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RESTRUCTURED ELECTRICITY MARKETS

California Market Design Enabled Exercise of Market Power

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Abbreviations

CAISO	California Independent System Operator
FERC	Federal Energy Regulatory Commission
MWh	megawatt hour

GAO
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

June 21, 2002

The Honorable Jay Inslee
The Honorable Peter DeFazio
House of Representatives

Electricity is vital to our daily lives and our national economy. The United States' electricity industry is in the midst of major change, and the results of this change will affect all consumers. Historically, utility monopolies have generated electricity and sold it to consumers at prices set by state regulators. Now, in as many as 24 states, numerous private companies compete to sell electricity at either the wholesale or retail level at prices determined by the market forces of demand and supply. This change, commonly referred to as restructuring, is being driven by federal legislation and regulatory rules as well as by state actions. Restructuring is intended to improve efficiency in the industry and ultimately lower consumer prices.

California is part of a broader western market, and electricity is routinely bought and sold across state and national boundaries. For example, California has historically imported as much as 20 percent of its electricity from surrounding states—such as Arizona, Oregon, and Washington as well as from Canada and Mexico. In addition, California has exported electricity during periods when supply has exceeded demand in the state. As in other markets, private electricity suppliers will try to sell their electricity in whatever location they can get the highest price. As a result, if prices rise in one state, supply will flow into that state from surrounding regions, and this potentially causes prices to rise in those regions as well.

California's electricity industry began operating in a restructured market in April 1998. As part of the state's restructuring plan, the three privately owned utilities[1] operating in the state—serving about 75 percent of California's customers—were encouraged to sell much of their electricity generating capacity to private generating companies, referred to as wholesale suppliers, to enhance competition in the wholesale electricity market. To provide electricity to consumers, the three utilities then had to rely largely on these wholesale suppliers. Wholesale market prices—the

[1] The three utilities are Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric.

prices utilities paid for electricity they sold to consumers—were determined in an auction run by a "power exchange," in which retailers purchased electricity from wholesale suppliers, generally no more than a day in advance of the delivery date. At the outset of restructuring, retail prices charged by the utilities to consumers were still determined by the California Public Utilities Commission. As such, retail prices were initially frozen at a level 10 percent below the pre-restructuring rate, with full retail competition and unregulated retail prices intended to begin later. Finally, the plan set up the California Independent System Operator (CAISO), a nonprofit, private corporation charged with managing the transmission system in the state and balancing demand and supply, at the last minute, to ensure reliability of supply. California's market design was approved by the Federal Energy Regulatory Commission (FERC), which has authority over the design and operation of wholesale electricity markets.

For two years, the state had relatively low wholesale electricity prices. Beginning in May 2000, however, wholesale prices rose dramatically in California and stayed relatively high for about a year. Causes for the high prices included fast-growing demand, slow-growing supply, and unusually dry and warm weather in the region, which led to decreased availability of electricity imported from surrounding areas to California.

State officials and others also claimed that wholesale suppliers were exercising market power to raise prices above competitive levels. In this context, market power refers to the ability of individual sellers of electricity to charge prices above competitive levels. The competitive price is, by common definition, equal to the additional costs that would be incurred to produce an additional unit of electricity sold in the market. As long as sufficient supplies exist, the competitive price is roughly proportional to the fuel costs required to generate the next unit of power. However, when supplies grow increasingly scarce, leading to a tight balance between demand and supply, generating costs can rise dramatically because they include the costs of running generating units at higher than normal rates, thereby increasing the likelihood of breakdowns. At the point that all available generating capacity is in use, the competitive price will rise until demand equals supply at that price.

It is possible for market power to be acquired and used through legitimate means. For example, a patent on a new medicine may enable a drug company legally to charge prices above the costs of producing the drug, or a gasoline station owner on a busy corner may be able to charge higher prices than a competitor on a less traveled block, even if they pay the same amount for the gas they sell. However, federal antitrust laws are

violated if a company achieves, protects, or expands its market power through anticompetitive business practices such as colluding with its competitors to raise prices.

