POWERING AHEAD

A New Standard for Clean Energy and Stable Prices in California

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Executive Summary

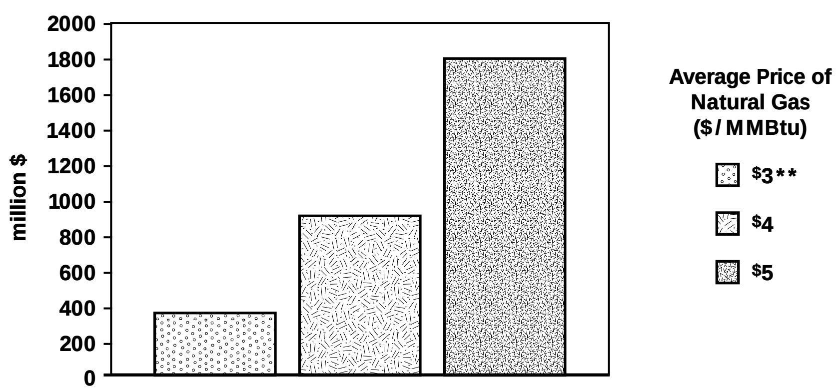
The renewable portfolio standard is a simple mechanism to diversify energy resources, stabilize electricity prices, and reduce air pollution and other harmful environmental impacts of electricity generation. The RPS ensures that clean renewable energy sources provide a minimum share of consumers' electricity needs. It provides market-based incentives to reduce the cost of renewable energy technologies, while bringing them into the mainstream.

The RPS is a simple mechanism to diversify energy resources, stabilize electricity prices, and reduce air pollution.

An RPS could help mitigate the problems that have plagued California's electricity supply over the past year, avoiding recurrence of electricity and natural gas price spikes, rolling blackouts, and increases in air emissions from power plants. Senator Byron Sher (D-Palo Alto) has introduced SB 532, which contains provisions for an RPS that would increase renewable energy sources (excluding hydroelectric generation) from roughly 10 percent of electricity use today to 20 percent by 2010. Over a variety of future scenarios in which natural gas prices range between $3 and $5 per million Btu, the RPS offers considerable savings on consumers' electricity bills.

California has a funding program—the public goods charge—to preserve the level of existing renewable generation and to add new and emerging renewable technologies. An RPS would complement this program by increasing the level of renewable energy generation in California's mix. The PGC provides a "push" for renewable technologies, while the RPS helps "pull" them into the California market

Figure ES-1. Net Present Value of RPS Savings 2003–2010*



* 2001 dollars.
** Average natural gas price 2003–2010. Source: EIA (2000a).

by ensuring that there are buyers for renewable energy. Twelve states have minimum renewable energy standards for electricity suppliers, while eight of these states also have renewable energy funds similar to California's.

What Are the Impacts of the California RPS?

Forecasting the direct impact of the RPS on consumer's electricity bills depends strongly on electricity prices, which in turn depend on projections of natural gas prices, since natural gas is the largest source of electricity generation in the state.

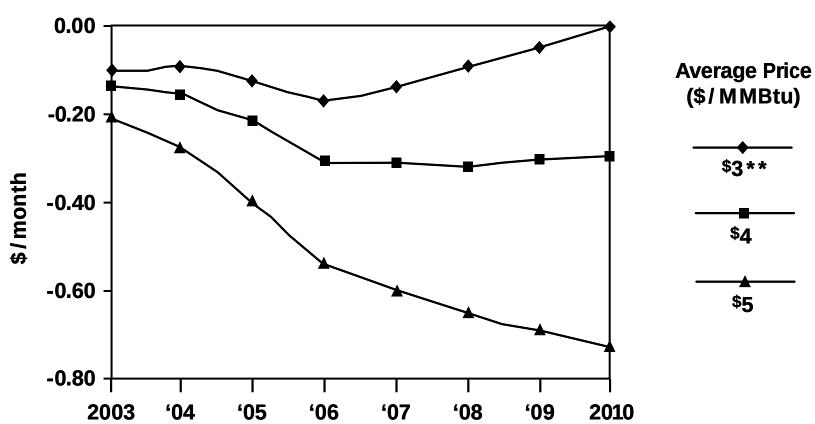
For the last two years, natural gas prices in California have averaged $4 to $6 per million Btu and have occasionally spiked to over $60. No forecast predicted the huge increase in natural gas costs that Californians have paid over the past year. Future gas price forecasts are limited for a number of reasons. Among these are a surge in natural gas use by power plants under construction and geologic assessments that indicate falling gas-field productivity. Furthermore, investments to develop additional infrastructure to serve the growing demand for natural gas—such as pipelines and liquefied natural gas facilities—may lead to prices in the range of $4 to $5 per million Btu or higher.

Whether natural gas prices are $3, $4, or $5 per million Btu, the RPS would save consumers money.

If average annual natural gas prices are $4 per million Btu through 2010, the RPS would save consumers money through 2010, reaching $918 million (in $2001). With natural gas prices of $5 per million Btu, the RPS would reduce consumers' bills even more, with an overall savings of $1.8 billion ($2001) by 2010. If natural gas prices decline, as in the US Energy Information Administration's projection of natural gas costs (about $3 per million Btu on average), the RPS would still save $360 million between 2003 and 2010 ($2001).

In the unlikely event that electricity prices fall below $3, the RPS could add a negligible amout to consumer electricity bills. A cost cap mechanism within the RPS ensures that costs would not exceed $10.44 per household annually in 2010 and thereafter. Thus the RPS would provide inexpensive insurance against high natural gas and electricity prices and could save consumers billions of dollars.

Figure ES-2. Change in Electricity Bills Under Three Natural Gas Prices*



* Typical household monthly bill based on 500 kWh per month, 2001 dollars.
** Average natural gas price 2003–2010. Source: EIA (2000a).

Given the considerable uncertainty in accurately forecasting electricity and natural gas supply, demand, and prices in California, we adopted conservative assumptions for this analysis, including the following:

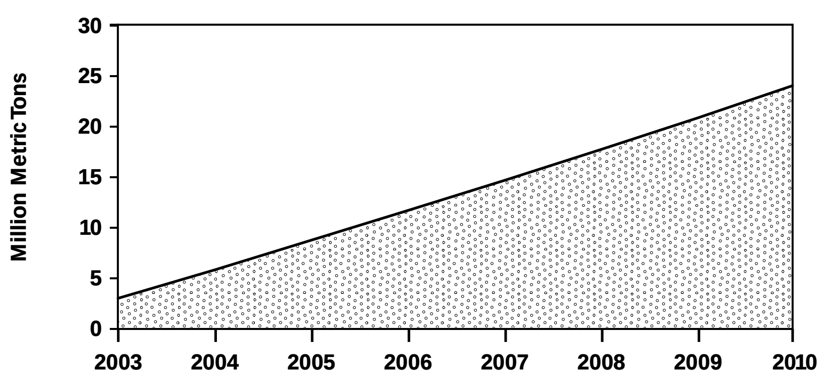
- Natural gas price projections that may be low, because they do not adequately capture the volatility and supply constraints likely to result from building a significant number of new gas plants in the West and around the country. Higher natural gas prices would increase the direct savings from the RPS.
- Electricity market prices that trend toward the annualized cost of a new natural gas combined-cycle power plant by 2003. This assumption may be low, because it does not reflect the prospect that long-term contracts recently signed by the state could keep wholesale electricity prices higher. In addition, older, less-efficient natural gas facilities could increase market prices. Noncompetitive market conditions or market distortions such as price manipulation could also lead to higher prices. Higher electricity market prices would increase the direct savings from the RPS.
- A 1.5 percent average annual growth rate in California's electricity demand, which is higher than the average annual growth of 1 percent experienced between 1990 and 1999. If demand grows more slowly, fewer new renewable resources would be needed to meet the RPS requirement, thereby reducing RPS costs.

Additional Benefits of the RPS

In investing, a diverse portfolio is desirable because diversity reduces risk and can produce greater returns. Adding renewable resources to the electricity generation portfolio reduces the risks posed by over-reliance on a single source of electricity and reduces costs when the costs of producing electricity from nonrenewable sources are high. In addition to providing insurance against higher natural gas or electricity market prices, the RPS protects against risks of supply interruptions or shortages. Because of California's abundant renewable resources, the RPS would make the state less dependent on electricity imports, another source of risk. Finally, consumers are likely to save money through lower natural gas bills for heating and other uses, as the RPS reduces demand for natural gas and so helps to keep natural gas prices down.

The RPS would also reduce air pollution and global warming emissions. The RPS would reduce emissions of carbon dioxide by more than 23.7 million metric tons a year

Figure ES-3. Carbon Dioxide Emissions Displaced by the RPS



by 2010. This is equivalent to removing 3.7 million cars from the road over the same period. What's more, the RPS would provide a hedge against future carbon-reduction measures likely to be required to slow global warming.

Increasing the use of clean renewable resources would also lead to reductions in other air pollutants, such as nitrogen oxides, which contribute to smog. Adding nonpolluting electricity plants to California's mix could also reduce the well-publicized cost pressures on fossil-fuel power plants from air quality requirements, which have contributed in part to higher energy prices in California.

The RPS would avoid the need to burn enough natural gas to fuel over 15 new average-sized (300 megawatt) power plants by 2010, somewhat reducing the pressure to drill for new natural gas supplies and build new pipelines.

