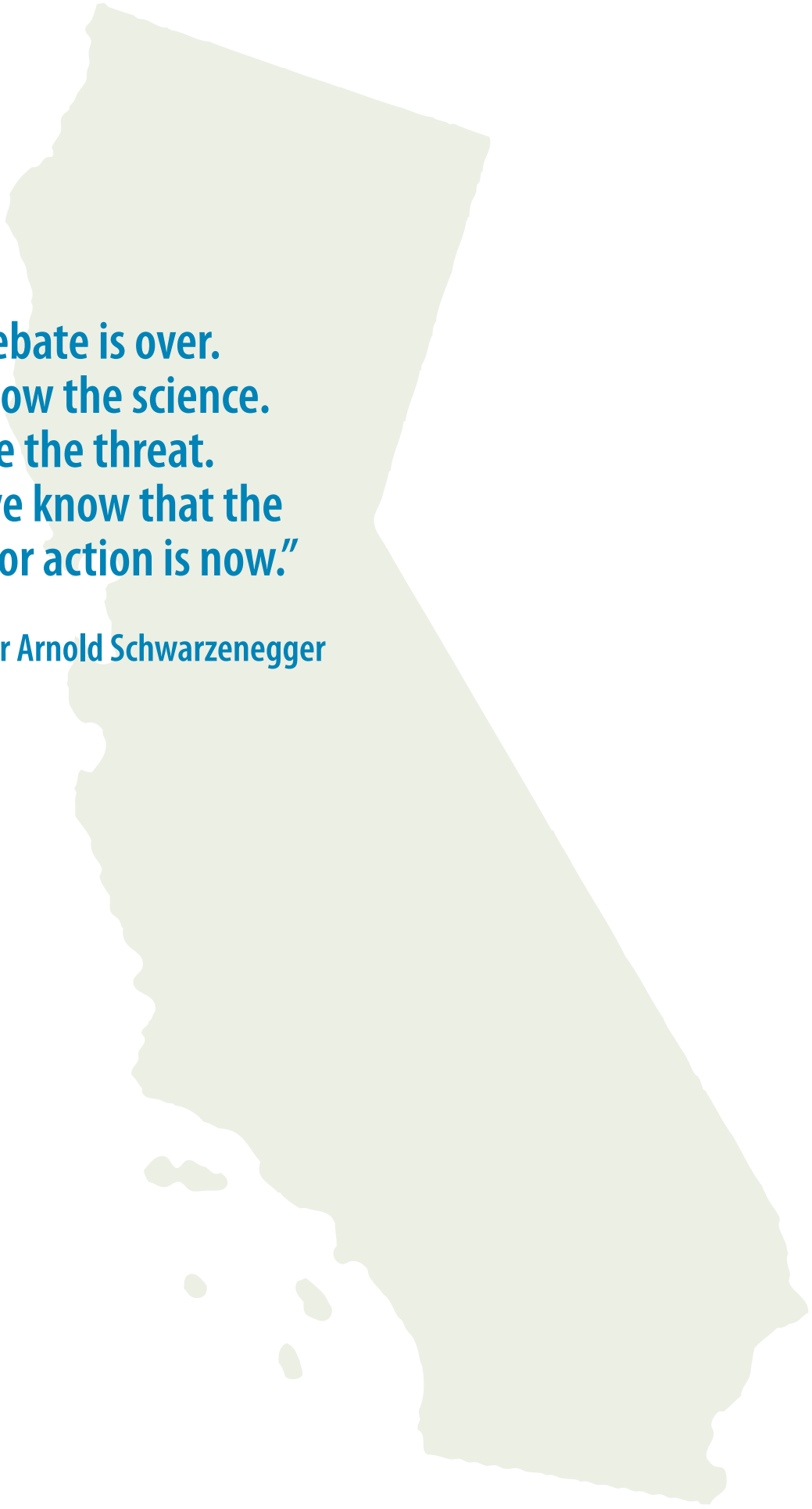
California
Energy
Commission

Arnold Schwarzenegger
Governor

INTEGRATED ENERGY POLICY REPORT

2007

Summary



"The debate is over.
We know the science.
We see the threat.
And we know that the
time for action is now."

Governor Arnold Schwarzenegger

Meeting California's Energy Needs in a Carbon-Constrained World

California's vibrant economy is dependent on reliable and affordable supplies of energy. Yet, fossil-based energy produces greenhouse gases that contribute significantly to climate change. California's challenge, like that of the rest of the developed world, is to maintain its growth and vitality while decreasing its greenhouse gas emissions.

Scientific consensus indicates that temperatures in the state are expected to increase during this century, and precipitation patterns are predicted to change – threatening California's environmental quality and robust economy. This temperature change will result in widespread environmental consequences – intensified air pollution, hotter summers and reduced farmland productivity, increased wildfires and pest infestations, decreased fish populations, and reduced snow packs in the Sierra Nevada Mountains, which will affect hydropower during the summer and contribute to possible water shortages.

Responding to the challenge of climate change, California Governor Arnold Schwarzenegger and the State Legislature passed the California Global

Focus of the *2007 Integrated Energy Policy Report*

- California's energy industries must meet environmental goals while accommodating economic and population growth.
- AB 32 – California must reduce greenhouse gas emissions to1990 levels by 2020.
- California's challenge is to meet growing energy needs while reducing CO_2 emissions.

Warming Solutions Act of 2006 (Assembly Bill 32, Núñez, Chapter 488, Statutes of 2006), capping California's greenhouse gas emissions at the 1990 level by 2020. Achieving that goal requires about a 29 percent[1] cut in emissions below projected 2020 levels. The Governor's long-term target is far more ambitious and calls for reducing emissions to 80 percent below 1990 levels by 2050. This is the level of worldwide reduction believed by many climate scientists as necessary to limit global temperature gains this century to 2 to 3 degrees Celsius.

The legislation marks a significant change in California's energy policies. Before its passage, energy policy makers focused on minimizing and stabilizing energy costs, ensuring supply, limiting dependence on imports and fossil fuels, protecting the environment, and benefiting the state's economy. With AB 32, California's energy policy goals must now also include reducing the state's greenhouse gas footprint.[2]

California at the Forefront, but with Challenges

Despite its early remoteness from most of the population centers in the United States, California has grown to become the most populous state in the nation and

Guiding Energy Policy

The California Energy Commission was created as the state's principal energy planning organization by then-Governor Ronald Reagan in 1974 to meet the energy challenges facing the state in response to the 1973 Oil Embargo. Six basic responsibilities guide the Energy Commission as it sets state energy policy: forecasting statewide electricity needs; licensing power plants to meet those needs; promoting energy conservation and efficiency measures; developing renewable energy resources and alternative energy technologies; research, development and demonstration; and planning for and directing state response to energy emergencies.

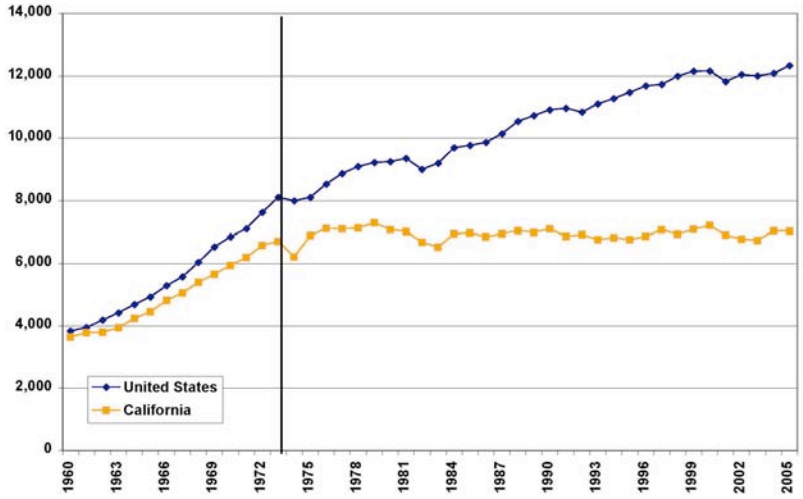
The Governor appoints the five members of the Commission to five-year terms that require Senate approval. The Commissioners represent the fields of engineering and physical science, economics, environmental protection, the public, and the law. The Energy Commission is unique among most governmental entities as all business is conducted in a public forum. A Public Adviser, also appointed by the Governor, ensures that the public and all interested parties are adequately represented at all Commission proceedings.

The Energy Commission receives its operational and administrative funding from an electricity consumption surcharge collected by the electric utilities through customers' utility bills, then transferred to the state's treasury. The surcharge is 2/10 of a mil, or $0.0002 per kilowatt hour of electricity consumption – about 12 to 14 cents per month on an average bill.

1 The 29 percent reduction of greenhouse gas emissions from a *business-as-usual* 2020 level is based on 173 million metric tons of carbon dioxide equivalent as adopted by the California Air Resources Board, December 6, 2007.

2 *Greenhouse gas footprint*, often referred to as *carbon footprint,* is a measure of the impact of human activities on Earth's climate systems, directly or indirectly, as greenhouse gas emissions produced over the life cycle of a product, service, or activity. These gases trap outgoing radiation that heats the atmosphere, increasing the *greenhouse effect* or global warming. The measure is usually expressed as tons of carbon dioxide (CO_2) equivalent. CO_2 accounts for about 89 percent of human-caused greenhouse gas emissions in California. Methane (CH_4), nitrous oxide (N_2O), and other man-made gases contribute the remainder of the gases.

Figure 1
California Holds the Line on Electricity Consumption
(Per Capita Electricity Sales in Kilowatt Hours per Person)



Source: California Energy Commission

the eighth largest economy in the world. Our diverse, dynamic, and creative population has put us at the forefront of environmental, economic, technological, political, social, and cultural development.