Because of concerns about market power, California officials appealed to FERC to mitigate the high prices. FERC is responsible for ensuring that electricity prices are "just and reasonable." If FERC determines that prices are not just and reasonable, FERC has authority to order refunds or make market changes, such as temporarily capping wholesale prices. Such a price cap would place a limit on the price suppliers could charge for their electricity.

In summer 2000, California used its authority, granted by FERC, to implement price caps in the wholesale market to mitigate the high prices. Further, in December 2000, FERC imposed its own price cap in an attempt to mitigate prices, although it allowed suppliers to sell at prices exceeding this cap if they could demonstrate that their costs were high enough to warrant such a price. All of the wholesale price caps imposed in 2000 were set at levels far above the frozen retail prices. In winter and spring of 2001—after many months of paying high wholesale prices and selling the electricity at much lower frozen retail prices—two of the three utilities became insolvent and were unable to purchase sufficient electricity to serve their customers. The state then began buying electricity from the market in the utilities' stead and eventually negotiated long-term contracts with wholesale suppliers to provide electricity to the state over periods of time as long as 20 years in the future.

Wholesale prices remained relatively high until about June 2001, when prices fell. A combination of events—cooler than usual weather, increased supply from the addition of new generating facilities, state conservation efforts, long-term purchases of electricity by the state, and a new region-wide price cap imposed by FERC—has been credited by various state, federal, and industry sources with causing prices to fall. The state is currently reviewing and redesigning its electricity market in order to ensure that the events that led to the high prices in 2000 and 2001 do not reoccur. The state is seeking approval from FERC for the new design.

You asked us to determine (1) whether wholesale suppliers of electricity exercised market power by raising prices above competitive levels after restructuring, and if so, (2) what role, if any, the design of California's market played in facilitating the suppliers' ability to exercise market power. To address your questions, we performed statistical and other analyses of electricity market data from April 1998 through October 2000;

reviewed numerous studies; and interviewed academics, industry experts, and analysts. Our analysis of market power is focused on the late summer and early fall of 2000. Because we did not have access to detailed company-specific data, we were unable to draw conclusions about the behavior of individual wholesale suppliers in 2000. In particular, we did not have data that would have enabled us to evaluate the effects of recently revealed trading strategies by Enron, wholesale suppliers, or other companies trading in electricity markets. Further, we did not assess whether the high prices experienced in California were the result of violations of federal antitrust or other laws relating to the sale of electric power. Such assessments fall under the jurisdiction of state attorneys general or federal entities such as the Department of Justice and the Federal Trade Commission. A number of lawsuits have been filed concerning various aspects of the California electricity market. Among these, are pending lawsuits alleging antitrust, fraud, and other violations of law. Appendix I provides a complete discussion of our methodology.

Results in Brief

Our analysis and other studies found evidence that wholesale electricity suppliers exercised market power by raising prices above competitive levels during the summer of 2000 and at other times after restructuring. Neither our analysis nor the other studies addressed whether any market power exercised in California was in violation of federal or other laws pertaining to the sale of electricity. However, our analysis and other studies found that during some periods, prices did not follow patterns consistent with prices under competitive conditions. For example, several studies concluded that wholesale suppliers were able to exercise market power by withholding electricity from the market, only making it available at the last minute when buyers were desperate to acquire enough electricity to meet demand and therefore willing to pay higher prices. As part of our analysis, we also found evidence of increasingly tight balances between demand and supply during the same period—a hot summer caused demand to rise, while dry weather the previous winter meant that hydroelectricity was in short supply. Because tight demand and supply balances would also lead to higher than normal prices, even under competitive conditions, we could not isolate how much of the relatively high prices was due to the exercise of market power. Other factors, such as environmental constraints on some electricity generators and higher fuel costs, were also identified by the other studies as contributing factors to the high prices.

