a high-temperature, dry steam is found that can be directly used to turn turbines and generate electricity (the other being Larderello, Italy). Other major geothermal locations in the state include the Imperial Valley area east of San Diego and the Coso Hot Springs area near Bakersfield. It is estimated that the state has a potential of more than 4,000 megawatts of additional power from geothermal energy, using current technologies.

3.2.4.3 Waste-to-Energy

Californians create nearly 2,900 pounds of household garbage and industrial waste each and every second**;** a total of 45 million tons of waste per year (according to the California Integrated Waste Management Board) (CEC, 2002h).

Historically, trash was primarily disposed of in landfills. Today, however, waste and its by-products are being recycled into more useful products. Some waste materials are being used as a fuel in power plants to create electricity or other forms of energy.

The combined ash and air pollution control residue typically ranges from 20 to 25 percent by weight of the incoming refuse processed. This ash residue may or may not be considered a hazardous material, depending on the makeup of the municipal waste.

It may be possible to avoid the production of hazardous ash by preventing the sources which create hazardous waste from entering the system. It is also possible to treat the ash. Both of these methods avoid the costs of disposal at a limited number of landfills classified as able to handle hazardous materials. Non-hazardous ash can be mixed with soils for use as land-fill cover, or can be sold (or given away) for such beneficial uses as pavement aggregate or for cinder block production.

Waste-to-energy power plants are defined by the type of fuel source they use, biomass, digester gas, industrial waste, landfill gas, or municipal solid waste. All together there are 103 waste-to-energy plants in California, with a total installed capacity of 1,070 megawatts, about two percent of the state's total electrical capacity. These plants produced 5,701 gWh of electricity in 1997 (CEC, 2002h). Two waste-to-energy plants are located in Los Angeles County, one in the city of Long Beach and one in the City of Commerce.

<u>Biomass Electricity</u>

Biomass energy is the term used for the use of wood products to heat homes and businesses. Biomass consists of organic residues from plants and animals, which are obtained primarily from harvesting and processing of agricultural and forestry crops. These are used as fuels in direct combustion power plants. The biomass is burned producing heat that is used to create steam to turn turbines to produce electricity. The steam can often be used for another process – such as drying of vegetables or used in a factory, i.e., cogeneration.

Examples of some of the biomass residues that are utilized in direct combustion power plants are: forest slash, urban wood waste, lumber waste, agricultural wastes, etc. The components of biomass include cellulose, hemicelluloses, lignin, lipids, proteins, simple sugars, starches, water, hydrocarbons, ash and other compounds. The total estimated biomass resource potential of California is approximately 47 million tons.

In the year 2000, California's waste-to-energy power plants installed capacity totaled 1,070 megawatts of electricity from 103 facilities (CEC, 2002h).

There is one biomass facility in both Riverside and San Bernardino counties.

Pyrolysis/Thermal Gasification

Pyrolysis and thermal gasification are related technologies. Pyrolysis heats organic material to high temperatures in the absence of gases such as air or oxygen. The process produces a mixture of combustible gases (primarily methane, complex hydrocarbons, hydrogen, and carbon monoxide), liquids and solid residues. Thermal gasification of Municipal Solid Waste (MSW) is different from pyrolysis in that the thermal decomposition takes place in the presence of a limited amount of oxygen or air.

The producer gas which is generated in either process can then be used in boilers or cleaned up and used in combustion turbine/generators. The primary area of research for this technology is the scrubbing of the producer gas of tars and particulates at high temperatures in order to protect combustion equipment downstream of the gasifier and still maintain high thermal efficiency.

Both of these technologies are in the development stage with a limited number of units in operation. The Hyperion Energy Recovery System operated by the City of Los Angeles had a system designed to fire dried sewage sludge in a staged fluidized bed combustor. The resulting gas was then combusted in stages, and the heat was used to turn water into steam, driving a ten megawatt steam turbine-generator.

Landfill Gas

When trash is buried in a landfill, an oxygen-free environment is created under the capping soil layer. With relatively dry conditions, landfill waste produces significant amounts of gas as it decomposes – mostly methane. With Californians dumping 45 million tons of waste per year, the total amount of landfill gases produced in California is tremendous (CEC, 2002h).

Landfill gas can be collected by a collection system, which typically consists of a series of wells drilled into the landfill and connected by a plastic piping system. The gas entering the gas collection system is saturated with water, and that water must be removed prior to further processing.

The typical dry composition of the low-energy content gas is 57 percent methane (natural gas), 42 percent carbon dioxide, 0.5 percent nitrogen, 0.2 percent hydrogen, and 0.2 percent oxygen. In addition, a significant number of other compounds are found in trace quantities. These include alkanes, aromatics, chlorocarbons, oxygenated compounds, other hydrocarbons and sulfur dioxide (CEC, 2002h).

After the water is removed, the landfill gas can be used directly in reciprocating engines. Or the carbon dioxide can be removed with further refining and purer methane can be used for electricity generation applications such as gas turbines and fuel cells. For example, Southern California Edison and LADWP operate a 40 kilowatt phosphoric acid fuel cell using processed landfill gas at a hotel/convention center complex in the City of Industry.

Digestor Gas

Anaerobic digestion is a biological process that produces a gas principally composed of methane (CH_4) and CO_2 otherwise known as biogas. These gases are produced from organic wastes such as livestock manure, food processing waste, etc.