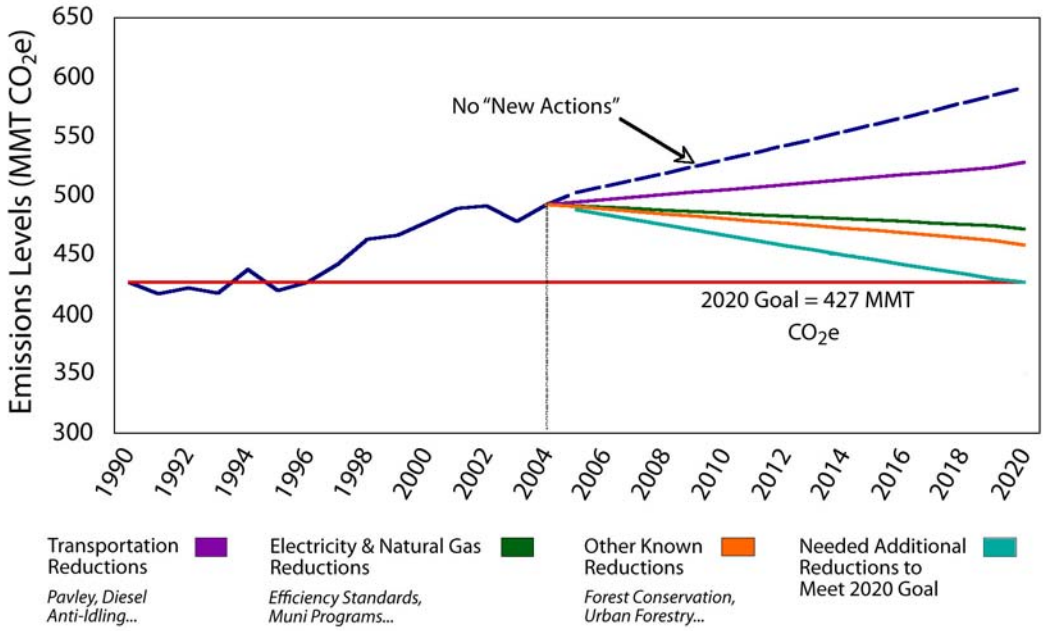
With a current population exceeding 37 million and projected to grow to more than 44 million by 2020, California's already over-burdened infrastructure – roads, pipelines, ports, refineries, power plants, and transmission lines – will be strained further to meet the state's increasing demand for energy. Most of the population growth is occurring in the hotter interior areas of the state, increasing the demand for air conditioning. California's limited mass transit options, particularly in the inland areas, and the historic tendency toward suburban sprawl, cause residents to rely more heavily on their cars, increasing individual vehicle miles traveled and energy demand.

Environmental consciousness is not new to California. In 1947, California passed the first state air pollution law, signed by Governor Earl Warren. The Air Pollution Control Act created an air pollution control district for every county. In 1975, in response to the OPEC oil embargo, Governor Reagan established the California Energy Commission to focus the state's energy policies on energy efficiency, renewable energy, research and development, and assurance of cost-effective, reliable, and environmentally preferred resources.

Largely as a result of these policies, California has the lowest electricity use per person in the nation. While the United States increased per capita electricity consumption by nearly 50 percent over the past 30 years, California's per capita electricity use remained almost flat, demonstrating the success of a variety of cutting-edge energy efficiency programs and cost-effective building and appliance efficiency standards (Figure 1).

These policies also influenced the fuel used to generate electric power. By the late 1970s, petroleum was the fuel source for more than half the state's electricity.

Figure 2
Reaching for the AB 32 Target



Source: California Energy Commission, Climate Action Team

Today, cleaner-burning natural gas fuels more than 40 percent of the state's electricity. Renewable energy supplies almost 11 percent of our electricity needs and, by 2010, state law requires that renewable energy will supply 20 percent.

To reduce the air pollution coming from automobiles, California adopted stringent tailpipe emission standards as early as 1966, and in 1971 adopted the first automobile nitrogen oxides standards – both were the first such standards in the nation. The California Smog Check Program, which assured the effectiveness of vehicle emission control systems, went into effect in 1984. In 1992, the first of many phases of reformulated clean burning gasoline was implemented in California, and in 1993, the state enacted new standards for cleaner diesel fuel.

Improving vehicle fuel efficiency offers potentially dramatic reductions in petroleum demand; however, only the federal government can implement vehicle fuel efficiency standards. California has continued efforts to reduce gasoline and diesel use and develop clean, alternative fuels. Assembly Bill 1007 (Pavley, Chapter 371, Statutes of 2005) directed the Energy Commission, in partnership with the California Air Resources Board (ARB), to develop and adopt a state plan to increase the use of alternative fuels in the transportation sector. The plan that was adopted in December 2007 describes strategies, highlights market penetration, and recommends new standards, requirements, financial incentives, and other policy mechanisms to address petroleum and greenhouse gas reduction and in-state biofuels production and use goals.

Executive Order S-1-07 calls for a Low Carbon Fuel Standard for California. By 2020, the Low Carbon Fuel Standard will result in a 10 percent reduction in the carbon content of all passenger vehicle fuels sold

in California. This is expected to replace 20 percent of our on-road gasoline consumption with lower carbon fuels, more than triple the size of the state's renewable fuels market, and place more than 7 million alternative fuel or hybrid vehicles on California's roads.

Yet, California's projected population growth will offset whatever gains existing efforts have made and continue to make in reducing emissions. The state currently emits almost 500 million metric tons of greenhouse gases – 28 percent from electricity generation and more than 38 percent from transportation. California must step up efforts with every emission-saving technique in its substantial repertoire for transportation and electricity to reduce greenhouse gases in 2020 to the levels mandated by the AB 32 goals (Figure 2).

The top dashed line on Figure 2 shows the anticipated growth in emissions levels with no new strategies undertaken to reduce this growth. The figure also depicts the potential effects of AB 32-compliant actions. The effects of these strategies can be significant compared to the projected unmitigated growth in emissions.

Inland Population Climbs

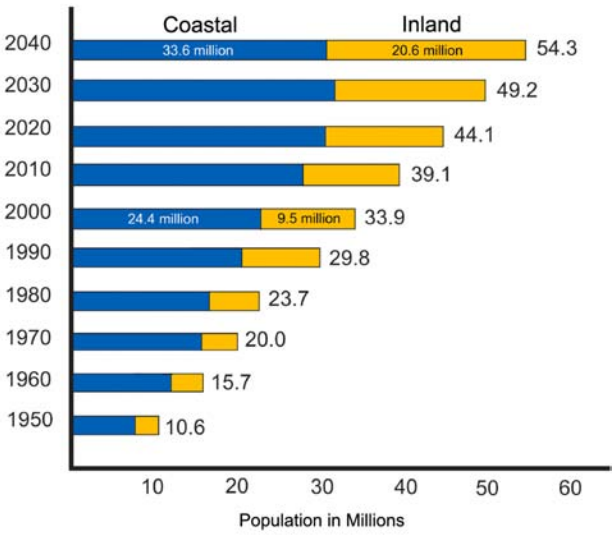
Lowering emissions while meeting the energy needs of a growing population is made even more challenging by the patterns of growth within the state. While today nearly 70 percent of the state's population today lives in coastal California, the inland areas – the San Joaquin Valley, Southern California's Inland Empire, and the Sacramento Valley – are growing faster than the coastal areas (Figure 3). By 2040, almost 40 percent of the state's population, or more than 20 million, will reside inland. This inland population growth increases the demand for electricity and transportation fuels. Compared to the more temperate coastal climate zones, the inland climate is more extreme.

Meeting AB 32 Goals

Some have argued that a single dimensional approach focusing on price, such as a carbon tax or a cap-and-trade program, would be the simplest approach for California to meet its AB 32 greenhouse emission goals. Others argue that the state's existing programs for energy efficiency and demand-side management, along with the Renewables Portfolio Standard, should be expanded as these programs will provide the earliest and most reliable emission reductions.

The Energy Commission believes that the most prudent avenue for addressing California's climate issues is to pursue both a pricing and program approach. The state must aggressively pursue and expand its energy efficiency and demand-side management programs, as well as meet its 33 percent Renewables Portfolio Standard. These important programs will provide early greenhouse gas emission reductions and serve as a solid foundation for cap-and-trade or carbon tax pricing.

Figure 3
California's Inland Population Increases



Source: California Department of Finance, Demographic Research Unit projections and Public Policy Institute of California

In the summer, hotter inland areas require more air conditioning than coastal areas, which increases peak electricity use. The Inland Empire and the Northern San Joaquin Valley are two of the fastest growing metropolitan areas in the United States. These areas often serve as bedroom communities for workers in the Los Angeles Basin and the San Francisco Bay Area. Growth in these inland areas means that more commuters drive longer distances to work each day, increasing the demand for transportation fuels.

Inland growth creates additional environmental problems. The San Joaquin Valley and the Inland Empire already have some of the worst air quality in the nation, and as California's growing population continues its inland trek, the situation is likely to worsen. By 2040, more people are projected to live in California's inland areas than lived in the entire state in 1970.