The design of California's electricity market enabled individual wholesale suppliers of electricity to exercise market power. In addition, once prices

rose, in part as a result of market power, the design lacked effective mitigation strategies to return prices to competitive levels. Prominent experts on market design and industry experts generally agree that two principal market design flaws increased wholesale suppliers' incentive and ability to raise prices above competitive levels: (1) retail prices were frozen, and (2) with few exceptions, the California Public Utilities Commission prohibited or discouraged long-term contracts between utilities and wholesale suppliers. The experts and analysts concluded that the frozen retail electricity prices in California made it more profitable for suppliers to raise prices, because when they did, consumers did not reduce their use of electricity. Because retail prices were frozen, consumers had no financial incentive to reduce their demand when wholesale prices rose in summer 2000. This is unlike most other markets, in which consumers choose to buy less when prices rise. When consumers respond to prices in this way, suppliers know that if they raise their prices, they will lose some of their business. Concerning the lack of long-term contracts between utilities and wholesale suppliers, the experts and analysts concluded that this situation increased suppliers' ability to exercise market power because, without contractual obligations to generate electricity, suppliers could withhold part of their supply. As a result, electric utilities—required by design to serve all of consumer demand in their service areas—had to compete to purchase increasingly scarce electricity. Under these circumstances, wholesale suppliers were able to raise their prices above competitive levels. Our analysis shows that California's market design also lacked effective price mitigation strategies to be used once the exercise of market power was suspected. More specifically, in 2000, price caps imposed by the California Independent System Operator were ineffective in reducing prices to competitive levels, allowing the high prices to persist. Other studies and expert opinion also concluded that these price caps did not work, in part because they applied only to the state of California, leading to problems getting needed electricity into the state when electricity prices in other states rose above the California price caps.

Background

Prior to restructuring, the electricity industry in California was organized around three regulated monopoly utilities, which were responsible for ensuring that electricity demand and supply were balanced at all times in order to maintain a reliable electricity system. The utilities owned and operated the electricity generating facilities as well as the electricity transmission system (i.e., the actual wires that carry electricity from generators to final consumers). The utilities sold electricity to consumers at prices determined by the state's Public Utilities Commission—a state

regulatory agency. Charges to cover the costs of generating the electricity as well as the costs of maintaining and operating the transmission system were included in the retail electricity prices set by the commission. Utilities were allowed to earn a "normal rate of return" on all approved capital expenditures required to build generating facilities and the transmission system itself.

Seeking to improve efficiency and reduce electricity prices, California began restructuring its electricity market during the 1990s. As part of the state's restructuring plan, the utilities were encouraged to sell much of their generating capacity to private companies. This divestiture was intended to increase the number of competitors in the wholesale electricity market. The plan also set up the California Independent System Operator (CAISO), a private nonprofit corporation charged with managing the transmission system in the state and balancing demand and supply to ensure reliability of the system. Under the plan, the utilities would still own some generating capacity and own and maintain the transmission system. In the restructured market, which formally opened on April 1, 1998, private generators were able to sell electricity to the utilities through the newly created California Power Exchange in daily and hourly auctions. The power exchange was intended to be the primary market for wholesale electricity sold in the state. To ensure that the power exchange was a competitive market with many suppliers, the Public Utilities Commission required the utilities to sell their remaining generating capacity into the power exchange market. The Public Utilities Commission also limited the utilities' ability to enter into long-term contracts to purchase electricity wholesale, which effectively required them to purchase almost all of their electricity needs from the power exchange. As a result of these actions, most electricity purchases occurred in the short term—generally, at most one day ahead of when the electricity was needed.