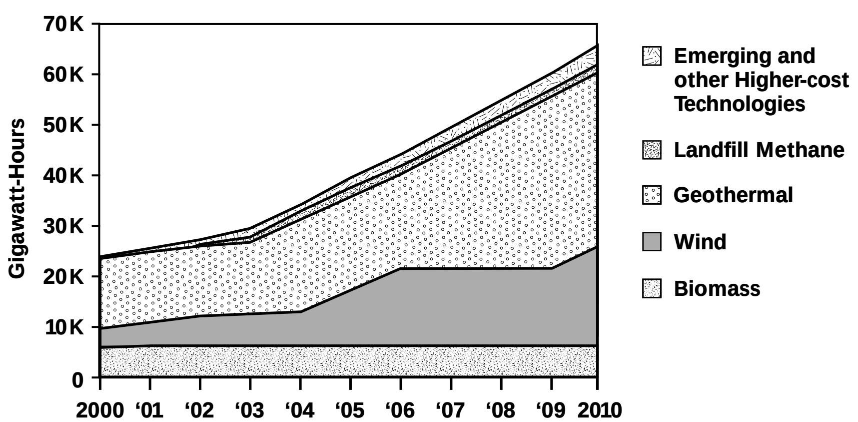
What Renewable Energy Sources Would Grow?

The RPS mechanism leaves the choice of which renewable sources to acquire to electricity suppliers, creating competition among developers of these resources to meet the standard at the lowest cost. Consequently, there is some uncertainty associated with projecting which renewable resources would be built to meet the RPS. Small differences in assumptions about the future cost of different renewable technologies could easily change the proportions of wind, geothermal, and biomass in the forecasted mix. How the California Energy Commission uses the PGC funds to promote different resources or to create more diversity among renewable energy sources would also affect the renewable energy mix.

In this analysis, wind and geothermal sources make up most of the increase in renewable energy. By 2010, wind power would grow from less than 1.5 percent of the state's total electricity mix to 6.1 percent. Geothermal generation would grow from less than 5 percent today to over 10 percent in 2010. In addition, landfill methane projects located in California would contribute 0.5 percent to the state's total electricity market by 2010.

The addition of an RPS could help free up PGC funds to ensure continued operation of existing renewable sources, if needed. Further, the RPS and PGC together could support greater deployment of higher-cost but high-value technologies than would be possible with either mechanism alone. These higher-cost technologies include biomass

Figure ES-4. Total Renewable Energy Generation



gasification, solar photovoltaics, small-scale wind turbines, solar thermal projects, and other technologies using eligible fuels such as fuel cells and methane digesters. The PGC, utility and municipal programs, and the RPS would all provide support for increasing these higher-cost technologies.

Together, the PGC and the RPS could make a real contribution to diversifying California's energy supply, helping to stabilize prices and reducing the many environmental impacts of California's electricity system. The RPS is a prudent and sensible response to the state's greatly expanded reliance upon fossil fuels such as natural gas to generate electricity.

CHAPTER 1

INTRODUCTION

The California power crisis that began in May 2000 has focused attention on the nature of the state's future energy supply. Once a national leader in developing a more efficient, clean, and stable power supply portfolio, California has now become a telling example of what can go wrong in a volatile, deregulated wholesale market tilted toward fossil fuels such as natural gas.

When natural gas prices go up, the cost of electricity increases dramatically. Wholesale electricity prices in California averaged 43 cents per kilowatt-hour in February 2001—over 14 times the average wholesale cost of February 1999 (Lucas and Salladay, 2001). The rise in the cost of wholesale electricity led to significant rate increases and the bankruptcy of Pacific Gas & Electric; Southern California Edison has also been on the brink.

California's primary response to future supply shortages has been to sign 38 contracts worth $43 billion and to authorize an additional $850 million for energy conservation programs. Roughly 70 percent of the power-supply contracts are for power from facilities that have not yet been built (Mendel, 2001). All but 2.5 percent—120 megawatts—of new electricity generators are fueled by natural gas, a fuel that is subject to supply constraints and rapid, extreme price fluctuation.

Significant additions of new renewable energy facilities will diversify California's energy portfolio.

It is never good to depend primarily on a single resource. As in an investment portfolio, diversity is necessary to hedge against risks. A prudent solution to diversifying California's power supply and address the risks posed by over-reliance on electricity from natural gas is to add significant new renewable energy facilities to its power plant portfolio.

In addition to being a source of diversity, renewable energy technologies are environmentally clean and generally have lower operating costs than traditional fossil-fueled power plants. Many of the technologies—such as wind, solar, and geothermal plants—do not use fuel at all. Biomass fuel costs can vary, depending on the source, but because they are generally obtained locally, they avoid the risks associated with imported fuels.

The more renewable energy resources that feed their electricity into the grid, the less demand there is for natural gas fuel, which then reduces natural gas and electricity prices for all consumers. Dampening the demand for natural gas also helps increase energy security by reducing dependence on out-of-state natural gas suppliers and fossil-fuel electricity generators.

Wind and solar power are the fastest growing energy sources in the world, with average annual market growth rates exceeding 25 percent over the past five years (Worldwatch Institute, 2001). Among the reasons for these impressive growth rates are that the costs of all renewable energy systems have declined substantially over the past 20 years. In Colorado, state regulators ruled that specific wind projects were the cheapest generation option available to be built this year (O' Bryant, 2001).

In the volatile and uncertain power market that California has been experiencing, investors are cautious about sinking large, long-term investments into wind or other renewable energy sources. While their operating costs are low, renewable technologies have high up-front capital costs for manufacturing and installing equipment.

An RPS that guarantees 20% of consumers' electricity comes from renewable energy would reduce electric bills, natural gas use, and power plant emissions, as well as foster economic development.

Natural gas turbines, with their low capital cost but high operating costs, reduce the risk of up-front investments, but introduce market risk because they are subject to the volatility of fuel prices. Because renewable technologies have high capital costs, investors may view them as the riskier investment. Further, a variety of market barriers, including traditional power transmission and dispatch protocols, still limit broader applications of wind and other intermittent renewable energy resources. Creating an assured market for renewable power can solve this problem.

The renewable portfolio standard (RPS) is a market-based mechanism that gradually increases the portion of electricity produced from renewable resources. The RPS requires that an increasing percentage of each electricity provider's resource portfolio come from renewable energy. The RPS creates a minimum commitment to a sustainable energy future and builds on the investments already made in renewable energy.

A California renewable portfolio standard that guarantees 20 percent of consumers' electricity comes from clean, stable renewable energy would reduce electric bills, natural gas use, and power plant emissions, as well as foster economic development. Several studies have shown that California and the surrounding region easily have enough renewable resources to more than double the state's current supply of renewable energy from 10 to 20 percent by 2010 and beyond (see appendix).

Without setting such goals, 90 percent or more of all new power supplies will continue to come from natural gas. California may already have locked itself into too many long-term electricity contracts generated from fossil fuels. Since many of these contracts have provisions that pass along the fluctuations in the cost of natural gas fuel, these long-term power purchases are still subject to the vagaries of supply and demand for fossil fuel. Whether fossil-fuel prices go up or down, California consumers are exposed to price risks that can be averted with a sufficient commitment to renewable energy resources.

The Union of Concerned Scientists analyzed the impacts of a renewable portfolio standard like the one proposed by Senator Byron Sher (D-Palo Alto) in SB 532. We examined a range of potential natural gas prices to predict the direct impacts an RPS would have on electricity bills.

This report first provides an overview of the RPS as a policy tool in Chapter 2. Our modeling methods and assumptions for the analysis are profiled in Chapter 3. Chapter 4 presents detailed results from this modeling, including savings and costs to consumers, renewable energy credit prices, California's electricity generation mix, and reductions to carbon dioxide emissions. Additional benefits from an RPS are highlighted in Chapter 5. Chapter 6 sums up our results and the implications of an RPS on California's energy future.

CHAPTER 2

WHAT IS A RENEWABLE PORTFOLIO STANDARD?

The renewable portfolio standard is a proven policy tool that stimulates the development of renewable energy sources. In this chapter we define the RPS, focusing on how this policy approach works, why it is necessary, and which states already use it. We then describe the RPS recently introduced in the California legislature and how that policy would interact with the state's public goods charge.

A renewable portfolio standard is a market-based policy mechanism that achieves a diverse electricity supply by creating a minimum commitment to electricity generation from renewable sources such as wind, geothermal, biomass, and solar energy. An RPS requires electricity providers to include a gradually increasing annual share of renewable energy in their power supply mix. An RPS ensures an increasing amount of renewable energy in the electricity mix in order to achieve environmental benefits, resource diversity, and reliability.[1]

Which States Already Have an RPS?

Although numerous legislative proposals for a national RPS have been proposed in Congress, most RPS initiatives have occurred at the state level. These state programs reflect the unique resource bases and needs of individual state power markets. The RPS has emerged as an increasingly popular state policy to promote a cleaner and more stable power supply.

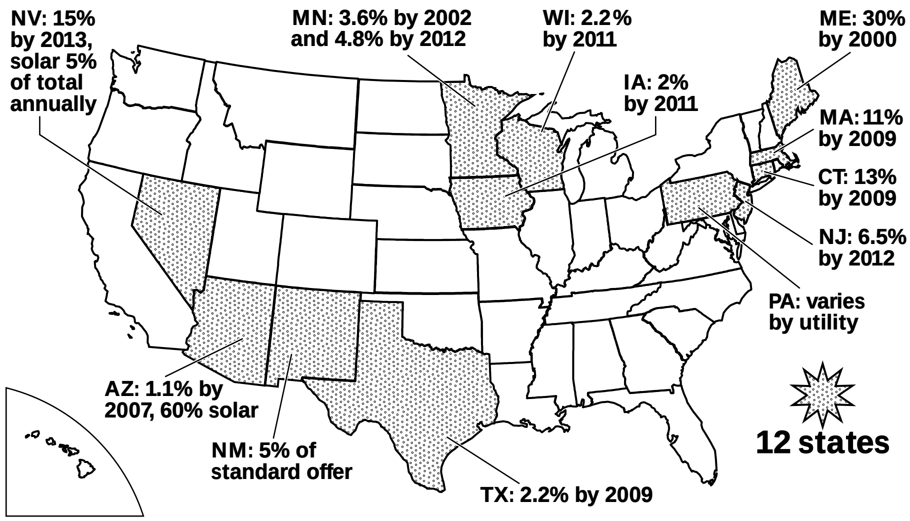
As of August 2001, 12 states have minimum renewable energy standards (UCS, 2001). As part of restructuring their electricity industries, Arizona, Connecticut, Maine, Massachusetts, Nevada, New Jersey, New Mexico, and Texas enacted renewable portfolio standards. Pennsylvania included renewable standards in restructuring settlements with distribution companies. Wisconsin enacted an RPS as part of electricity reliability legislation, without restructuring to allow retail competition. Nevada revisited and significantly increased its RPS this year, raising the standard from 1 percent by 2009 to require 15 percent by 2013. Iowa and Minnesota have also enacted minimum renewable energy requirements for regulated utilities.