Focus on Greenhouse Gas Emissions

California's greenhouse gas emissions are huge and growing. In 2004, California produced almost 500 million metric tons of carbon dioxide (CO_2) – a greenhouse gas emission equivalent – making the state the second largest emitter of greenhouse gas emissions in the United States after Texas and about twelfth in the world. Eighty-nine percent of California's greenhouse gases are from CO_2 and the remaining gases include methane, nitrous oxide, and other man-made gases.[3]

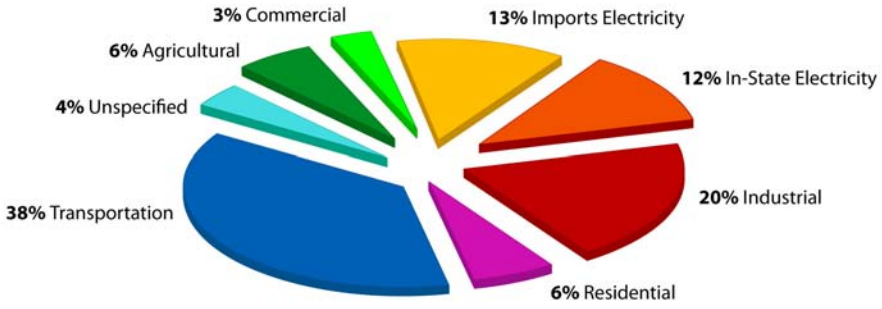
The transportation sector is the largest contributor to California's greenhouse gas emissions, producing more than 38 percent of the state's total emissions in 2004 (Figure 4). Electricity generation is the second largest source. While imported electricity is a relatively small share of California's electricity mix, ranging from 22 to 32 percent of total electricity used, these sources contribute 39 to 57 percent of the greenhouse gas emissions associated with electricity consumption in California. This is because a significant percentage of electricity imported to California from the Southwest comes from coal-based generation. Electricity imports from the Pacific Northwest are primarily hydroelectricity.

California's ability to slow the rate of growth of greenhouse gas emissions will largely depend on the success of its energy efficiency and renewable energy programs. In fact, the state's programs and commitments have lowered its greenhouse gas emissions rate of growth by more than half what it otherwise would have been.[4] And California's energy programs and policies have had multiple benefits that include expanding energy diversity, lowering energy demand, and improving air quality and public health.

3 The California Air Resources Board estimates that the distribution of greenhouse emissions in 1990, by contrast, was as follows: transportation, 35 percent; imported electricity, 14 percent; in-state electricity, 11 percent; industrial, 24 percent; residential, 7 percent; agricultural, 5 percent; and commercial, 3 percent.

4 National Resources Defense Council comments to the Energy Commission, April 5, 2005.

Figure 4
California Greenhouse Gas Emissions in 2004



Source: California Air Resources Board,
Greenhouse Gas Emissions Inventory, November 2007

California's Energy System: Powering a Nation-State

Today one in eight Americans, or more than 37 million people, lives in this Golden State.

California has doubled its population since 1965, a growth rate faster than any other developed region in the world and already larger than the populations of Canada (33 million) and Australia (21 million).[5] If California were a nation, its population would rank 33rd in the world. In fact, California's population exceeds the combined populations of its western neighbors – Oregon, Colorado, Wyoming, Montana, Idaho, Washington, Nevada, Arizona, Utah, New Mexico, Alaska, Hawaii, the Yukon Territory, and British Columbia. Population projections indicate that the state will add another 7 million people in the next dozen years, moving toward 60 million residents by 2050. The challenge California faces is continuing to provide a quality environment and reliable energy services to support our world-class economy.

To maintain this economic output and meet the energy service demands of its citizens, California requires a significant amount of energy. Energy expenditures total nearly $100 billion annually. Now, with the passage of AB 32, California has a stringent mandate to significantly reduce greenhouse gas emissions requiring government, consumers, and businesses to take a hard look at exactly how energy is used in the state and ways to choose an energy system that is less carbon intensive.

Energy Consumption

California's overall energy consumption continues to be dominated by transportation. More than 40 percent of all energy consumed in the state is used to move people and goods – and almost all of this transportation energy is derived from petroleum (Figure 5).

5 Johnson, H., "How Should California Grow?" *Western City Magazine*, July 2007.

Figure 5
Energy Use by Sector

Source: California Energy Commission 2006

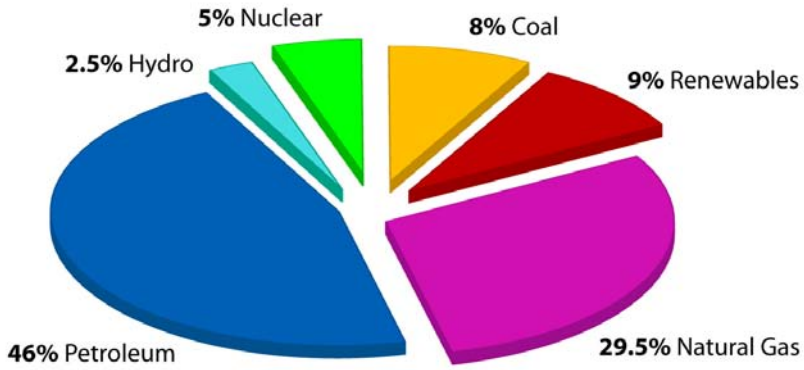
Despite diversifying the mix of energy resources used to generate electricity, more than 80 percent of the energy consumed in the state still comes from two fossil fuels – natural gas and petroleum. This continuing dependence, combined with continuing population growth, places California's economic and environmental well being at risk.

Energy Supply

To understand the challenges California faces in cutting back on greenhouse gases, it is important to examine the origin of the state's energy supplies. California's energy system is heavily dependent on petroleum and natural gas (Figure 6). Petroleum powers the transportation sector and natural gas is used to generate electricity or for heating buildings and water.

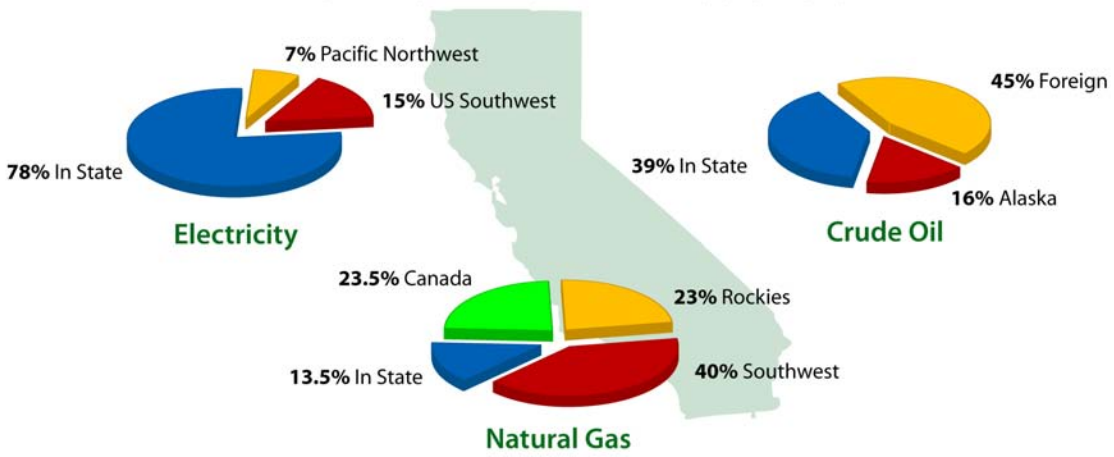
The state produces about 13.5 percent of the natural gas it uses, 39 percent of the petroleum, and more than three-quarters of the electricity. The state imports electricity and natural gas from neighboring states and Canada, while crude oil is imported from Alaska and foreign sources (Figure 7). Importing energy means exporting state dollars. Energy efficiency can reduce these expenditures as well as conserve finite resources.

Figure 6
California's Energy Sources 2006



Source: California Energy Commission 2006

Figure 7
California's Energy Picture



Source: California Energy Commission 2006

California's Electricity System

Electricity accounts for 28 percent of the state's CO_2 emissions, and demand for electricity is forecasted to grow at a steady pace, fed by increased population and a robust economy. Electricity consumption is dominated by commercial and residential use (Figure 8). Even with a decrease in the rate of population growth, from 1.8 percent to 1.2 percent annually, the cumulative growth will significantly affect statewide annual electricity consumption. In addition, trends toward bigger houses and more and larger appliances increase the expected growth in electricity demand. Projected effects of more aggressive building and appliance energy efficiency standards and programs will mitigate some of this electricity growth, but overall electricity use is still expected to increase an average of 1.25 percent annually. *Peak*[6] demand is growing at a rate of 1.35 percent per year, the result of new and growing communities in the hotter inland areas of the state, with higher air conditioning use.

New power plants licensed by the Energy Commission have added almost 13,000 megawatts – 36 plants – to the state's grid since 1998. An additional 2,278 megawatts are currently under construction, and 18 additional plants, totaling 8,361 megawatts, have been approved, but construction has not moved forward on these facilities. Of these megawatts, 99 percent are fueled by natural gas and 1 percent by geothermal.

In 1991, one-third of California's electricity came from natural gas-fired power plants. By 2006, this amount had increased to 41.5 percent. Relying on a single fuel source for generation can be risky, as generators learned even before the 2000–2001 electricity crisis. At a time of high oil prices and tight supplies in the 1970s, oil-fired power plants supplied more than half the state's electricity. Today, none of California's electricity comes from petroleum as the state turned to cleaner burning sources of power.