Under restructuring, retail prices were frozen, while wholesale prices were to be determined by market conditions of demand and supply. In an attempt to ensure that consumers received some immediate benefits from restructuring, California's restructuring legislation required retail prices be frozen for up to 4 years at a level 10 percent below the prices that were in effect immediately prior to restructuring. Policy makers anticipated that the reduced retail prices would be higher than wholesale prices and would therefore allow the utilities to continue to recover costs they incurred in the old regulated market and that had not yet been recouped. Wholesale prices were determined in the power exchange market, and the CAISO bought some electricity near the last minute to maintain a precise balance between demand and supply. FERC's authority was unchanged; the agency

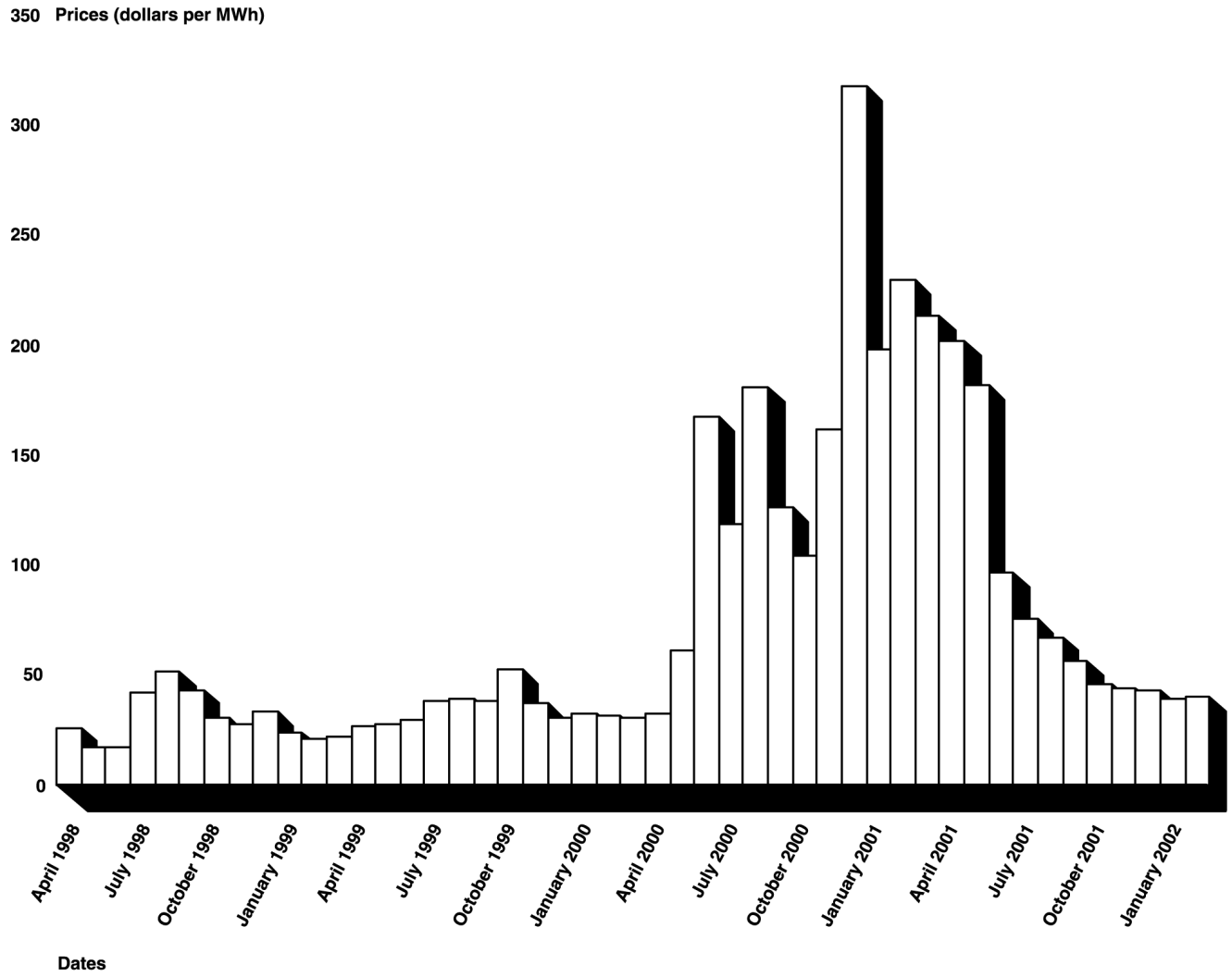
continues to monitor the functioning of wholesale markets and retains responsibility for ensuring that wholesale prices are just and reasonable.