An RPS requires electricity providers to include a gradually increasing annual share of renewable energy in their mix of power supply.

The most successful state RPS to date is in Texas, where 900 MW of new wind power and 100 MW of other renewable energy facilities will come on line by the end of 2001. The RPS was signed into law by then-Governor George W. Bush and implemented by Federal Energy Regulatory Commission Chair Pat Wood, a former Texas utility regulator. The Texas RPS is successful for several reasons: requirements for

1 For more information on developing RPS policies, see Nogee et al. (1999) and Rader and Hempling, (2001).

Figure 1. States with Renewable Portfolio Standards



new renewable energy are high enough to trigger market growth; they apply across the board to all electricity providers; and they can be met using tradable renewable energy credits (see discussion below). Another important feature is a significant financial penalty that applies if retail providers do not comply with the RPS target.

Why Is an RPS Needed?

An RPS makes sense for several reasons. The RPS overcomes numerous market barriers that currently hamper the development of renewable energy, particularly those that raise the cost of renewable energy and prevent it from becoming a larger part of the electricity supply on its own. As outlined below, the RPS is an effective tool to overcome these barriers and drive down costs for new renewable energy technologies so that they can eventually compete with fossil-fuel generators on a more level playing field.

A renewable energy requirement will stimulate a long-term market for renewable energy, which in turn will reduce the investment risk associated with building renewable facilities. Lower investment risk promotes cost-effective financing of new projects in the near term. Increasing the deployment of renewable technologies drives down manufacturing and other related costs over the long term. And this helps bring these technologies into the mainstream.

Why Is an RPS Cost-Effective?

Most RPS laws enacted in the United States do not specify targets for particular renewable energy technologies, instead they allow the market to determine which technologies should be built based on their costs.[2] This flexibility leads to competition among renewable energy generators, assuring that the standard is met at the lowest cost. Historically, electricity market conditions that do not reflect the full environmental

[2] Nevada requires that 5 percent of renewable energy under the RPS be generated using solar resources. Arizona requires 60 percent of its renewable energy come from solar photovoltaics or solar thermal.

and public health costs of electricity production have resulted in prices below renewable energy capital and production costs for even the most cost-effective renewable technologies. Consequently, some mechanism is needed to value the public benefits of renewable energy and compensate renewable generators for the portion of their costs that is above market prices.

Renewable energy credits provide a flexible means of achieving RPS goals.

One way to ensure that renewable generators obtain the revenues they need to meet their costs is to establish a system of tradable renewable energy credits. One REC is created for every unit of renewable energy generated. Renewable generators earn RECs and then sell them to entities with RPS target requirements at a price that reflects the difference between electric market prices and the cost of meeting targets. This mechanism ensures that renewable energy generators are paid for their energy in the same manner that any other electricity generator is, but also receive revenues that reflect the cost of their product if it is above electricity market prices.

An RPS with a tradable REC market provides many additional benefits that can reduce the cost and complexity of implementing an RPS, such as

- an easy and efficient system for achieving and tracking compliance
- compliance flexibility, particularly if RECs can be banked from one year to the next
- the ability to set a cap on RPS costs by capping the price of RECs

How Do Electricity Providers Comply with the RPS?

An RPS target can be met in a number of ways. Retail electricity providers can generate the clean, stable electricity themselves from new renewable energy power plants that they construct and own or that they authorize third parties to develop. Or a retail electricity provider can purchase renewable energy from another party, such as a private electricity generator that has excess capacity to sell into power markets. If a tradable REC system has been established, the electricity provider can comply with the RPS target by purchasing RECs from renewable generators or other parties that exceed the minimum standard and are seeking to sell excess renewable energy generation. RECs can also be bundled with renewable energy generated under a long-term contract.

Texas and Wisconsin currently use credit trading for RPS compliance. The New England states are moving toward a credit-trading system for identifying all generation sales, to be used in disclosing the fuel mix to customers and in complying with emission portfolio laws as well as the RPS. Renewable energy credit trading is also similar to the Clean Air Act emission cap and allowance trading system, which permits lower-cost, market-based compliance with air pollution regulations.

A Renewable Portfolio Standard for California

Legislation introduced in California is designed to address the state's unique market conditions, where a large and diverse mix of existing renewable resources currently operates and where the potential to expand renewable energy technologies is significant. The following are the key design features of the proposed legislation.

Renewable Energy Target

As currently drafted, SB 532 would require 10 percent of California's total electricity sales to come from renewable energy sources (excluding hydroelectric generation) on January 1, 2003. The renewable energy share of the market would gradually increase each year until it reaches 20 percent of the state's total electricity mix in 2010. This 20 percent market share would be maintained through at least 2020. The significant level of renewable energy in SB 532 is necessary to achieve the full benefits of the market price hedging effect that renewable energy provides.

Requirement Applicability

In the current proposal, the requirement to meet RPS goals would apply to all retail electricity providers, including the following:

- investor-owned utility distribution companies
- municipal districts and utilities
- irrigation districts
- rural cooperatives
- private retail marketers
- public and private aggregators

In addition, any self-generating entity that generates and consumes more than 2 megawatts of electricity from nonfossil fuels must also meet the RPS target. This provision ensures that large customers cannot avoid complying with the RPS by generating their own electricity.

The RPS and the Public Goods Charge

The RPS is compatible with and complements the public goods charge that California currently uses to fund energy efficiency, renewable energy, and research and development for new technologies that benefit the public. The PGC for renewable resources is a small surcharge per kilowatt-hour. It helps ensure that existing renewable energy generators can continue to operate and provides incentives for new and emerging technologies. This charge was re-authorized in 2000 to continue through 2012.

The RPS can complement the public goods charge to increase the level of renewable energy generation in California's mix. Eight states—Arizona, Connecticut, Massachusetts, Minnesota, New Jersey, New Mexico, Pennsylvania, and Wisconsin—already have both renewable energy funds similar to California's and minimum renewable energy standards for electricity suppliers.

The PGC provides a "push" for renewable technologies, while the RPS helps "pull" them into the market. The addition of an RPS could help free up PGC funds to ensure continued operation of existing renewable sources, if needed. The RPS and PGC together could also help ensure that additional higher-cost but high-value technologies are developed than would occur under either policy alone.

CHAPTER 3

METHODS

Modeling Method and Assumptions

This report presents results from a spreadsheet model developed to estimate the electricity price impacts, renewable energy mix, and air emission reductions from a renewable portfolio standard (RPS) in California. In our analysis, we assumed that renewable sources would supply 10 percent of the state's total annual electricity in 2003. The target for total annual renewable energy supply would increase linearly to 20 percent in 2010 and maintain this 20 percent market share through 2020. The basis for the analysis is SB 532, as introduced in August 2001. As with any proposal, the specifics in the bill may change as the legislature considers it.

The modeling method and most important assumptions are summarized below. A more detailed discussion appears in the appendix.

Renewable Energy Supply

Eligible resources include the following nonhydroelectric renewable energy facilities:

- wind
- geothermal steam
- solar photovoltaics
- stolar thermal technologies
- biomass sources, including landfill methane gas

We first projected the annualized cost of installing, operating, and maintaining eligible renewable technologies over a 20-year period, including financing costs and a reasonable return on investment. The renewable resource potential in California and the western grid was based on projections developed for the Energy Information Administration (EIA) and used in the National Energy Modeling System (NEMS). Renewable energy technology costs and performance were generally based on the November 2000 *Scenarios for a Clean Energy Future* study by five of the Department of Energy's national laboratories (IWG, 2000).[3] We assumed that federal production tax credits would be available for new wind, biomass, and landfill methane facilities coming on line through 2006, as in the bill recently passed by the US House of Representatives.

For each renewable technology, we then projected the price it could obtain by selling its power into the wholesale electricity market. This price varies by technology because the output of intermittent renewable energy sources such as wind and solar varies with the season and time of day. Wholesale electricity market prices also vary by

[3] We modified some of the IWG assumptions, as described in the appendix and in Clemmer et al. (2001).

season and time of day. We assumed that annual average electricity prices would trend toward the cost of generating electricity with new natural gas combined-cycle power plants by 2003. We based the cost of building and operating a new natural gas plant, including natural gas prices, on projections from the EIA's *Annual Energy Outlook 2001* (EIA, 2000a). We also estimated the market price and associated value of renewable generation for several different gas prices.

Next, we calculated the difference between the cost of each renewable technology and its value in the wholesale electricity market. With this information we developed a renewable energy supply curve for each year by ranking technology and resource options in California and the western grid from the least expensive to the most expensive renewable energy options. The model "builds" the least expensive renewable technologies needed and available to meet the standard each year.