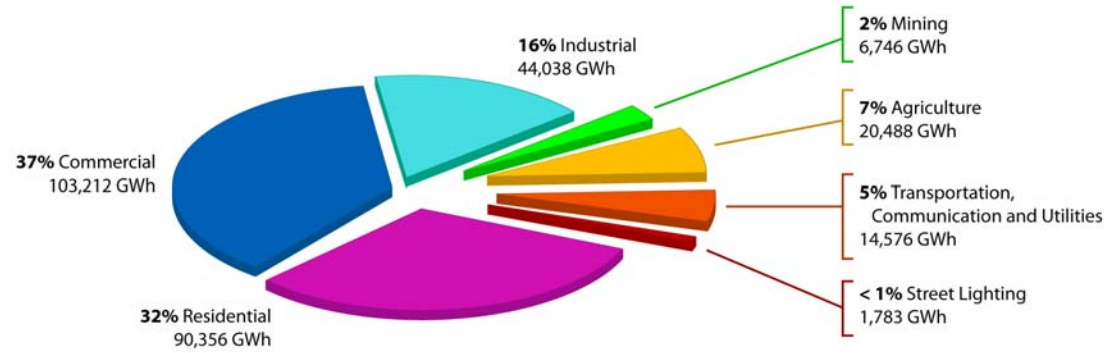
California's massive electricity generation system generates over 290,000 gigawatt hours each year, transported over the state's 32,000 miles of transmission lines (Figure 9). Electric distribution systems throughout California mainly use designs, technologies, and strategies that were designed to meet the needs of mid-20th century customers. These large and complex systems have historically provided reliable electric power to millions of consumers throughout

Key Findings: California's Electricity System

- The electricity sector can reduce CO_2 emissions to below 1990 levels if all cost-effective efficiency and a 33 percent Renewables Portfolio Standard are achieved.
- California's per capita electricity use has stayed flat because of efficiency standards and utility efficiency programs, but increased population, in large part, adds to the state's overall electricity growth.
- Growth of inland population will result in higher summer peak electricity demand, which reduces the electricity system's efficiency.
- Natural gas generates about 40 percent of California's electricity and will remain the major fuel for electricity generation over the near term.
- Coal and nuclear are not expected to contribute significantly to the state's near-term AB 32 goals.

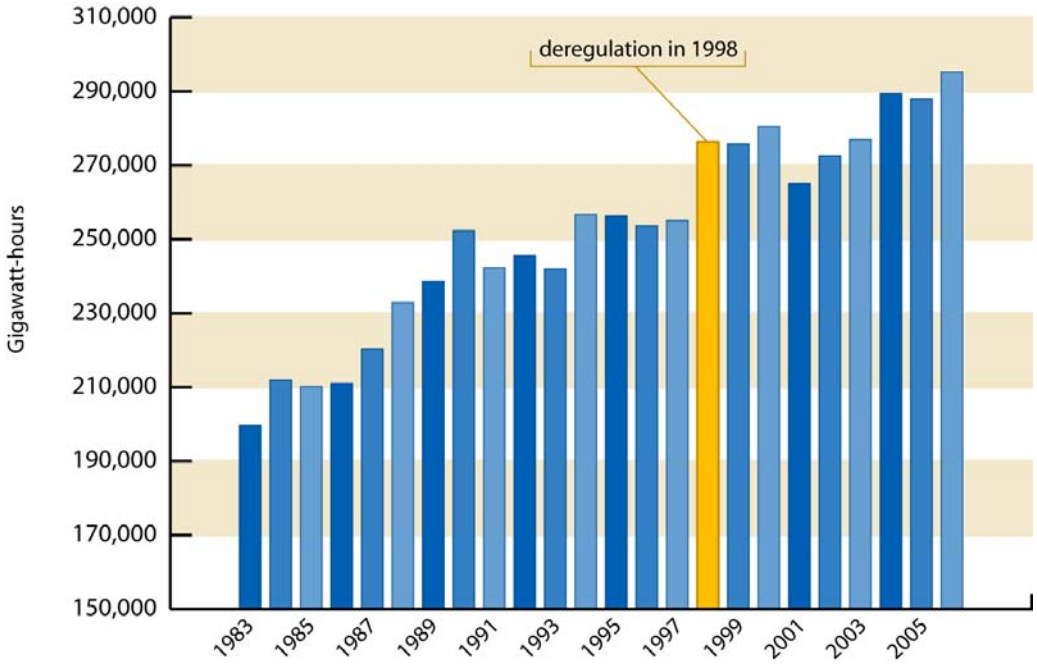
6 *Peak* refers to the highest hourly demand for electricity. Summer demand peaks are mostly driven by increased air conditioning during the hottest hours of the day on the hottest days of the year.

Figure 8
Electricity Consumption by Sector 2006



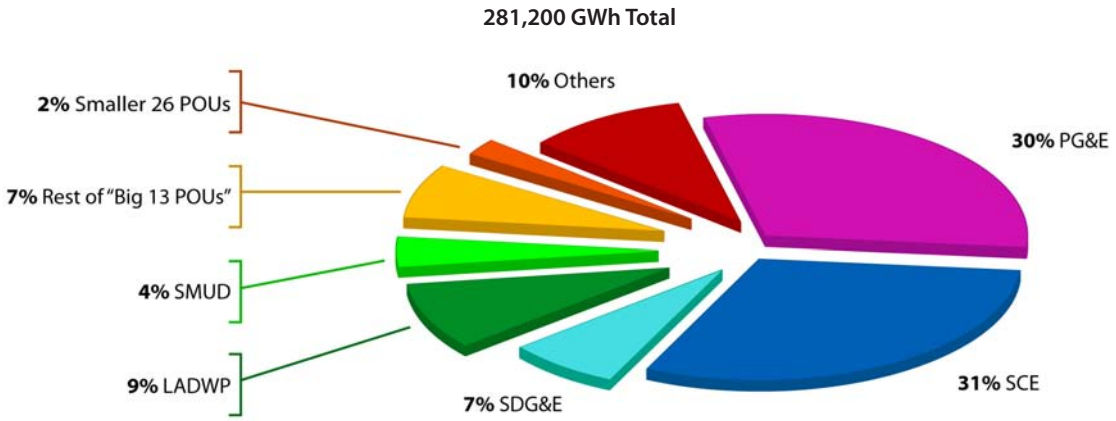
Source: California Energy Commission

Figure 9
California's Electricity Generation



Source: California Energy Commission

Figure 10:
Investor and Publicly Owned Utility(POU) Shares of California's Electricity Consumption – 2006



Source: California Energy Commission

the state; however, aging infrastructure, coupled with modern demands, is starting to erode the system's reliability. About 90 percent of all customer outages are caused by distribution problems.

Five major utilities provide about 80 percent of all electricity consumed in California: investor-owned Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E), and the publicly owned Los Angeles Department of Water and Power (LADWP) and Sacramento Municipal Utility District (SMUD) (Figure 10).[7]

The remaining 20 percent is provided by three smaller investor-owned utilities (Bear Valley, PacifiCorp, and Sierra-Pacific Power) and 24 municipal utility districts, three rural cooperatives, about 12 irrigation or water districts, and one state and one federal water agency (electricity is used for pumping water).

Almost 22 percent of the electricity used in the state is imported, coming from sources in 11 western states, Canada, and Mexico. In 2006, California enacted SB 1368 (Perata, Chapter 598, Statutes of 2006), a law prohibiting utilities from making long-term commitments for electricity generated by plants that create more CO_2 than clean-burning natural gas plants create. Similar requirements have been adopted by Washington State. The law has discouraged the construction of new, dirty coal-fired plants in the West and serves as another example of how California's clean energy decisions can drive the market in other states and other regions of the country.

Since 2003, California's energy policy has recognized a *loading order*[8] as the preferred sequence for meeting growing electricity needs. The loading order specifies that the first resources that should be added are energy efficiency and demand response; next would be renewable energy and distributed generation; and third, clean fossil-fueled sources and infrastructure improvement. This strategy helps to reduce CO_2 emissions and diversify sources of energy supply.

7 California Energy Commission, *California Energy Demand 2008–2018: Staff Revised Forecast*, November 2007, CEC-200-2007-015-SF2.

8 The loading order, adopted as the state's energy policy, is the accepted protocol that describes the priority sequence for actions to address increasing energy needs.

Conventional Resources

Even as California increases its use of efficiency and renewable resources, conventional resources – natural gas, nuclear, coal, and large hydroelectric – will continue to be the mainstay of the state's resource mix for the immediate future.

Non-renewable generation resources and large hydroelectric currently account for 89 percent of the state's electricity supply. Even when California's 33 percent renewable target is met, two-thirds of the state's electricity will still come from conventional sources – the vast majority of which will be natural gas-fired.

While nuclear and "clean" coal-fired generation offer the potential to generate electricity with lower CO_2 emissions, the Energy Commission does not expect them to contribute significantly to the state's near-term AB 32 goals given the economic, environmental, and regulatory barriers these technologies face.

Key Findings: Conventional Resources

- Large hydroelectric and non-renewable generation resources (natural gas, nuclear and imported coal) currently account for 89 percent of California's electricity supply.
- Even if California's 33 percent renewable energy target is met, two-thirds of the state's electricity will still come from conventional sources.

Energy Efficiency

Energy efficiency is the least expensive strategy for meeting climate goals. With the pressure of increasing population growth and that growth occurring in the drier, hotter inland areas, energy efficiency and demand response programs have become even more important for mitigating load. The state's efficiency standards and the utilities' programs have made a significant difference in California's energy use, but more are needed and are available cost-effectively.

The Energy Commission, the California Public Utilities Commission (CPUC), and the publicly owned utilities are collaborating to step up the state's efficiency efforts. Assembly Bill 2021 (Levine, Chapter 734, Statutes of 2006) requires the Energy Commission, in consultation with the CPUC and the publicly owned utilities, to produce a statewide estimate for the investor-owned and publicly owned utilities of "all potentially achievable cost-effective electricity and natural gas efficiency savings and establish statewide annual targets for energy efficiency savings and demand reduction over 10 years." The Energy Commission concluded that the targets should be set to achieve all of the state's cost-effective energy efficiency. The CPUC supported this goal and has described a course of action focused on programs under their authority.

Key Findings: Energy Efficiency

- Energy efficiency is the least expensive strategy to achieve AB 32 goals.
- It is feasible to achieve 100 percent cost-effective efficiency with building and appliance standards, utility programs, and new strategies and technologies.

Electricity from Renewable Energy

Renewable resources are essential for reducing greenhouse gas emissions and reaching AB 32 goals. Over the last three decades, the state has built one of the largest and most diverse renewable generation portfolios in the world. Currently, about 11 percent of the state's electricity is from renewable energy sources such as solar, wind, geothermal, and biomass.