For the first two years of California's restructured market, overall wholesale prices were fairly low, averaging about $33 per megawatt-hour (MWh)[2] compared with the frozen retail prices, which were set at about $65 per MWh. However, overall wholesale prices rose significantly in May 2000 and remained very high through May 2001.[3] These overall prices reached an all-time peak in December 2000 of $317 per MWh. Figure 1 shows the monthly average overall prices since April 1998, when the restructured market began operating, through February 2002.

[2] One megawatt-hour is enough electricity to serve the needs of 750 typical homes for an hour.

[3] Overall prices are an average of prices paid in the power exchange markets and prices paid by the CAISO for last-minute purchases.

Figure 1: Average Monthly Prices of Electricity in California, April 1998-February 2002



Source: GAO's presentation of data from CAISO.

As we reported in June 2001, average wholesale prices of electricity sold through the power exchange during the months of May through December 2000 were between 2 and 13 times higher than prices in the same months

of the previous year.[4] In addition, there were frequent periods, especially in the winter of 2000-2001, when the electricity system was in danger of service disruptions, and there were a number of days when rolling blackouts occurred. During this period, two of the state's three major utilities became insolvent and were unable to pay for their purchases of electricity. The California Power Exchange ceased doing business in January 2001 and later declared bankruptcy, as the state assumed responsibility for buying electricity on behalf of the utilities. (See app. II for a timeline of key events occurring in the California electricity market.)

Various factors have been cited as contributing to California's high electricity prices.

- Increased demand for electricity combined with a shortage of supply created increased scarcity beginning in May 2000. As we noted in our June 2001 report, demand for electricity rose by as much as 13 percent from 1995 through 2000, while supply growth did not keep pace.[5]
- Imported electricity from the Pacific Northwest, which California depended upon to meet its needs, was less available because an extremely dry winter in 2000 had reduced hydropower generation. In addition, imports from southwestern states were less available because higher-than-normal temperatures increased electricity demand in those states.
- Costs of generating electricity rose in 2000. In particular, prices of natural gas—the fuel used to generate as much as 40 percent of California's electricity—rose in 2000 compared to 1998 and 1999 prices. Also the costs of emissions permits, which some generating plants are required to own in order to operate, also rose in 2000.
- California state officials and others cited the exercise of market power by suppliers as a cause of the dramatically higher prices.

California officials attempted to mitigate high wholesale electricity prices in several ways. The CAISO attempted to control wholesale price increases by using a price cap to limit the maximum price it would pay for electricity it purchased. During the summer of 2000, this maximum price was lowered twice: from $750 to $500 per MWh in July and again from

[4] U.S. General Accounting Office, *Energy Markets: Results of Studies Assessing High Electricity Prices in California*, GAO-01-857 (Washington, D.C.: June 29, 2001) .

[5] U.S. General Accounting Office, *California Electricity Market Options for 2001: Military Generation and Private Backup Possibilities*, GAO-01-865R (Washington, D.C.: June 29, 2001).

$500 to $250 in August. Despite the caps, overall wholesale electricity prices remained higher than in the previous two years. As a result, California requested assistance from FERC. In December 2000, FERC implemented its own mitigation strategy that capped wholesale prices at $150 per MWh, but allowed suppliers to charge higher prices if they could demonstrate to FERC that their costs of generating the electricity exceeded the price cap. Even after FERC's actions, prices remained much higher than normal through May 2001. In June 2001, FERC implemented a region-wide price cap that effectively limited prices to a maximum of about $92 per MWh in all western states.[6] The state also took steps to expedite the siting of new power plants, promote energy conservation (in part by raising retail prices), and to negotiate long-term contracts with electricity suppliers.