Anaerobic processes could either occur naturally or in a controlled environment such as a biogas plant. Organic waste such as livestock manure and various types of bacteria are put in an airtight container called a digester so the process could occur. Depending on the waste feedstock and the system design, biogas is typically 55 to 75 percent pure methane. State-of-the-art systems report producing biogas that is more than 95 percent pure methane (CEC, 2002h).

Many anaerobic digestion technologies are commercially available and have been demonstrated for use with agricultural wastes and for treating municipal and industrial wastewater. Where unprocessed wastes cause odor and water pollution such as in large dairies, anaerobic digestion reduces the odor and liquid waste disposal problems and produces a biogas fuel that can be used for process heating and/or electricity generation.

3.2.4.4 Wind Power

There are many windy areas in California. Wind as an energy source can be problematic because it is not windy all year long, nor is the speed constant. It is usually windier during the summer months when wind rushes inland from cooler areas, such as near the ocean, to replace hot rising air in California's warm central valleys and deserts. By placing mechanical wind turbines in these windy areas, the moving wind can be tapped to make electricity.

A wind turbine is similar to a pinwheel or the propeller of an airplane. The blade of a turbine is tilted at an angle. The movement of the air is channeled, creating low and high pressures on the blade, which force it to move. The blade is connected to a shaft, which in turn is connected to an electrical generator. The mechanical energy of the turning blades is changed into electricity.

There are more than 14,000 wind turbines in California grouped together in what are called wind farms. The farms have roughly 1,800 megawatts of installed capacity. These wind farms are located mostly in the three windiest areas of the state:

- Altamont Pass east of San Francisco (outside the District)
- San Gorgonio Pass near Palm Springs (within the District)
- Tehachapi south of Bakersfield (outside the District)

Together these three places make enough electricity to supply an entire city the size of San Francisco with electrical power. All together the wind turbines in California produce about one percent of California's total electricity.

3.4.2.5 Solar

The sun's energy can be used directly to produce energy. Modern day devices that convert sunlight into energy are called (PV) cells or solar cells. More commonly, they are known as solar cells. Solar cells are used on calculators, sidewalk lighting systems, and along side freeways to power phones.

As an out-growth of the space exploration, and following the energy crises of the 1970s, PV development increased. In 1979, ARCO Solar began construction of the world's largest PV manufacturing facility, in Camarillo, California. ARCO Solar was the first company to produce more than one megawatt of PV modules in one year. Four years later, ARCO Solar dedicated a six megawatt PV facility in central California in the Carrissa Plain. The 120-acre unmanned facility supplied the Pacific Gas and Electric Company utility grid with enough power for about 2,500 homes (CEC, 2002h).

When large collections of PV panels or modules are put together, they can be tied into the electricity grid system. San Bernardino County is the only county in the District where solar power plants exist (CEC, 2002i).

Over the past 20 years, solar electricity generation technologies have grown, registering annual growth rates between 25 and 41 percent. Costs have also fallen by 80 percent. Global solar electric generation technologies contribute roughly 2,000 megawatts of electricity today. That figure is less than a tenth of the world's global electricity supply (CEC, 2002h).

California actually gets far more of its electricity from solar thermal power plants. Nine distinct solar thermal power plants located in the Mojave Desert total 360 megawatts, the largest central solar power station in the world, enough electricity to power about 360,000 homes (CEC, 2002h).

These solar thermal power plants rely upon curved mirrored troughs that concentrate sunlight. The sun heats a liquid that creates steam to turn a traditional turbine. A more efficient technology is called the "stirling dish," which is powered by a new kind of engine. Instead of the internal combustion engine, which relies upon an explosion inside the engine walls to turn pistons, the stirling dish engine relies upon the sun to heat tubes filled with hydrogen that turn the crankshaft.

Solar thermal electric capacity is predicted to increase worldwide. The cost of building, operating, and maintaining solar thermal electric systems has decreased dramatically -- in some cases by a factor of ten – during the 1980s and 1990s and is expected to continue dropping. Solar-thermal designs may be economically competitive with some conventional electricity-generating technologies. By 2010, some solar thermal electric technologies could be producing electricity at $0.06 to $0.07 per kilowatt hour (kWh) (CEC, 2002h).

3.2.4.6 Fuel Cells

Unlike conventional technologies, fuel is not "burned" but is combined in a chemical process. A fuel cell consists of two electrodes sandwiched around an electrolyte. Oxygen passes over one electrode and hydrogen over the other, generating electricity, water and heat.

Hydrogen fuel is fed into the "anode" of the fuel cell. Oxygen (or air) enters the fuel cell through the cathode. Encouraged by a catalyst, the hydrogen atom splits into a proton and an electron, which take different paths to the cathode. The proton passes through the electrolyte. The electrons create a separate current that can be utilized before they return to the cathode, to be reunited with the hydrogen and oxygen in a molecule of water.

A fuel cell system, which includes a "fuel reformer", can obtain hydrogen from any hydrocarbon fuel - from natural gas, methanol, and even gasoline. Other possible fuels include propane, hydrogen, anaerobic digester gas from wastewater treatment facilities, and landfill gas.

Fuel cells are being designed for use in stationary electric power plants to provide electricity for distributed power generation. These small systems can provide primary or back up power to commercial and industrial customers such as hotels, hospitals, manufacturing facilities, and retail shopping centers.