Senate Bill 1078 (Sher, Chapter 516, Statutes of 2002) introduced a Renewables Portfolio Standard (RPS) with the goal of increasing the portion of electricity derived from renewable resources and sold to retail customers to 20 percent by 2017. Senate Bill 1250 (Perata, Chapter 512, Statutes of 2006) accelerated the 20 percent goal to 2010.

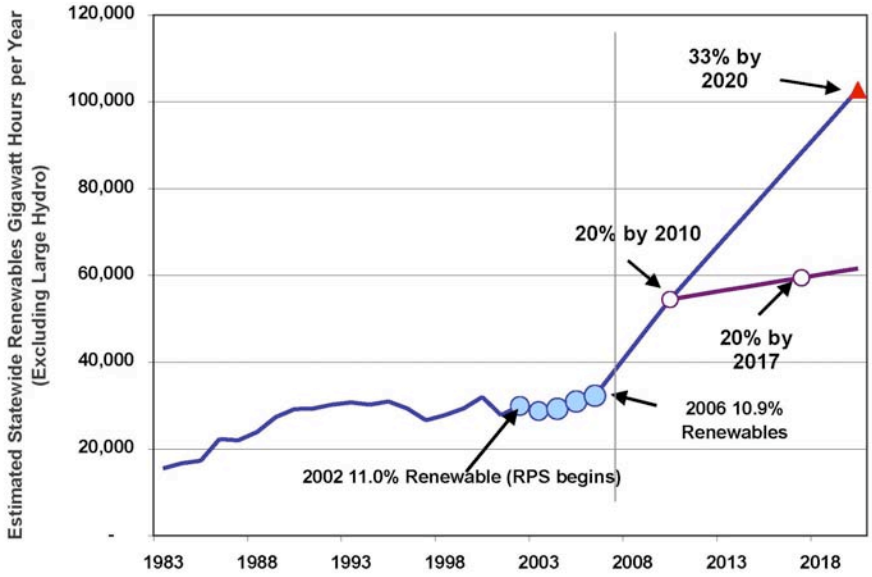
The Governor, the Energy Commission, and the CPUC have endorsed a further enhanced target of 33 percent from renewable energy by 2020. Additionally, in Executive Order S-06-06, the Governor called for a 20 percent target within the RPS goals to be met with electricity from biomass and established the Bioenergy Action Plan to develop an integrated and comprehensive state policy on biomass.

So far, however, the RPS results have not kept pace with its mandate, due principally to insufficient transmission infrastructure and complex administration (Figure 11). Even with almost 400 megawatts from new renewable energy facilities added to the system, load growth has matched these additions, and California remains at the same percentage of electricity from renewables as when the law was passed (Figure 12). Although they may have contracted for the necessary amount by 2010, the investor-owned utilities are not expected to be able to serve 20 percent of their retail load with renewable energy by 2010. A goal of 33 percent goal by 2020 *is* feasible, but only if the state commits to significant investments in transmission infrastructure and begins now to implement key programmatic changes.

Key Findings: Renewable Energy

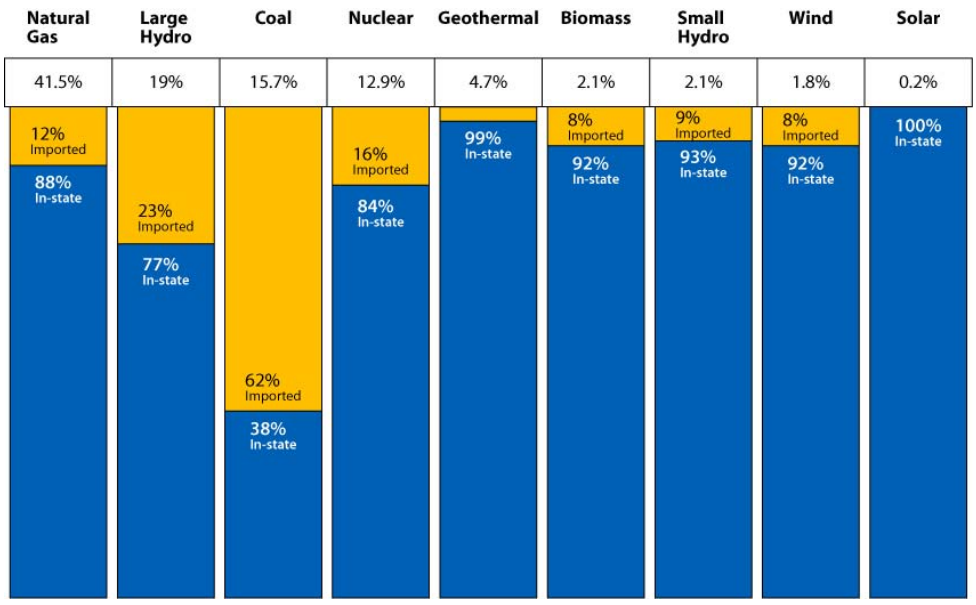
- Renewable energy is essential for meeting AB 32 goals.
- Utilities are falling short of the RPS goal and not expected to deliver the 20 percent renewables by 2010 although they may have sufficient quantities under contract.
- A target of 33 percent renewables by 2020 is achievable with programs improvements in transmission siting, dispatchability and reliability, and contract assurance (feed-in tariff).

Figure 11
Progress Toward California's Renewable Energy Goals



Source: California Energy Commission, 2007 IEPR

Figure 12
California's Electricity Mix – 2006



Source: California Energy Commission, *Gross System Power Report 2006*

California's Natural Gas System

Almost 30 years ago, California's serious air quality problems made natural gas the fuel of choice for electricity generation. Natural gas was cleaner, relatively cheap, and helped diversify the state's electricity generation system. Today, natural gas provides almost a third of the state's total energy requirements and will continue to be a major fuel in California's supply portfolio.

Only 13.5 percent of the natural gas California used came from in-state production in 2006; the rest was delivered by pipelines from several production areas in the western United States and western Canada.[9] California is at the end of those pipelines, forcing it to compete with other states for supplies (Figure 13). Once the gas arrives in California, it is distributed by the state's three major gas utilities that provide a collective total of 98 percent of the state's natural gas. Palo Alto is the only municipal utility in California that operates city-owned utility services for natural gas customers.

Generating electricity consumes about half of all natural gas in the state – making this the single largest use. The residential sector consumes 22 percent of the natural gas and of this amount, 88 percent is used for space and water heating (Figure 14). Since 1970, the number of households in California has almost doubled from 6.5 million to 12.5 million, pushing total residential natural gas consumption up from about 5,500 million therms in 1970 to about 6,700 million therms in 2007. However, the average annual gas consumption per household has dropped more than 36 percent, from 845 therms to 538 therms[10] as a result of building and appliance energy efficiency standards.

9 <www.energy.ca.gov>.

10 California Energy Commission, *Utility Annual Statistical Reports*, Federal Energy Regulatory Commission Form 2, and *Annual Report to the California Public Utilities Commission*.

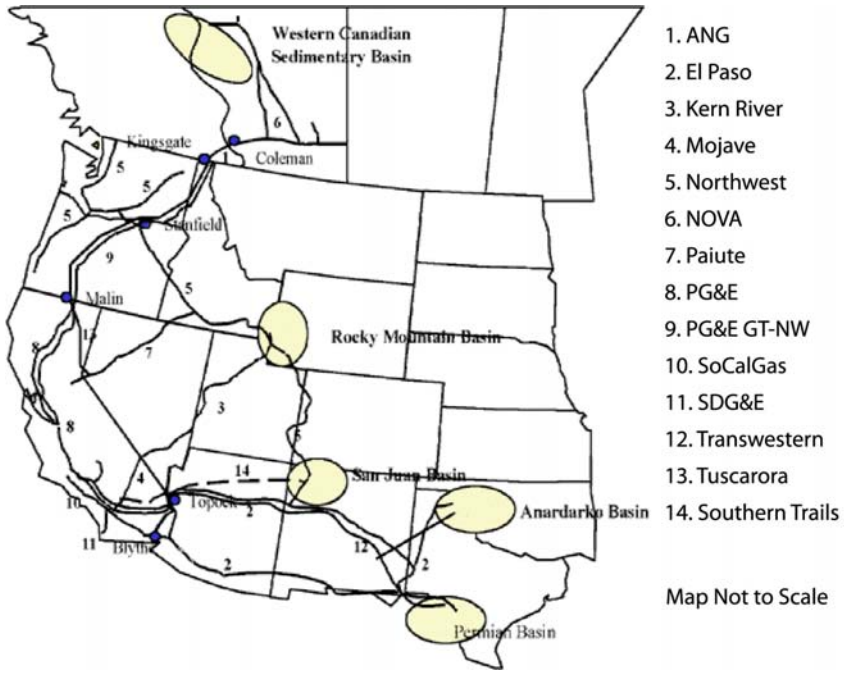
Key Findings: California's Natural Gas System

- California imports 85 percent of its natural gas supplies; reliance on imported gas leaves the state vulnerable to price shocks and supply disruptions.
- Natural gas supplies for North America are projected to continue declining.
- Global warming concerns will increase U.S. and Canadian natural gas demand in power plants displacing coal-fired generation.
- Imported liquefied natural gas has the potential to provide new natural gas supplies but market conditions and environmental reviews will determine whether facilities are built in California.

Natural gas has become an increasingly important source of energy since more of the state's power plants rely on this fuel. While California's successful efficiency programs and its reliance on renewable sources of electricity should slow the demand for natural gas, competition for the state's imported supply is increasing. Our reliance on imported gas leaves the state vulnerable to price shocks and supply disruptions.