In June 2001, overall wholesale prices fell dramatically and continued to decline for several more months, eventually dropping to about $40 per MWh as of December 2001. Numerous reasons have been advanced for these decreasing prices, including the price mitigation efforts by the state and FERC. In addition, demand was lower because of moderate weather conditions, and electricity-generating costs fell due to lower costs for purchasing natural gas.

Despite the current moderate electricity prices and estimates of enough electricity to meet the state's needs for the summer of 2002, California's electricity market faces an uncertain future for a number of reasons: (1) FERC's region-wide price caps are scheduled to expire September 30, 2002; (2) CAISO is still in the process of redesigning the electricity market and will seek approval from FERC for their new design; and (3) California officials are attempting to renegotiate many of the long-term contracts they signed with wholesale electricity suppliers in early 2001 because the prices they negotiated are much higher than current market prices. Further, as we recently reported, many proposals for new power plants in California have been cancelled because of factors such as the national economic slowdown; lower electricity prices; and the increased risk of entering a market where the market design and rules are uncertain.[7]

[6] The FERC price cap is actually linked to costs of generating electricity. If costs rise or fall, the cap will also rise or fall.

[7] U.S. General Accounting Office, *Restructured Electricity Markets: Three State's Experiences in Adding Generating Capacity*, GAO-02-427 (Washington, D.C.: May 24, 2002).

Suppliers Exercised Market Power during Periods of Tight Demand and Supply Balances

Our analysis found that electricity suppliers exercised market power by raising prices above competitive levels during some periods after the restructured market opened. In particular, we found that in parts of 2000, electricity prices did not follow the usual pattern of rising during the high-demand hours and falling during low-demand hours—rather, the highest prices were not found in the hours of highest demand. In addition, numerous studies conducted by prominent economists and other industry analysts also found evidence that individual suppliers exercised market power by raising their prices above competitive levels during certain periods. In explaining the high prices, the studies pointed to other factors as well, such as environmental constraints on some generators, higher fuel costs, and a generally tighter supply-demand balance, which increased suppliers' costs and contributed to relatively scarce supply during 2000. Table 1 summarizes our findings and the results of the other studies.

Table 1: Studies of Market Power in California's Restructured Electricity Market

Study/Authors	Period studied	Methodology	Results or findings
GAO analysis	April 1998-October 2000	Estimated the relationship between market price and total demand for electricity during a baseline period. Estimated the relationship between price and demand in August-October 2000 period—a high price period—and compared it to the baseline. Used other market data to attempt to explain observed differences. Remaining unexplained differences attributed in part to market power.	Prices across different levels of demand were inconsistent with baseline relationship between price and demand. Other factors—including fuel costs and levels of imported electricity, total demand, and in-state generation—did not explain the different pattern. Price pattern was consistent with market power being exercised in off-peak hours.
Berkeley/Stanford study	June 1998-October 2000	Estimated the marginal cost of supplying electricity and compared this cost to market prices. Prices greater than marginal cost were deemed to imply exercise of market power.	Market power was exercised in peak demand periods in 1998 and 1999, and more extensively in summer 2000. Fifty-one percent of total electricity expenditures in summer 2000 were attributable to market power.
MIT study	June-September, 2000	Estimated competitive benchmark prices. Compared actual market prices with the benchmark. Prices higher than benchmark were deemed to imply exercise of market power.	Prices far exceeded competitive levels during study period. Fuel costs, emissions permit prices, and other factors accounted for some of high prices. Market power accounted for the rest.
CAISO-A study	May-November, 2000	Reviewed individual suppliers' offers to sell electricity. Compared the offered prices with estimated marginal costs of generating power for each supplier. Offered prices higher than marginal costs were deemed to imply exercise of market power.	Some offers to sell were inconsistent with competitive behavior. Evidence indicates that suppliers withheld electricity to drive up prices.