Renewable Energy Credits

We assumed an accounting and verification system in which eligible generators are issued renewable energy credits (REC). In most cases, generators would probably sell their RECs along with their electricity generation, although RECs could also be traded separately. For this analysis, we assumed that RECs would be available only to eligible facilities installed in California or in other western states after January 1, 2001. Renewable resources installed before that date would, we assumed, receive adequate financial support from existing public goods charges and long-term contracts. To implement the cost cap in SB 532, we assumed that REC prices would be capped at 1.5 cents per kilowatt-hour ($2001).

New renewable generation would avoid significant carbon dioxide emissions.

The model determines the market-clearing price for RECs as the point at which quantity of renewable energy demanded is equal to available quantity and incremental (or above-market) cost of eligible renewable supply by resource/technology. The marginal unit (the last unit needed to meet the demand for renewable energy) is assumed to set the REC price for all eligible renewable energy technologies. The model calculates the price of RECs based on the difference between the market-clearing REC price for the renewable energy generation needed to meet the RPS requirement, and the projected wholesale price of electricity in California in each year. We then adjusted the REC price downward to reflect funds available from the public goods charge. Because RECs would, we assumed, be traded under long-term contracts, the renewable generation installed in a given year would receive the same price over a 20-year period. Thus, the total annual RPS costs or savings are equal to the REC price multiplied by the incremental generation installed in the current year and all previous years.

Avoided Carbon Dioxide Emissions

Introducing new renewable generation into California's power market would result in considerable carbon dioxide emissions being avoided. To calculate the amount avoided, we assumed that most of the renewable energy technologies built because of the RPS would be zero emitters of CO_2 (wind, geothermal, and photovoltaics) or net zero emitters (biomass and landfill gas).[4] Thus, the total amount of renewable energy

[4] Biomass absorbs carbon dioxide as it grows and releases it when burned. So long as biomass is replaced with new growth, it is approximately a net zero emitter. When biomass in landfills decays, it emits

production could be considered an offset against CO_2 from fossil-fuel plants that would otherwise supply electricity to meet California's demand.

To estimate avoided CO_2 emissions, we used the following approach:

- Estimate the percent of time each type of fossil-fueled generating unit was the marginal unit (the highest cost unit running to meet demand) during 2000[5]
- Assign a CO_2 emission rate to each of the fossil unit types representing typical emission characteristics based on publicly available data
- Develop a weighted-average annual CO_2 emission rate for 2003
- Adjust the weighted-average annual CO_2 emission rates applicable to later years to reflect the retirement of older, less-efficient plants and the introduction of more efficient, gas-fired combined-cycle and combustion turbine capacity in California over time
- Apply the weighted-average CO_2 emission rate of California's electricity generators to the electricity provided by the renewable energy sources added to meet the RPS target

Conservative Assumptions

Given the considerable uncertainty in accurately forecasting electricity and natural gas supply, demand and prices in California, we adopted conservative assumptions for this analysis, as discussed below.

Natural Gas Prices

The natural gas price projections used in this analysis may not adequately capture the volatility and supply constraints likely to result from building a significant number of new gas plants in the West and around the country. We also did not estimate the savings on consumer gas and electricity bills likely to result from lower gas prices due to the RPS.[6]

Electricity Market Prices

Long-term contracts recently signed by the state could keep the wholesale cost of electricity higher than our assumption that annual average prices would trend to the annualized cost of a new natural gas combined-cycle power plant by 2003. Older, less-efficient natural gas facilities can be more expensive than new gas plants, thereby increasing electricity prices beyond the levels estimated in this report. Assuming that wholesale electricity prices would reflect new natural gas combined-cycle plants also does not account for higher prices that could result from noncompetitive market conditions or market distortions such as price manipulation.

methane, a powerful greenhouse gas. Biomass energy generation that avoids landfilling or that burns landfill methane that would otherwise be released into the atmosphere can reduce the equivalent of more carbon dioxide than is released when it is burned.

5 We adjusted the 2000 operating data to reflect abnormally hot and dry weather and the significant additions to gas-fired combined-cycle capacity planned by 2003.

6 For example, see Clemmer et al. (2001).

Electricity Demand

We assumed a 1.5 percent average annual growth rate in California's electricity demand. Increased energy efficiency from higher prices and new funding recently passed by the legislature could easily result in a lower growth rate, such as the average annual growth of 1 percent experienced between 1990 and 1999. Lower overall demand would mean that fewer new renewable resources would be needed to meet the RPS requirement, thereby lowering costs.

Renewable Energy Supply

The renewable energy resource potential for California and the surrounding region is based on data the EIA used in the National Energy Modeling System. We believe most of the EIA's assumptions are conservative. For example, the EIA recently reduced the overall potential in the West for geothermal energy by 45 percent and for biomass by over 48 percent compared with data used in earlier versions of the model. As discussed in the appendix, we also excluded 5 percent of the EIA's estimate of construction and demolition debris to ensure that no contaminated materials would be used. In addition, we reduced the EIA's estimate of windy land area available in California and the surrounding region by over 35 percent to account for land-use exclusions.

Renewable Technology Costs

We assumed higher capital costs for wind power through 2010 than the costs given in the DOE's *Scenarios for a Clean Energy Future* report, to conform to more recent data. We also assumed that transmission interconnection costs were over four times higher for renewable technologies than for new natural gas power plants. This assumption accounts for the additional distance typically needed to connect wind generators to the electricity transmission grid as well as the lower economies of scale associated with smaller projects.

Public Goods Charge

We assumed that funds from the new renewables PGC account would be spread evenly across all new nonemerging renewables competing for the RPS. Targeting more of the funds for higher-cost technologies would be likely to reduce overall RPS costs. We also assumed that higher-cost technologies (such as biomass gasification, solar photovoltaic, solar thermal, and small-scale wind turbine projects) would achieve a penetration of 1 percent of California's electricity by 2010. The California Energy Commission assumes a 1 percent penetration of small-scale emerging renewable resources by 2006, with less overall funding allocated to these technologies than assumed in our report.

Renewable Energy Credit Prices

The REC program is likely to be implemented with mechanisms that would allow greater flexibility among participants, which are not included in our model. For example, generators could be permitted to bank unused RECs from one compliance period to the next. These mechanisms could help reduce REC prices below the levels calculated in our analysis.

CHAPTER 4

WHAT WE FOUND

The findings of our analysis fall into three categories. First we present the estimated savings to consumers as a result of the renewable portfolio standard. A discussion of the new renewable energy generation that is brought on line to meet the target follows. Lastly, we will show how the RPS displaces fossil-fuel generation and carbon dioxide emissions.

The Effects of the RPS on Electricity Consumers

Recent history provides a lesson about the difficulty of predicting future electricity market conditions. Who would have predicted the price spikes witnessed in late 2000 and early 2001 in 1996, when California's deregulation legislation was signed into law? Who could have predicted the significant reduction in energy use from conservation efforts?

Our analysis shows that the price of natural gas would play an important role in determining the total cost or savings of the RPS to California electricity consumers. To address the effect of this uncertainty on electricity prices and RPS costs and benefits, we performed sensitivity analyses to determine how different natural gas prices would affect our estimate of RPS impacts, holding the remaining assumptions constant. Figure 2 illustrates the change in a typical household's monthly electricity bill when the RPS is implemented under three different natural gas price forecasts:

- $3 per million Btu (the Energy Information Administration's average 2001 forecast)
- average prices of $4 per million Btu through 2010
- average prices of $5 per million Btu through 2010

It is possible that currently available forecasts, such as the one produced by the Energy Information Administration (2000a), are too low. Natural gas prices could, for many reasons, exceed EIA projections. Among these are a surge in gas use for new power plants under construction and geologic assessments that indicate falling productivity.

Investments to develop additional infrastructure to serve the growing demand for natural gas—such as pipelines and liquefied natural gas facilities—could lead to prices in the range of $4 to $5 per million Btu (Freedman, 2001; Kennett, 2001). Average natural gas prices were $5 per million Btu or above between October of 2000 and March of 2001. During that same period, natural gas prices in Southern California were consistently above $10 per million Btu, with short-term spikes in the spot market as high as $60 per million Btu ("Weekly Prices," 2001; CEC, 2001a). The average annual gas prices included in the EIA's reference-case forecast for the Pacific Coast Census region in 2000 and 2001 were over $4 per million Btu (EIA, 2000a).

Based on these factors, we investigated the impacts on the RPS if gas prices remained at $4 per million Btu and at $5 per million Btu from 2003 to 2010. As natural gas prices go up from an average of $3 per million Btu in the EIA's forecast to an average of $5 per million Btu, the impact of the RPS on consumers' monthly electricity bills greatly increases consumer savings. The greatest difference between the three price forecasts occurs in 2010, demonstrating that when the RPS is fully implemented consumers would be less vulnerable to high natural gas prices.

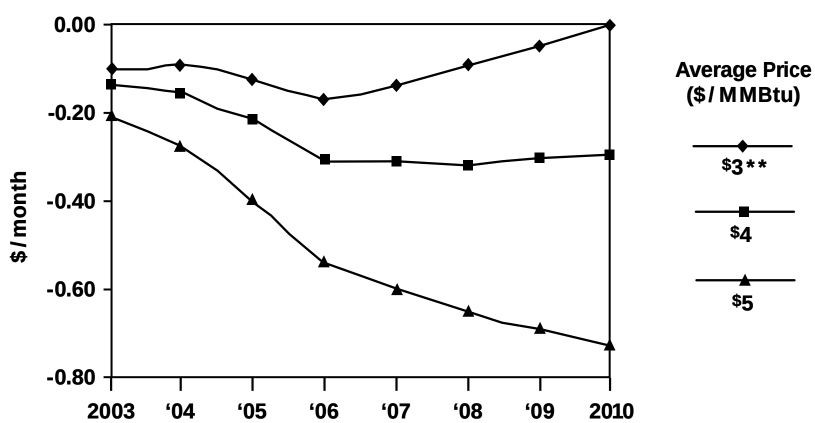
With natural gas prices at $4 per million Btu, average savings per customer would reach 29¢ per month in 2010, or $3.48 per year.