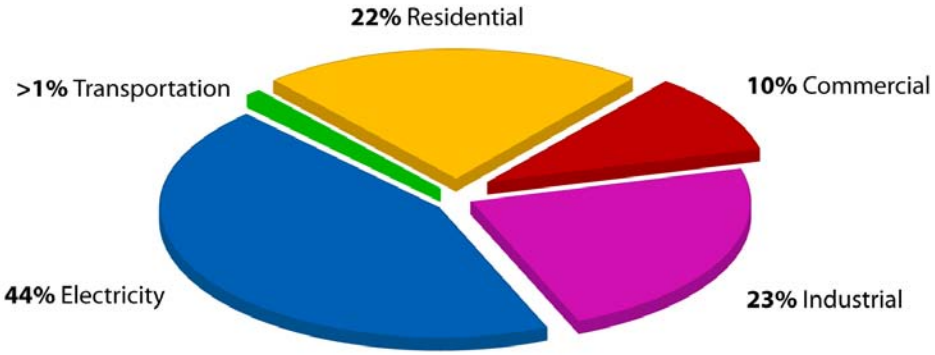
Imports of liquefied natural gas (LNG) are expected to supplement conventional supply sources and help stabilize prices. Importing LNG by tankers from foreign sources has the potential to furnish new supplies. Developers have proposed 13 terminals for the West Coast but, to date, none have been approved in California or Oregon. A newly constructed facility in Baja California, however, is expected to begin operation by the end of 2008. While 30 to 50 percent of this Sempra-owned plant is contracted for use in Mexico, the remainder should be available to California markets.

Figure 13
Natural Gas Resource Areas and Pipelines



Source: California Energy Commission

Figure 14
California Natural Gas Use 2006



Source: California Energy Commission, Utility and Pipeline Filings

California's Transportation System

Perhaps no other population in the world has embraced the automobile as passionately – nor is any other state defined as much by the car – as California.

Cars give Californians the individual freedom and autonomy its citizens crave. This freedom comes with a high price, both to the environment and consumer pocketbooks. Vehicles are the major contributor to global warming pollution. More than 38 percent of CO_2 and other greenhouse gases in California come from burning transportation fuels, mainly gasoline and diesel in cars and trucks. California must change its relationship with automobiles and the way it views transportation – at a personal, as well as a state policy, level.

Decreasing California's reliance on petroleum fuels is critical. By 2020, at current trends, more than 44 million Californians will consume more than 24 billion gallons of gasoline and diesel fuel each year. The consequences are clear: major investments in petroleum refinery and delivery infrastructure expansions, more dependency on foreign energy supplies, and decreased environmental and public health quality.

California's energy policy – the loading order – identifies energy efficiency, renewables, and new infrastructure improvements as the state's priorities in meeting growing energy demand. These strategies also apply to transportation. Improved efficiency of transportation energy use, in large part through vehicle standards, is the most effective and sustainable strategy for reducing the state's demand for transportation fuels. Applying these preferred strategies to transportation focuses first on the pursuit of maximum achievable energy efficiency. Efficiency improvements can be made in vehicle energy use, individual vehicle miles traveled, and goods movement.

Key Findings: California's Transportation System

- Demand for gasoline and diesel is projected to increase by 1 to 2 percent annually.
- California's crude oil supplies from foreign sources will continue to grow.
- Refiners are importing more finished petroleum products to keep up with demand.
- Imports have stressed the transportation infrastructures; the state must expand marine terminals, storage facilities, and pipelines.
- Transportation is responsible for 38 percent of the state's greenhouse gas emissions.
- Reducing these emissions will require more efficient vehicles, lower carbon fuels, and fewer miles of automobile use.

More than 40 percent of all energy used in the state moves people and goods, and most transportation fuel demand is met by petroleum. The state's nearly 26 million registered vehicles consume about 380 million barrels of gasoline (16 billion gallons) and almost 100 million barrels of diesel (4 billion gallons) each year. California is the third largest consumer of gasoline in the world, behind the entire United States and China.

Protecting the State's Petroleum Infrastructure

California's sources of crude oil have changed dramatically since the early 1990s. At that time, the state imported 48 percent of its crude oil from Alaska and

only 5 percent from foreign sources.[11] Today, foreign imports – primarily from Saudi Arabia, Ecuador, Iraq, and Mexico – contribute more than 45 percent of crude oil supplies, and Alaska imports have dropped to 16 percent as the North Slope oil field production declines.[12]

With more than 60 percent of the oil used by California-based refineries and 10 percent of the refined petroleum products imported from outside the state, marine facilities are a vital part of the state's petroleum infrastructure. Because no pipelines bring crude oil or petroleum products into California, all crude supplies and products must arrive by ship. These marine facilities include terminals with docks for unloading both crude oil and finished petroleum products into storage tanks through a network of pipelines. The same facilities are also used to export petroleum products to other states along the West Coast and to foreign destinations.

Facilities for importing or exporting crude oil and refined fuels are available at 46 marine terminals in California – 39 are located in the two major refining centers, Los Angeles and San Francisco Bay. The other seven marine terminals – in San Diego, Ventura, and Humboldt counties – are not directly linked to refineries, but are used to ship and receive refined products in areas not served by pipelines.

The network of pipelines within the state is another important component of the petroleum supply system, bringing California crude from import terminals and both onshore and offshore oil fields to refineries and distributing finished fuels like gasoline, diesel, and jet fuel to more than 70 distribution terminals scattered throughout the state. Trucks deliver gasoline and diesel from these distribution centers to local stations.

Pipelines also help put California at the center of a regional petroleum market. California refineries supply Nevada with almost 100 percent of its transportation fuels. Arizona gets more than 60 percent of its fuel from California, while Oregon depends on California's refiners for 25 to 35 percent of its fuel.[13]

As the demand for transportation fuels continues to grow, California's 21 refineries have responded by gradually increasing their capacity; however, they are at their maximum ability to refine crude oil. In 2005, they processed more than 1.9 million barrels per day, ranking the state the third highest producer of transportation fuels in the nation. Ten of these refineries are located in the Los Angeles Basin and five in the San Francisco Bay Area. Between these two refining centers, more than 90 percent of California's crude oil input is processed. Of the remaining six refineries, three operate in Bakersfield, two in Santa Maria, and one in Oxnard. Just 14 of the 21 refineries produce ARB reformulated gasoline and diesel, while the remaining facilities produce non-fuel products such as lubricants and asphalt.[14] Until the mid-1990s, California refineries kept pace with the demand for gasoline and diesel fuel, but since then refiners are importing more finished products and blending components to meet demand.

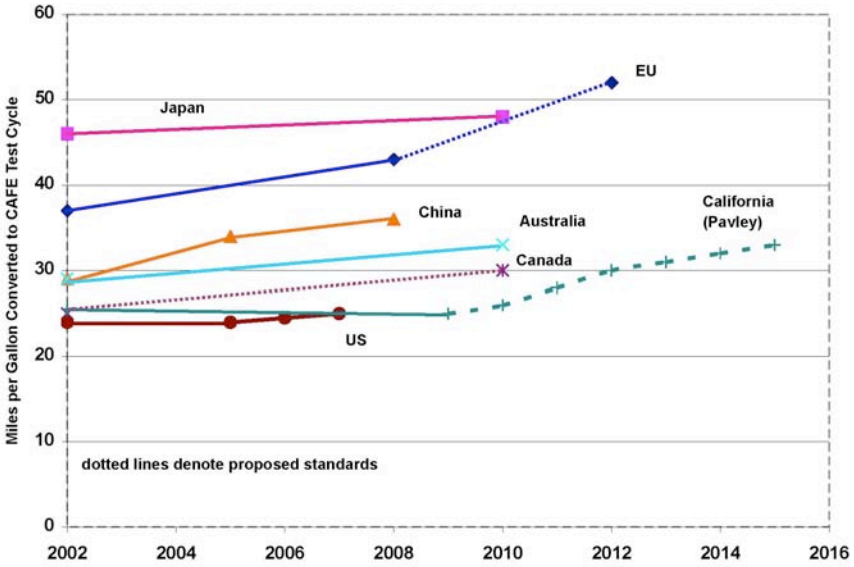
11 California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, *2006 Annual Report of the State Oil & Gas Supervisor*, publication PR06, 2007, p. 3, <ftp.consrv.ca.gov/pub/oil/annual_reports/2006/0101summary1_06.pdf> and California Energy Commission analysis of Petroleum Industry Information Reporting Act monthly crude oil receipt data.

12 California Energy Commission analysis of Petroleum Industry Information Reporting Act monthly crude oil receipt data.

13 Arizona and Nevada estimates from California Energy Commission analysis of Kinder Morgan pipeline shipment information. Oregon estimate from California Energy Commission analysis of U.S. Army Corps of Engineers marine shipments information.

14 California Energy Commission analysis of Petroleum Industry Information Reporting Act data. A table listing the various California refineries and type of gasoline and diesel fuel production is available at <www.energy.ca.gov/oil/refineries.html>.

Figure 15
Comparison of Passenger Car Fuel Economy



Source: California Energy Commission, 2007 IEPR

Climate Impacts of Transportation

As the third largest consumer of gasoline in the world (behind only the United States as a whole and China), California would like to replicate its success with electricity efficiency in the transportation sector. But federal law prohibits states from setting the minimum number of miles per gallon new cars and light trucks must achieve. Earlier this decade, the Energy Commission and the ARB reviewed the technical and economic aspects of a major reduction in the petroleum dependence of California's transportation sector.[15] Based on this research, in 2005, Governor Schwarzenegger appealed to the United States House of Representatives "to establish new fuel economy standards that double the fuel efficiency of new cars, light trucks and SUVs."[16] On December 19, 2007, President Bush signed legislation to raise the fuel efficiency standard for cars to 35 miles per gallon by 2020. The proposed 35 mile per gallon standard pales in comparison to Japan's current standard of 45 miles per gallon and Europe's standard of more than 50 miles per gallon by 2012, and may ultimately be too little, too late to rescue American automobile manufacturers (Figure 15).

The California Legislature also took advantage of a federal Clean Air Act provision that allows states to set their own emission standards (with a waiver from the United States Environmental Protection Agency [U.S. EPA]) and passed California's Clean Car Law, Assembly Bill 1493 (Pavley, Chapter 200, Statues of 2002), the first such regulation in the United States, to limit greenhouse gas emissions from passenger cars and light trucks. The Clean Car Law would cut greenhouse gas emissions by 30 percent by 2016 from all cars sold in California starting in 2009. As allowed under federal law, 19 other states adopted these California standards pending receipt of the EPA waiver. Unfortunately, in December 2007, after almost two years, the EPA denied California's request (and that

15 California Energy Commission and the California Air Resources Board *AB 2076 Report*, adopted 2003.

16 May 13, 2005 letter from Governor Arnold Schwarzenegger to Jeff Bingaman, chairman, Energy and Commerce Committee of the U.S. House of Representatives, and Pete Domenici, member, Energy and Commerce Committee, U.S. House of Representatives.

of other states that would follow California's lead) for a waiver to set more stringent greenhouse gas emissions from vehicles. Almost immediately, on January 2, 2008, California filed suit in the federal court to reverse the EPA's waiver denial.

Assembly Bill 1007 (Pavley, Chapter 371, Statutes of 2005) tasked the Energy Commission to develop a plan for reducing the state's petroleum use and greenhouse gas emissions and for increasing the use of non-petroleum transportation fuels in California. As required by the statute, the Energy Commission adopted the State Alternative Fuels Plan in October 2007. Results of the plan's full fuel cycle ("well-to-wheels") analysis demonstrate that certain alternative fuels can provide substantial greenhouse gas reduction benefits when used in mid-sized passenger cars and urban buses. Fuels such as ethanol, natural gas, liquefied propane gas, electricity, and hydrogen can have important advantages over conventional gasoline and diesel fuels.

The plan concludes that regulations alone cannot achieve the state's policy goals; California requires a portfolio of alternative, low-carbon fuels to meet the goals of petroleum and greenhouse gas emissions reduction and increasing biofuel production. The plan recommends multiple strategies that combine private capital investment, financial incentives, and technology advancement. Substantial investment is also needed in fueling infrastructure, production facilities, vehicle components, and commercial development of *second generation*[17] alternative fuels and advanced technology vehicles. In 2007, Governor Schwarzenegger signed AB 118 (Núñez, Chapter 750, Statutes of 2007) into law, providing a much-needed funding source for incentives to encourage this investment.

17 *Second generation* alternative fuels refer to those biofuels that are under development and often called "advanced" or "emerging," such as biobutanol, which is an ethanol substitute produced from cellulose.

Land Use Decisions Affect Climate

Decisions affecting land use directly impact energy use and the consequent production of greenhouse gases, primarily because of the strong relationship between where we live and work and our transportation needs. Significant efforts are necessary to reduce vehicle miles traveled to meet the state's emission reduction goals. California must begin reversing the current 2 percent annual growth rate of vehicle miles traveled. Research shows that increasing a community's density and its accessibility to job centers are the two most significant factors for reducing vehicle miles traveled.

Housing, transportation planning, and local greenhouse gas reductions require local and regional approaches. California's metropolitan planning organizations are involved in long-range planning efforts to develop transportation plans that incorporate improved land use decisions. These plans are expected to reduce energy and climate impacts in metropolitan regions. The state-sponsored Blueprint Planning Program has engaged nearly all of the state's metropolitan planning organizations in a long-range planning effort that will result in plans to coordinate land use and transportation development. The plans accommodate housing needs, reduce the rate of growth of vehicle miles traveled, and identify priority-planning areas. They are in early stages of implementation and may require technical, financial, and regulatory assistance to achieve their goals.

While the state has limited land use authority, it does have some key leverage points (California Environmental Quality Act, housing elements, bond funding, and others) that it can use to assist local governments in reducing energy use and greenhouse gas emissions that result from land use planning choices. In addition, the state can provide local governments with tools and technical assistance to help meet greenhouse gas emission goals.

Key Findings: Land Use Decisions Affect Climate

- Land use decisions directly affect energy use.
- Urban sprawl contributes to the 2 percent annual growth rate of vehicle miles traveled.
- Even with more efficient vehicles and lower greenhouse gas emitting fuels, vehicle miles traveled must be reduced.
- State government has limited land use authority; however, it can assist local governments in its planning choices.

The Governor's Strategic Growth Infrastructure Bond package represents an opportunity to influence the energy efficiency and environmental friendliness of communities through project funding criteria. Utilities are playing a small but growing role in collaborative planning efforts with local governments. The potential for mutual benefit from planning efforts between these groups is great, but may require regulatory support to achieve.

Bioenergy for Electric Generation and Transportation

California has large untapped biomass resources, including residues from forestry, urban, and agricultural wastes. Bioenergy cuts across all energy supply sectors because biomass can be used to create electricity, transportation fuels, and biogas. Using biomass to produce energy can reduce the waste stream in California's forests, landfills, and farmlands and improve forest health while reducing the risk of catastrophic wildfires.

Because of the importance of this strategic fuel source, Governor Schwarzenegger issued Executive Order S-06-06 in April 2006 to establish specific biomass production and use targets for California. The Executive Order sets a target for biomass to comprise 20 percent of the state's Renewables Portfolio Standard for 2010 and 2020. In addition, the order states that California shall produce a minimum of 20 percent of its biofuels within the state by 2010, 40 percent by 2020, and 75 percent by 2050. The Executive Order also directed the Energy Commission to report on progress made toward achieving these targets in the *Integrated Energy Policy Report*.

Biomass currently represents nearly 19 percent of the state's renewable resource requirements for 2010, close to the Governor's goal of 20 percent. Sustaining this progress beyond 2010, however, will require a concerted and coordinated effort by state government and the private sector.

Key issues that must still be addressed include regulatory uncertainty and adequately valuing the public benefits of biomass energy. A number of state agencies have jurisdiction over aspects of biomass production and use. Overlapping or conflicting regulations make it difficult for any individual agency to evaluate the overall environmental impacts and benefits of proposed projects. At the same time, bioenergy provides unique benefits not currently quantified in the marketplace. Recognizing and properly valuing these benefits would compensate project developers and help the biomass industry meet the Governor's goal for bioenergy in California.

Powering the Future

As the world's eighth largest economy,[18] third largest consumer of gasoline, and twelfth largest emitter of greenhouse gases, California must be a leader in reducing greenhouse gases and a major participant in slowing global warming. Clearly the state requires an energy system that provides for its growing population in a way that is economically achievable within the rigorous environmental parameters mandated by state law. Meeting the mandate of AB 32 will require aggressive and immediate action from all Californians – government, private entities, and individual citizens. The *2007 Integrated Energy Policy Report* contains a considered review of the major energy issues facing the state as it grapples with meeting the enormous challenge of reducing greenhouse gas emissions and offers recommendations that recognize this responsibility.

A single state cannot stabilize the world's climate. But California has a reputation for innovation. Other states and countries follow our lead. If history is a predictor of a state's ability to make a difference on the world stage, California's actions on climate change will drive global progress.

18 California Department of Finance, Top Countries Ranked by Gross Domestic Product, California's World Ranking 2006. <www.dof.ca.gov/HTML/FS_DATA/LatestEconData/FS_Misc.htm>.

Recommendations

Energy Efficiency

The Energy Commission strongly supports capturing all cost-effective efficiency savings potential and recommends that this agency:

- Adopt statewide energy efficiency targets for 2016 equal to 100 percent of economic potential, to be achieved by a combination of state and local standards, utility programs, and other strategies.
- Enlist publicly owned utilities in a collaborative relationship to further their efforts in aggressively ramping up energy efficiency programs. Publicly owned utilities can use their knowledge of local conditions and customers to craft new program ideas.
- Pursue legislation that would require energy audits and a cost-effective level of efficiency improvements at the time of sale of a building.
- Initiate a rulemaking, involving the CPUC and California ISO, to pursue the adoption of load management standards under the Energy Commission's existing authority.
- Enact appliance standards to improve the efficiency of appliances sold in California, including standards to increase the efficacy of general service lighting.
- Increase the efficiency standards for buildings so that, when combined with on-site generation, newly constructed buildings can be net zero energy by 2020 for residences and by 2030 for commercial buildings.
- Investigate market-based approaches to energy efficiency, such as "white tags" or "white certificates" (also known as energy efficiency certificates or credits), the companion to renewable energy credits.

Renewable Energy

The Energy Commission strongly supports renewable energy development to achieve the RPS targets and recommends that this agency:

- Leverage its power plant licensing and transmission corridor designation authority, its environmental expertise, and its transmission planning and policy experience to guide further renewable resource development in California.
- Establish a more cohesive statewide approach for renewables development that identifies preferred renewable generation and transmission projects in a "road map" for renewables.
- Implement a feed-in tariff, set initially at the market price referent, for all RPS-eligible renewables up to 20 megawatts in size.
- Collaborate with the CPUC to evaluate feed-in tariffs for larger projects. Such tariffs should incorporate the value of a diverse mix of renewables as well as features of the most successful European feed-in tariffs.
- Collaborate with the CPUC to establish an appropriate feed-in tariff for excess generation from customer-owned solar installations.

The Energy Commission also recommends that:

- The wind industry expand and repower existing wind sites to increase the efficient use of existing infrastructure.
- The CPUC revise the market price referent calculation to more fully reflect price volatility; market costs of long-term, fixed-price power; and appropriate greenhouse gas adders.

- The greenhouse gas reductions attributable to the RPS be removed from any cap-and-trade allowance system.