With natural gas prices of $4 per million Btu, the RPS would save consumers money each year through 2010, reaching 29¢ per month ($3.48 per year) in 2010 and thereafter. This adds up to $918 million in cumulative savings for the entire state ($2001). (See Figure 3.) With natural gas prices at $5 per million Btu, the cumulative savings reach $1.8 billion ($2001). Average savings per customer would climb to 73¢ per month in 2010 and thereafter, or $8.76 per year.

If natural gas prices follow the EIA forecast, the statewide cumulative savings between 2003 and 2010 would be $361 million ($2001). The typical household using 500 kWh per month would save 10¢ per month in 2003, the first year of RPS implementation. Savings would increase to 17¢ per month in 2006. Starting in 2007, typical household monthly savings would decrease gradually to 0¢ per month in 2010. Consumers would realize higher savings in the early years of the RPS implementation under the EIA's natural gas price forecast, largely due to the federal production tax credit for new wind turbines and biomass.

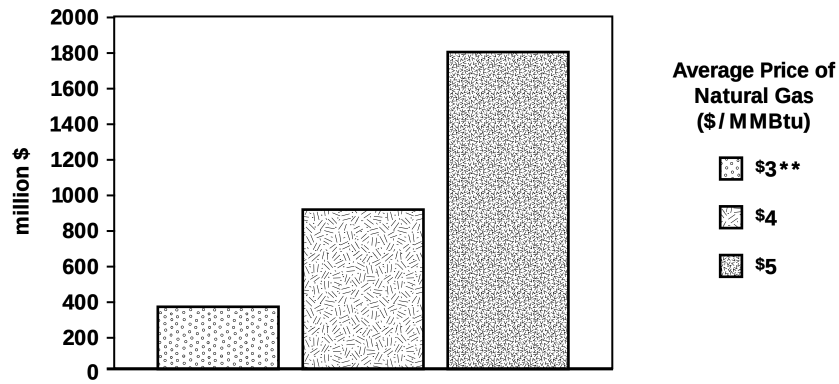
What if, on the other hand, natural gas prices fell in the next few years? In that case, implementing the RPS would lead to negligible increases in electricity prices. However, because electricity generation from natural gas would still exceed renewable energy generation, consumers would experience lower overall electricity bills than they see today. They would also realize further savings from lower natural gas bills for heating and other uses.

Figure 2. Change in Electricity Bills under Three Natural Gas Prices*



* Typical household monthly bill based on 500 kWh per month, 2001 dollars.
** Average natural gas price 2003–2010. Source: EIA (2000a).

Figure 3. Net Present Value of RPS Savings 2003–2010*



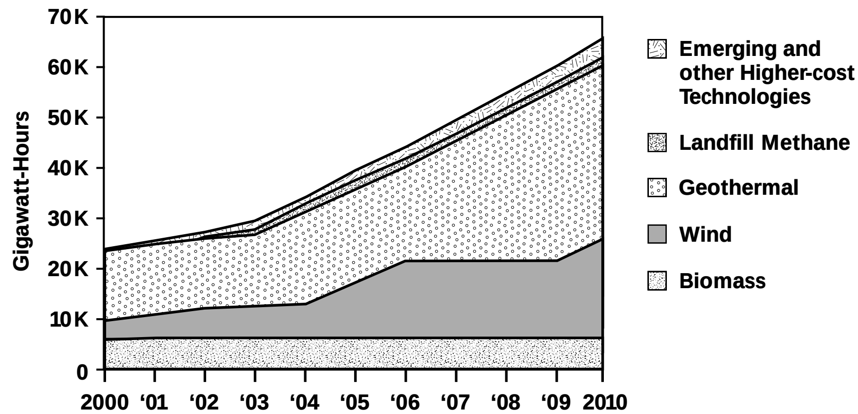
* 2001 dollars.
**Average natural gas price 2003–2010. Source: EIA (2000a).

The most the RPS could add to electricity bills would be an extra 5¢ per month in 2003, increasing to 87¢ per month in 2010. A cost cap mechanism within the RPS ensures that RPS costs would not exceed this level. Our analysis found that the cost cap would be reached in 2010 if natural gas prices were extremely low. If natural gas prices should decline, electricity prices would fall as well. Under these circumstances, the RPS could lead to minimally higher electric prices than would occur without the standard. For example, if natural gas prices were below $2 per million Btu, the cost cap would be reached in 2010. Electricity consumers would still see net savings of $6.65 per month in 2010, compared with today's natural gas prices of $4 per million Btu. The RPS would marginally reduce consumer savings if natural gas prices declined, but would protect consumers against unexpected increases in natural gas prices such as those seen in the last two years. This protection could save consumers billions of dollars. Viewed this way, the RPS would provide inexpensive insurance against high natural gas and electricity prices.

In our model, renewable energy credits are a proxy for the difference between the cost of producing renewable energy and market prices. Under the three natural gas price scenarios examined, REC prices associated with renewable energy developed under long-term contracts are negative, indicating that renewable energy sources are the least-expensive new supply options when compared with our assumptions about California's electricity market prices.

It is possible, however, that the market structure in California could lead to renewable energy sales through a mechanism other than long-term contracts. If that were the case, market prices would place an upper limit on what renewable generators could sell their energy for, assuming the same costs and market conditions modeled here. In the extreme, if all the additional renewable energy added to California's supply were sold at electricity market prices, there would be no direct electricity bill savings, but there would also be no costs. In other words, REC prices would be zero and the RPS would become a break-even proposition in terms of its impacts on consumer bills (see the appendix for additional discussion).

Figure 4. Total Renewable Energy Generation



New Renewable Energy Generation Mix

Under a 20 percent RPS, most additional renewable facilities would be likely to be wind farms and geothermal plants. These renewable technologies are available in large quantities in California and the West at relatively low cost. Geothermal energy is projected to grow from under 5 percent of California's electricity in 2002 to over 10 percent by 2010.[7] Wind power's contribution to California's electricity mix would more than triple from nearly 2 percent in 2002 to over 6 percent in 2010.

Between 2003 and 2006, the model predicts that a diverse mix of new wind, landfill methane, and geothermal generation would be installed to meet the RPS targets, along with additional generation from repowering existing wind projects. Both new wind and landfill methane projects would benefit from the assumed extension and expansion of the federal production tax credit through 2006. In 2007, after the assumed expiration of the PTC, geothermal energy would provide the most of the new renewable generation through 2009. Our model results show that by 2010, about 40 percent of the potential wind power resources in California would be developed (about 4,900 MW out of 12,500 MW). Nearly 45 percent of California's potential geothermal generation sources would be developed (2,480 MW out of 5,600 MW).

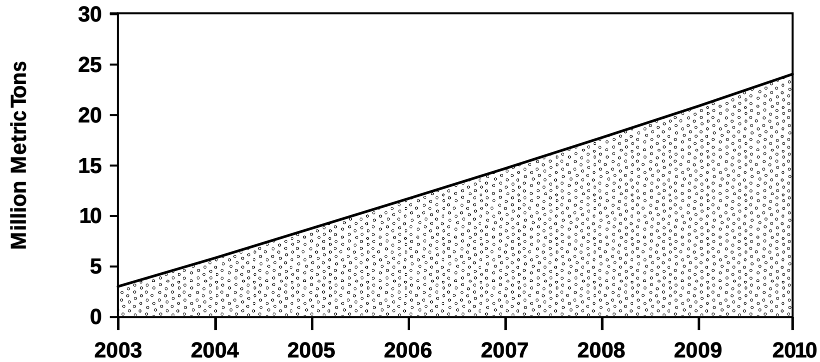
Our analysis also shows that geothermal energy imported from Nevada, Oregon, and Utah would make a small contribution to meeting the RPS target, making up 5 percent of the California's renewable energy by 2010. Imported wind power would not be competitive under the RPS because of the transmission costs of wheeling power from remote locations in other western states and the availability of significant quantities of low-cost wind power in California.

Higher-cost renewable energy technologies—such as solar photovoltaics, solar thermal electric, small wind turbines, fuel cells using eligible renewable fuels, and biomass gasification—play a small but important role in the forecast, together providing 1 percent of California's electricity in 2010. New landfill methane projects would also make a small contribution to the RPS.

We assume that existing biomass projects maintain their current market share of 2 percent of California's electricity through 2010. Our analysis found that new

[7] Including losses and large self-generators.

Figure 5. Carbon Dioxide Emissions Displaced by the RPS



biomass facilities are not competitive with new wind, geothermal, and landfill methane projects. However, we assumed that money from PGC funds and other sources could provide incentives for higher-cost technologies such as biomass gasification.

Displaced Fossil-Fuel Generation and Emissions

The most fundamental measurement of the impact of the proposed RPS on California is the quantity of kilowatt-hours generated by new renewable energy power plants built in response to the RPS. This result serves as the basis for determining the value of these clean power facilities both to California's electricity grid and to the regional, state, and global environment. Our analysis shows that new renewable energy resources would produce approximately 38,000 gigawatt-hours of electricity per year in 2010. The total renewable energy added to California's energy mix to meet the RPS target would displace the same amount of energy that could be produced by nearly 16 new natural gas–fired combined-cycle power plants in 2010.[8] Virtually all new power plants being built in California, as well as the rest of the United States, are fueled by natural gas.[9]

The shift from fossil-fueled power plants to renewable energy sources would avoid emissions of a significant amount of carbon dioxide emissions, a major contributor to global climate change. The electricity produced from new wind, geothermal, solar, and landfill gas projects built to meet the RPS target would avoid emissions of 3.2 million metric tons of CO_2 in 2003. Displaced CO_2 emissions would increase annually to nearly 24 million metric tons in 2010—the equivalent of taking 3.7 million cars off the road in that year.

[8] We assumed these plants operate 90 percent of the time and average 300 MW.

[9] For a listing of new power plant projects in California, see CEC (2001b). For US data, see EPSA (2001).

CHAPTER 5

ADDITIONAL BENEfiTS OF A RENEWABLE PORTFOLIO STANDARD

Boosting renewable energy production through a renewable portfolio standard can deliver a wide range of economic and environmental benefits for California that our analysis does not capture.

In addition to the direct benefits that every retail electricity consumer would see, the RPS would greatly reduce a number of risks that could negatively impact California's overall economy, and local, regional, and global environments. Price risks to consumers—as well as electricity providers—would be reduced significantly if a diverse set of renewable energy technologies were added to the supply mix. The analogy of the RPS as insurance is apt. A sufficient level of renewable energy resources provides fundamental value to the system by hedging against the volatility of future fossil-fuel prices.

Renewable energy resources provide a hedge against the volatility of future fossil-fuel prices.

Incremental and modular renewable energy technologies would allow new capacity to come on line quickly at existing sites. They could thus help reduce the risk of future fuel or electricity supply shortages in the near term. They could also help mitigate the risks of service and supply disruptions associated with fossil-fuel power plants.

Reducing Over-reliance on Natural Gas

The advantages of increasing renewable energy supply extend beyond electricity markets. A recent UCS study of the economic benefits from a suite of national energy policies showed that an RPS could help lower the demand for, and subsequently the price of, natural gas (Clemmer et al., 2001). Other studies have also shown that an RPS can reduce natural gas prices (IWG, 2000; Clemmer et al., 1999; EIA, 1999; EIA, 1998). The *Scenarios for a Clean Energy Future* study, for example, found that a 7.5 percent national RPS by 2010 would reduce natural gas prices by 7.5 percent. The analysis found the 7.5 percent target enough to offset about half of the incremental cost of the added renewable sources in most early years and to turn the RPS into a net economic benefit after 2015.

California's electricity use constituted 5 percent of the country's demand for natural gas in 1999. The state's total natural gas demand—for both electricity and heating fuel—made up more than 10 percent of the total US demand (EIA, 2000b). Thus, reducing California's share of total US natural gas consumption could decrease demand nationally. Within the state, an RPS would help reduce demand for natural gas and create more competitors for natural gas plants. The RPS would put downward pressure on natural gas prices in California and throughout the West, which in turn would reduce both electricity and natural gas bills for *all* California consumers.

This effect is especially important as the state builds more natural gas plants whose demand for fuel could push natural gas prices upward. Since many of the long-term power purchase contracts made by the state's Department of Water Resources include provisions for passing natural gas fuel prices on to consumers, the RPS could reduce the costs of the fossil-fuel power that is sure to dominate California's future energy supply portfolio.

Environmental Improvement

Shifting from fossil fuels to renewable energy sources not only would provide an insurance policy to stabilize long-term electricity and natural gas prices for consumers, but would also improve the public health of all citizens. Displacing the air emissions from fossil-fuel facilities would lower the number of asthma attacks, emergency room visits, premature deaths, and other illnesses, thereby lowering health care and insurance costs and increasing worker productivity.

Renewable energy projects would bring economic development to rural and often economically depressed regions.

The RPS could even help reduce the environmental compliance costs linked to the development of natural gas power plants. Nitrogen oxide (NO_x) emissions from power plants contribute smog formation. Because many areas of California exceed air quality standards for smog, new fossil-fuel power plants must acquire emission offsets for the NO_x they emit. California's air quality standards require new polluting sources to offset an equal or greater amount of NO_x emissions. Since renewable sources do not need NO_x offsets, the RPS could help reduce these compliance costs, ultimately benefiting ratepayers. Reducing NO_x emissions would also reduce the demand for NO_x allowances, potentially increasing RPS benefits even further.

By reducing carbon emissions, the RPS would also reduce the cost of future carbon-reduction measures likely to be required to slow global warming. Climate change is expected to place significant stresses on California's ecosystems and water resources (Field et al., 1999). A California RPS would not by itself have a significant impact on global warming. But the state is a significant element of the national economy. If it were to implement an RPS, that would send an important signal to the nation and the world about the state's recognition of the necessity of reducing carbon emissions and its willingness to do so.

Bringing more wind, geothermal, solar, and methane landfill gas projects on line in California would provide other environmental benefits. For example, there would be less need to

- use water for cooling thermal steam power plants, thereby preserving an increasingly scarce resource in California and the West
- expand natural gas drilling into sensitive public lands
- construct some of the 301,000 miles of natural gas transmission and distribution pipelines that are included in the Bush administration's energy plan (NEDP, 2001)

Economic Development

The economic gains linked to renewable energy sources would be equally impressive. Because California will need new renewable sources, the RPS will stimulate investment in new renewable energy, creating jobs and income in rural areas as well as in the high tech and manufacturing sectors. With a strong in-state renewable energy industry, California's economy would benefit from the large export potential of this industry. By using native renewable resources, California can keep jobs and dollars in the state, benefiting local economies.

Renewable energy projects would bring economic development to rural and often economically depressed regions. For example, wind power produces lease or royalty payments to rural landowners, tax revenues for counties and school districts, and jobs in wind turbine manufacturing, construction, and plant operations. For one rancher in the Altamont Pass, these amounted to $400,000 in a single year (Asmus, 2001). By promoting a market in the state, California may again attract manufacturers supplying the growing global market for renewable technologies. Greatly expanding renewable energy sources, coupled with fresh investments in energy efficiency, could save consumers money in the long run, while generating new forms of clean, local economic development.

CHAPTER 6

SEIZING THE OPPORTUNITY

California's energy crisis has dramatically driven home the importance of having reliable power and stable electricity prices. A renewable portfolio standard in California like the one proposed by Senator Byron Sher (D-Palo Alto) in SB 532 will diversify California's electricity supply, overcome barriers to renewable development, and further develop the state's extensive homegrown renewable energy resources. The state can secure more clean, reliable, stable, and affordable energy supplies and save consumers money at the same time.

We've presented the results of our analysis of an RPS that guarantees 20 percent of consumers' electricity comes from clean, stable renewable energy by 2010. Our study estimated the impacts that the RPS would have on electric bills, natural gas use, and power plant emissions.

- A typical household's electric bills would be lower at natural gas prices of $3, $4, and $5 per million Btu. Annual bills would be as much as $8.75 lower in 2010. From 2003 to 2010, the cumulative savings for the entire state range from $361 million to $1.8 billion ($2001).
- The RPS would reduce the state's use of natural gas to produce electricity by the amount of fuel it takes to run over 15 new natural gas plants for a year. While not measured in this study, the benefits of reducing demand for natural gas are likely to have economic benefits in the form of lower natural gas prices. These lower prices would save consumers money on their gas bills, and possibly drive down the costs of generating electricity, leading to further consumer savings.
- By using clean renewable energy instead of polluting power plants to produce electricity, the RPS would also reduce emissions of pollutants that lead to climate change, smog, acid rain, and water contamination. By 2010, the RPS would reduce California's annual CO_2 emissions by about 24 million tons.

The recent electricity-supply crisis and high natural gas prices demonstrate that California needs renewable energy sources now more than ever. California is vulnerable to price spikes, supply interruptions, and energy shortages. The state must diversify its energy mix to make it less susceptible to such problems in the future. Renewable energy sources such as wind, geothermal, and biomass have more stable prices because they do not use fossil fuels. Diversifying the power supply with California's abundant, cost-effective renewable resources will reduce price volatility and the environmental problems of fossil-fuel power plants, while making the state less dependent on fossil-fuel and electricity imports.

Under any future natural gas and electricity price scenario, an RPS would provide Californians with cleaner, more reliable, and diverse sources of electricity. This simple, yet effective policy tool complements and extends the public goods charge programs that currently exist in California. The PGC pushes renewable technologies down the cost-reduction supply curve; the RPS pulls up demand for these clean, state-of-the-art technologies. Working in concert, the PGC and RPS could provide a model for other states that wish to reduce the risks of energy market volatility that California has experienced over the last year.

The California RPS builds upon successes in Texas and 11 other states, but it is tailored to California's unique renewable resource base and addresses specific challenges facing the state from growing commitments to new fossil-fuel generation. Enacting an RPS in 2001 would set the stage for reviving renewable energy in California, helping the state meet future rising energy demands, provide insurance against volatile market prices, and reduce air emissions.

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Appendix

Calculating the RPS Impacts

We developed an analytical model to estimate the effects the RPS requirement would have on electricity costs. These impacts are driven by the costs of developing new renewable energy resources required to meet the RPS target as it grows over time. We assumed that the additional electricity generation needed to meet the RPS could come from wind, geothermal, solar, biomass, and landfill gas projects, plus incremental energy from repowering existing wind farms. Facilities in California and the surrounding ten western states would be eligible to meet the RPS target requirements.

In our analysis, we assumed that a market for tradable renewable energy credits (RECs) would develop and that renewable energy from sources that begin operating after January 1, 2001 would be eligible to earn RECs. Retail suppliers could use energy purchased from facilities in operation before or after January 1, 2001, to offset their overall RPS requirement, but energy from existing facilities (pre-January 1, 2001) would not be eligible for RECs.

A fundamental premise of this analysis is that renewable energy producers and retail electricity providers would exchange RECs under long-term contracts. Early anecdotal evidence from the implementation of the Texas RPS supports this approach. Further, most new and existing power plants supplying electricity to California have recently signed long-term contracts with the state to help reduce the future price volatility that occurred in spot markets over the course of the last year.