Improving Electricity Infrastructure

The Energy Commission supports the improved use of California's electricity infrastructure and recommends that this agency:

- Conduct a public process including the CPUC, utilities, and other stakeholders to determine an effective method to better delineate the energy efficiency savings assumptions in the Energy Commission's staff forecasts.

- Develop a common portfolio analytic methodology to clearly influence the long-term procurement plans filed by the investor-owned utilities.

- Refine in the *2009 Integrated Energy Policy Report* the input data used for developing technologies in the Cost of Generation Model and establish a process to regularly update changing technology costs over time.

- Include in the *2009 Integrated Energy Policy Report* a robust assessment of the effect of high levels of preferred resources on reducing natural gas prices.

- Ensure that California's interests in the nuclear process are protected by taking an active role in the Yucca Mountain licensing proceeding; challenging the U.S. Department of Energy's inadequate response to potential impacts identified by California; and continuing to participate in Department of Energy and regional planning activities for nuclear waste shipments.

- Incorporate Institute of Nuclear Power Operations (INPO) reviews and ratings of reactor operations into a meaningful public process while maintaining the value of the INPO reviews as candid assessments.

- Assess the reliability implications of federal and state once-through cooling regulations for California's operating nuclear plants.

The Energy Commission also recommends the CPUC:

- Require investor-owned utilities to procure enough capacity from long-term contracts to allow for the orderly retirement or repowering of aging plants by 2012.

- Require Southern California Edison to develop, as part of its long-term procurement plans, a contingency plan to replace generation from Palo Verde should it be shut down for an extended period.

Improving Transmission System

The Energy Commission supports the development of a modern electric distribution system to incorporate new resources and recommends that the state:

- Integrate distribution planning with other resource procurement processes to support the use of new low-carbon resources and applications — renewables, demand response, efficient combined heat and power, distributed generation, energy storage, advanced metering infrastructure, and plug-in hybrid electric vehicles.

- Fund research to develop and demonstrate technologies that will accelerate the transformation of the distribution grid into an intelligent and sustainable network.

- Develop new rate designs that will encourage consumers and utilities to invest in promising technologies.

- Provide financial incentives for utilities to meet goals related to performance, achievement of designated goals, service reliability, and customer assistance to achieve greater efficiency of electricity use.

- Allow utilities to recover the remaining book-value costs of equipment rendered obsolete by the deployment of a qualified smart grid system.

Distributed Generation

The Energy Commission continues to support distributed generation and recommends that this agency:

- Work with the CPUC to eliminate non-bypassable charges for combined heat and power and distributed generation and punitive standby reservation charges for distributed generation.

- Develop a methodology for estimating distributed generation costs and benefits.

The Energy Commission also recommends:

- The CPUC continue the work of the "Rule 21" industry/utility collaborative working group to refine interconnection standards, provide third party resolution of interconnection issues, and streamline permitting.

- The state adopt greenhouse gas reduction measures and regulations that fully reflect the benefits of combined heat and power.

- The CPUC adopt a tariff structure to make distributed generation projects "cost and revenue neutral," while granting owners credit for system benefits, such as reduced congestion.

- The CPUC base self-generation program incentives on overall efficiency and performance of systems, regardless of fuel type.

- The CPUC adopt revenue-neutral programs that would allow high efficiency combined heat and power on an equal footing with bulk power from utilities.

Natural Gas

The Energy Commission recommends this agency take the following actions to maintain a reliable supply of natural gas:

- Improve the ability to forecast natural gas production, demand, and price, including:

  - Conducting a rigorous verification of the models used to forecast natural gas supply and price.

  - Developing probabilities and quantifying outcomes for demand scenarios to gain better insight into natural gas demand.

- Increase natural gas research and development for ways to advance energy efficiency for both consumers and power plants.

- Support displacing natural gas with renewable sources to generate electricity and alternatives such as solar for water and space heating.

- Establish with the CPUC an appropriate feed-in tariff for pipeline-quality biogas.

The Energy Commission also recommends:

- The state secure alternative and diverse sources of natural gas, including liquefied natural gas, through licensing facilities that meet stringent environmental and public health and safety standards.

- California's utilities adopt all cost-effective energy efficiency measures for natural gas, including replacement of aging power plants with new efficient power plants.

Transportation

The Energy Commission recommends the following actions by this agency to meet California's growing transportation needs:

- Propose legislation that allows state appeals in the petroleum marine infrastructure lease renewal process at the Ports of Los Angeles and Long Beach.

- Assess the impact on infrastructure development of the State Lands Commission Marine Oil Terminal Engineering and Maintenance Standards, especially on clean fuels marine terminals in the Ports of Los Angeles and Long Beach.

- Advocate for a federal funding mechanism to maintain an adequate depth for tanker traffic in the Pinole Shoal in San Francisco Bay.

The Energy Commission also recommends:

- The state increase alternative fuels use to 9 percent by 2012, 11 percent by 2017, and 26 percent by 2022, to meet the AB 1007 goals that reduce petroleum fuels use and greenhouse gas emissions.

Land Use

The Energy Commission supports the adoption of efficient and effective land use planning and recommends that the state:

- Adopt a unified statewide growth management plan, based on local and regional plans, aligning state planning, financing, infrastructure, and regulatory land use policies and programs.

- Require regional transportation planning and air quality agencies to adopt 25-year and 50-year regional growth plans that provide housing, transportation, and community services for projected population increases while reducing greenhouse gas emissions to state-determined climate change targets.

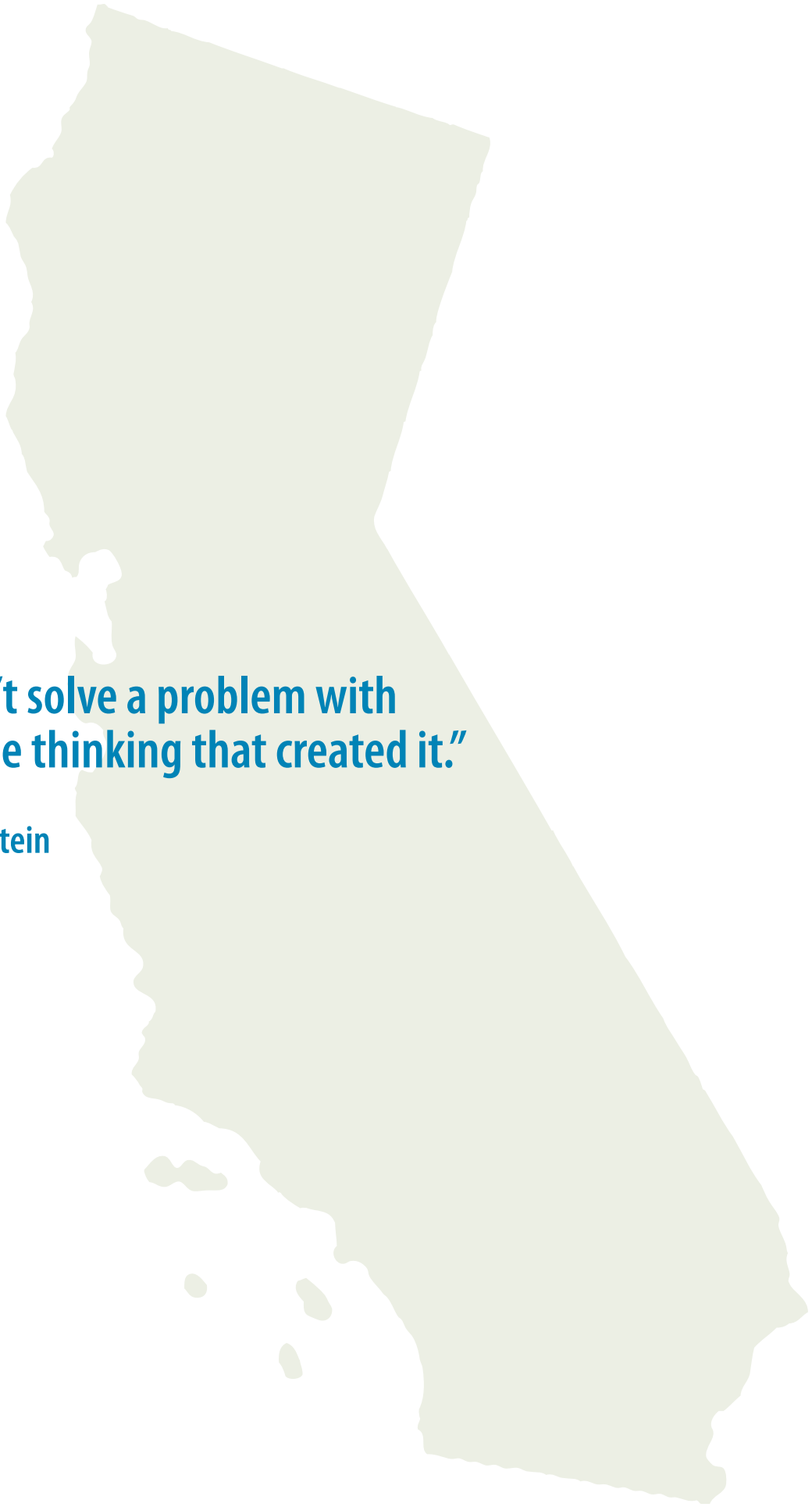
- Expand efforts to provide technical and financial assistance to regional agencies and local governments to facilitate climate-friendly and energy-efficient planning and development.

- Model climate-friendly and energy-efficient development patterns.

- Determine the extent to which state and local tax policies affect and guide land use practices and revise policies that encourage growth that is inconsistent with the state's growth management plan.

- Direct California's utilities to play an active role with regional and local governments to encourage climate-friendly and energy-efficient development in their service areas.

- Work with California's Congressional delegation to ensure that future federal highway and other transportation and land use-related legislation and programs include energy reduction and climate stabilization considerations.



"You can't solve a problem with the same thinking that created it."

Albert Einstein

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