As described in Chapter 3, we used the following approach to estimate the cost of the RPS:

1. Calculate a REC price for each year based on the difference between the most expensive unit needed to supply additional generation to meet the RPS target in that year and its value in the wholesale electricity market.
2. Adjust the REC price to reflect funds available from the public goods charge (PGC) and the estimated costs of administering the RPS.
3. Calculate a weighted-average REC price for each year by multiplying the REC prices in all previous years by the incremental generation needed in each of those years. This reflects our assumption that most RECs will be traded through long-term contracts.
4. Compute the total cost of the RPS by multiplying the weighted-average REC price (expressed in ¢ per kWh) by the new renewable generation (kWh) needed to meet the RPS requirement in each year.

To determine the number of RECs that would be generated each year, we first multiplied the RPS percentage requirement in each year by the sum of California retail electricity sales forecast, transmission losses, and an estimate of electricity produced by large on-site self-generators.[1] Next, we subtracted out eligible renewable generation from facilities installed before January 1, 2001.

We assumed that new, high-cost emerging renewable energy projects would receive funding from utility programs or from the PGC New or Emerging Accounts and other programs. While these facilities would be eligible for RECs, we assumed they would not set the market clearing REC price. Emerging renewable projects would not be built in response to the REC market alone, due to their high costs. These facilities would recover their incremental costs through the PGC program. Therefore, we assumed that the PGC would provide the incentive to build them and that they would bid their generation into the market at the REC clearing price.

The analysis assumed a renewable energy credit price cap of 1.5¢ per kWh. If the REC market reached the cap in any given year, we assumed that retail suppliers could comply with their requirement by purchasing proxy RECs from a program administrator. We also assumed that the administrator would use the proceeds from these proxy credits to purchase as much renewable energy as possible from the least expensive renewable energy generation available in the market.

If the REC market reached the price cap, the incremental cost of purchasing additional renewable energy generation would be likely to be more expensive than the 1.5¢ per kWh REC cap price. Therefore, the amount of actual renewable energy generated would fall short of the amount needed to meet the RPS target. Any shortfall in meeting the RPS target would be added to the target for the following year. The shortfall would be made up in future years, if the credit price fell below the cap.

Under certain conditions, renewable generation could be less expensive than long-term wholesale electricity prices. In effect, this means REC prices, a proxy for the incremental cost of renewable generation, would have a negative value. This could occur if natural gas prices and electricity market prices remained high for an extended period of time, if the federal production tax credit for renewable energy was available, or as the cost of renewable generation from certain technologies fell over time due to mass production and performance improvements. When one or more of these conditions exist, we assumed that retail electricity suppliers would purchase renewable generation under long-term contracts that are below projected wholesale electricity prices. This is consistent with the following assumptions:

- Renewable generators would supply energy to the market through long-term fixed price contracts that bring them sufficient revenues to cover their investment and operating costs plus a reasonable return.
- There is no significant spot market for energy that is more financially attractive to renewable energy suppliers than long-term contracts, given the considerable uncertainty surrounding future natural gas and electricity prices.

For this analysis, we assumed that the savings realized from adding renewable energy sources to California's energy mix through the RPS would be passed on to consumers in the form of lower electricity prices. If renewable generators whose costs

[1] Total electricity sales (CEC, 2001c); losses and self-supply (CEC, 2000).

are below electricity market prices were able to sell their electricity at wholesale market prices, then any estimated savings from those resources would approach zero.

While renewable generators might be able to sell their power at values equivalent to long-term wholesale market prices, we also expect considerable competition between renewable generators to sign favorable long-term contracts with retail suppliers that are close to their costs (including a return on investment). To the extent that this occurs, renewable generation would put downward pressure on wholesale prices and would result in savings for consumers.

Data Sources

Our general approach for this analysis was to use broadly accepted forecasts and other input data as the basis for the analysis. In light of the volatility of current electricity and natural gas markets, any projections of the future must be viewed with caution. Our analytical approach addresses uncertainty in a conservative way that illustrates the approximate magnitude of economic and environmental impacts of an RPS program in California. Where appropriate, we adjusted input data and made conservative assumptions that would result in a higher estimate of RPS impacts. Because several of the assumptions used for our analysis were conservative, an RPS might well deliver greater benefits at lower costs than we have estimated.

We incorporated the following data into the model to assess how the proposed RPS of 20 percent renewable energy by 2010 would impact California:

- natural gas prices
- wholesale electricity prices
- electricity demand
- renewable energy supply
- renewable energy technology costs
- renewable energy imports
- production tax credit
- financing costs
- PGC funding levels
- administrative and transaction costs

Each is discussed below.

Natural Gas Prices

Forecasting natural gas prices under today's market conditions is a difficult task. Despite their recent drop from record levels this past year, plans to increase natural gas use for electricity generation in California and throughout the country are likely to continue to push gas prices up. In this analysis, we used the EIA's reference case natural gas price forecast from the *Annual Energy Outlook 2001* report for the Pacific Coast Census region, which includes California. The forecast shows a smooth trajectory that does not correspond to the historically volatile prices.

Given this uncertainty, some have also argued that these forecasts may not adequately reflect potential natural gas supply constraints and the need for additional supply infrastructure. Because natural gas prices are the element of the model with the greatest uncertainty and because they can have the greatest effect on the results, we performed a series of sensitivity analyses for these prices. We therefore analyzed the impact of the RPS assuming average gas prices of $4 per million Btu and $5 per million, as well as what gas prices would be necessary to hit the 1.5¢ per kWh cost cap.

Wholesale Electricity Prices

In California, wholesale electricity prices have shown unprecedented increases and volatility. These price changes went through two distinct phases. From 1998 through early 2000, wholesale spot market and bilateral prices for electricity in California averaged around 3¢ per kWh. These prices roughly followed the energy costs of the marginal generating plants serving the California market: natural gas-fired power plants. Since May 2000, California spot market prices have at times more than tripled historical price levels. Some new power plants are under construction, and California has directed increased attention to lowering regulatory barriers to the development of new capacity. It is therefore unlikely that the high spot prices that occurred in the first half of 2001 will persist over the long term.

One area of considerable uncertainty is the time it will take for wholesale prices to make the transition from the recent high prices to the long-term cost of new gas-fired plants. To what extent the long-term contracts recently signed by the state of California will affect this transition is also uncertain. The modeling method for calculating wholesale electricity prices assumed the following:

- Average long-term wholesale prices will eventually approximate the cost of power from new entrants to the market. We based this cost on the annualized “all-in” cost of power from a newly constructed gas-fired combined-cycle plant.[2] This approach reflects a long-term “equilibrium” approach to market entry; short-term prices will probably diverge significantly from time to time.
- As new generating capacity delivers energy to the California market and additional demand-side reductions are developed, we assumed wholesale prices would decline to the average long-term price by 2003.

In developing the wholesale electricity market price projections, we assumed a functional relationship between natural gas and electricity prices that yields a reasonable approximation of the effect of changing natural gas prices on electricity prices. We broke average annual prices down into nine periods throughout the year to account for differences in the price of electricity and the value of renewable energy during peak, off-peak, and shoulder periods.

By assuming that market prices converge with natural gas combined-cycle plant prices by 2003, we are not accounting for the risk that market prices could remain high or rebound to earlier levels at some future date. The large number of new gas plants coming on line should reduce this risk in the near future. Over time, however, the market is unlikely to maintain a large power surplus. Demand and supply will converge again. Load-response programs, in which customers are paid to reduce use when supplies are tight, will also help reduce the risk of price spikes. The RPS provides another hedge against spikes or sustained periods in which market prices exceed the long-term cost of new natural gas units.

[2] The long-term cost of new natural gas combined-cycle plants used in the model were derived from *Annual Energy Outlook 2001* (EIA, 2000a) and included in *Clean Energy Blueprint* (Clemmer et al., 2001). See below for assumptions on natural gas prices.

On the other hand, experience this summer indicates that prices could drop more quickly than anticipated in this analysis. It is uncertain at this point, however, the degree to which recent price decreases reflect any of the following:

- cooler weather
- one-time emergency conservation efforts
- more structural efficiency improvements
- a stabilizing impact of the state's long-term power purchase contracts
- a reduction in market manipulation as the result of Federal Energy Regulatory Commission actions or unfavorable publicity

To the extent prices decline more quickly than anticipated, our analysis may overestimate savings during the early years of the RPS. Because there is little renewable energy development under the RPS during these years, however, the effect would be very small.

Electricity Demand

Recent events have made forecasting future electricity demand highly uncertain. We conservatively assume a 1.5 percent average annual growth rate after 2001, which is slightly lower than the California Energy Commission's June 2000 demand forecast of 1.8 percent between 2000 and 2010 (CEC, 2000).[3] We adjusted the CEC forecast to reflect the impact of recent high wholesale electricity prices and the corresponding dampening of electricity demand in California. In addition, the CEC's forecast did not include the impacts of a recently passed law providing significant new funding for energy efficiency measures over the next 10 years. By comparison, the average annual growth rate between 1990 and 1999 was 1 percent. Some have argued that a growth rate of 1 percent may be reasonable given the recent high prices and increased investment in efficiency. If demand for electricity in California is lower than the 1.5 percent assumed for our analysis, the cost of the RPS would be lower because less renewable generation would be necessary to meet the RPS targets.

Renewable Energy Supply

The quality and quantity of energy production from renewable resources varies greatly from location to location. In some cases, quality or quantity can decline over time due to increasing use of the resource. For solar and wind technologies, the capacity factor (the average output divided by the maximum potential output) defines the quality of the resource, which in turn impacts the amount of energy generated by these intermittent renewable resources. For biomass technologies, the prime limitation is the cost and availability of biomass fuel. For geothermal technologies, capital and operating costs of the plants determine the resource quality, which in turn varies greatly with the temperature of the geothermal reservoirs.

We based our assumptions on the potential renewable resources available in California and the West on data from several sources used by the EIA in the National Energy Modeling System (NEMS). These data limit potential wind power projects to the best wind sites—Class 4 to 6—located within 20 miles of existing transmission

[3] We also assume a 4 percent reduction in electricity use in California from 2000 to 2001, based on actual data reported by the California Energy Commission (2001d) from the California System Operator for the first half of 2001.

lines. In addition, it excludes all environmentally protected lands (such as parks and wilderness areas), all wetlands, all urban areas, 50 percent of forested lands, 30 percent of agricultural areas, and 10 percent of range and barren lands. The analysis also includes incremental generation from the repowering of existing wind facilities.

It is possible to project the amount of windy land with specific wind speed characteristics with a reasonable degree of accuracy. However, there is considerable uncertainty as to how much of this land can ultimately be developed due to competing land uses and other siting-related factors. We assumed that at least 35 percent of the estimated potential, as assessed by National Renewable Energy Laboratory, would not be available for these reasons. Even with these exclusions, over 12,500 MW of potential wind capacity is available for development in California, as well as over 320,000 MW of wind potential in the surrounding region.

We also included an estimate of the incremental generation from the repowering of existing wind facilities based on data from several sources (AWEA, 2001; CEC, 1997; Gipe and White, 1993; Johnson, 2001). We assumed that fewer large, state-of-the-art turbines would replace all existing first- and second-generation wind turbines installed before 1990 at Altamont, Tehachapi, and San Gorgonio by 2006. We further assumed that overall capacity would remain the same but total existing wind generation in California would increase by over one-third. Finally, we assumed that repowering existing wind projects would be less costly than developing new "greenfield" wind projects.

We based geothermal steam power plant characteristics on data from NEMS for 51 sites throughout the West. In *Annual Energy Outlook 2001,* the EIA reduced the potential that could be developed at these sites by 45 percent compared with previous analyses, so we did not apply additional adjustments (EIA, 2000a). Even with the EIA's reduction in geothermal potential, California has approximately 5,200 MW of geothermal potential at 6¢ per kWh or less, with an equivalent amount available at this cost in the surrounding region.

Biomass resources included in the model are agricultural, urban, forest, and mill residues under $2.50 per million Btu based on data from NEMS. We did not include municipal solid waste as eligible biomass. The EIA recently reduced the overall potential for biomass in California and the West by over 48 percent compared with data used in earlier analyses. The EIA's data shows that no forest residues are available in California below $2.50 per million Btu, so the analysis effectively excludes them for economic reasons. For areas outside of California, we excluded 50 percent of the estimated forest residues to provide an extra margin against using unsustainable sources. We excluded an additional 5 percent of construction and demolition debris, on top of the 75 percent exclusion included in the EIA data, to provide an extra margin against using potentially contaminated stocks. After applying these exclusions, California still has over 1,000 MW of biomass potential below $2.50 per million Btu.

We also included the EIA estimates of the potential for converting landfill gas into electricity. This data shows a total potential of 1,095 MW in California.

Renewable Energy Technology Costs

The following new renewable energy technologies are included in the analysis: wind, geothermal, biomass gasification, and landfill methane. We calculated costs of large-scale solar thermal and solar photovoltaic facilities separately to evaluate high-cost renewable technologies. We based renewable energy technology cost and performance figures on the projections used in our national *Clean Energy Blueprint* report (UCS, 2001). These are quite similar to the projections used in *Scenarios for a Clean Energy Future* (IWG, 2000). Capital costs for all renewable energy technologies (except geothermal) are projected to fall over time, due to continued growth in global capacity and research and development spending. In addition, we assumed new wind turbines would have increasing capacity factors, to account for taller towers and technology improvements. We reduced capital costs for geothermal plants from the EIA by 15 percent to account for technological advances that have occurred since the original data was collected (Entingh, 2001).

One important deviation from the IWG study was the use of somewhat higher capital costs for wind through 2010, a conservative adjustment designed to conform to more recent cost data.

In our analysis, we assumed that transmission interconnection costs would be higher for all the renewable energy technologies than for new natural gas power plants. This assumption accounts for the additional distance typically required to connect these renewable generators to the electricity transmission grid as well as the lower economies of scale associated with smaller projects.[4] We also assumed that out-of-state renewable energy generators and intermittent resources (e.g., wind and solar) would pay higher transmission wheeling charges than in-state renewable energy projects and dispatchable resources (e.g., geothermal and biomass)(Caldwell, 2001).[5]

In one important area, we have not been conservative. We assumed that wind or solar generators would not incur financial penalties in their transmission or distribution charges because of their intermittent nature. Such penalties are inappropriate, as they do not reflect any added costs these technologies impose on the system, although they have been proposed or implemented in some regions. Such penalties are not a forecast variable, but under the control of policymakers. We have therefore assumed that policymakers who would implement an RPS would not also take steps to artificially increase its costs.

Renewable Energy Imports

We assumed that renewable energy generators installed after January 1, 2001, within the Western Systems Coordinating Council control area and that possess a transmission contract path to California would be eligible to meet the California RPS target. We added restrictions on renewable energy imports potentially available to California based on competing out-of-state demand for renewable energy due to policies enacted in other states (such as the Nevada RPS) and higher transmission costs.

Production Tax Credit

The federal government provides a production tax credit (PTC) to renewable energy generators based on the amount of renewable electricity they produce. Currently, new renewable facilities that use wind, biomass crops grown for energy, or poultry litter

4 We assumed interconnection costs of $210 per kW for renewable projects in California based on discussions with several renewable developers, experts, and studies. For wind projects, we included an additional $15–90 per kW to account for greater distances to existing transmission lines. We assumed interconnection costs of $50 per kW for natural gas facilities in California.

5 We assume a transition to a regional transmission system with uniform pricing by 2004.

receive a payment of 1.7¢ per kWh for the first ten years of operation. The PTC is currently set to expire at the end of 2001. However, the US House of Representatives has already voted to extend the PTC through 2006 and expand eligibility to include renewable energy facilities that use landfill gas, and other forms of biomass and organic wastes. We have assumed that the US Senate, which is generally more favorable to renewable energy than the House, will adopt the House PTC.

Financing Costs

The cost of financing new power-plant construction is an important factor in determining the cost of meeting an RPS target. Since most renewable technologies are more capital intensive (but have lower operating costs) than competing fossil-fuel technologies, higher financing costs tend to discourage renewable energy development and raise the cost of an RPS to consumers. We assumed that all projects coming on line to meet the RPS requirement would recover their capital investment through an annual carrying charge of 15 percent. We also assumed that new natural gas combined-cycle power plants would have an annual carrying charge of approximately 15 percent, based on data the EIA used in *Annual Energy Outlook 2001*.

The financing cost assumption used for renewable energy resources is consistent with a return on equity of 16 percent, an debt interest rate of 9.5 for a term of 12 years, and a 60/40 debt/equity ratio. We also assumed a 5-year depreciation period for renewable projects in accordance with federal law, compared with a 15- to 20-year period for new gas plants. Financing costs for new renewable energy technologies and gas plants also include taxes, insurance, and the interest accrued during construction.

California recently established the California Power Authority, which will have the authority to issue $5 billion in bonds. If the new agency issues bonds that provide low-cost renewable energy projects, the actual RPS costs would be lower than the costs predicted in the model.

Public Goods Charge

Renewable energy technologies are eligible for funding through 2012 through the public goods charge (PGC). The CEC released a five-year investment plan in June 2001 that proposed the following allocation through 2006:

- 50 percent of the funds to new renewable resources
- 20 percent to existing renewable resources
- 15 percent to small-scale emerging renewable resources
- 15 percent to consumer education and green marketing

As the RPS succeeds in pulling new renewable energy sources into the market, we assume that PGC funding allocations would evolve to optimize their impact. Renewable energy credits should fully cover the incremental costs of the lowest-cost new renewable facilities. PGC funding currently dedicated to low-cost new renewable technologies could be freed up to help maintain and increase generation from existing renewable sources and to increase development of higher-cost technologies that may have other public benefits and of emerging technologies. We assumed that the PGC, in conjunction with long-term contracts, would allow sufficient funding to maintain or increase the level of generation from existing renewable sources.

For our study, we assumed that half the funding the CEC currently allocates to the "new renewables" account would instead be allocated to higher-cost existing and new technologies such as biomass gasification, solar photovoltaic, solar thermal, and small-scale wind turbine projects. The rationale for this change is that most new renewable energy projects developed under the RPS will be low-cost facilities that would have otherwise applied for subsidies from the "new renewables" account in the absence of an RPS.

We assumed that the higher-cost new renewable energy projects, some of which are currently eligible for the emerging account, would supply 1 percent of California's electricity by 2010. This appears to be conservative considering that the CEC's investment plan target for small-scale emerging technologies is 1 percent by 2006 for less overall funding that we have assumed here.

In addition, we assumed that the CEC would distribute the other half of the current annual funding in the "new renewables" account uniformly across the new low-cost renewable generation installed in that year, thereby reducing REC prices somewhat. Finally, we assumed that the funding provided for existing renewable resources through the PGC and long-term contracts would be sufficient to maintain existing renewable energy generation at 2000 levels throughout the forecast.

Administrative and Transaction Costs

We also included administrative and transaction costs based on estimates developed by Sustainable Energy Advantage and La Capra Associates for a cost analysis of implementing the Massachusetts RPS (Grace et al., 2000). The analysis includes cost estimates for

- setting up a REC registry
- developing and purchasing computer systems for implementing the registry
- providing education and outreach to customers
- running the registry
- executing retail suppliers REC transactions

These costs, while not trivial, are small enough that their impact on electricity prices would be negligible (1.3¢ per MWh or 1,000 kWh in 2003 to 3.2¢ per MWh in 2010) when spread over all electricity demand in the state.