Study/Authors	Period studied	Methodology	Results or findings
CAISO-B study:	April 1998-February 2001	Estimated baseline marginal costs of generating electricity that would occur under competition. Compared market prices to these costs. Prices higher than marginal costs were deemed to imply exercise of market power.	Suppliers exercised market power during the study period. Overall costs to state attributed to market power: $6.2 billion.
California State Auditor Study	April 1998-December 2001	Reviewed other studies, interviewed experts, reviewed bidding data.	Suppliers deliberately attempted to manipulate prices. Suppliers withheld supply, causing CAISO to pay high prices to maintain system balance and avoid blackouts.

Source: GAO's analysis and GAO's presentation of data from other studies.

Our Analysis Found Suppliers Exercised Market Power

To determine whether there was evidence that wholesale electricity suppliers exercised market power in California, we evaluated data from August through October 1998—a period of relatively low wholesale prices—to establish a competitive baseline relationship between wholesale electricity prices and the level of demand. We selected this baseline period because previous studies indicated that prices during the period were, for the most part, competitive. Then we compared the baseline to the period from August through October 2000, when wholesale prices were on average much higher, to determine whether the pattern of prices was consistent for comparable situations in the two periods. [8] Our analysis used price data from the power exchange market and demand data from CAISO.

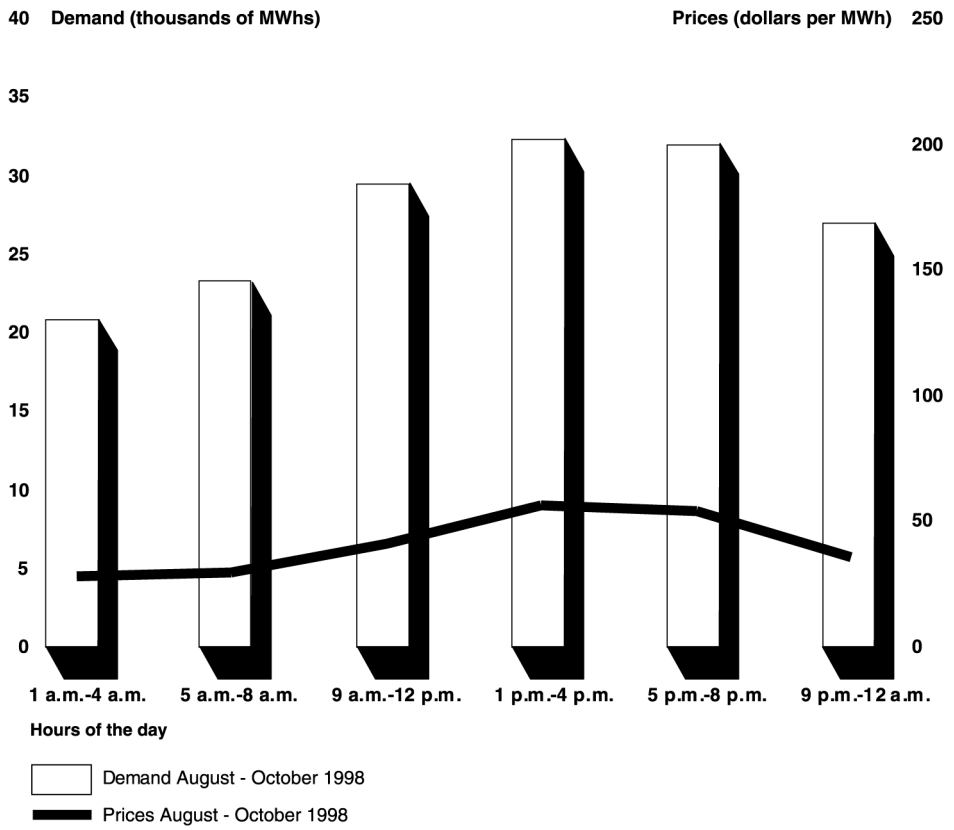
Under competitive conditions, prices of electricity are expected to follow a pattern in which high prices correspond to hours of the day in which demand for electricity is high and low prices correspond to low-demand hours. This pattern occurs because competitive electricity prices reflect the changing costs of producing electricity. The competitive price of a MWh of electricity is equal to the additional amount it would cost to generate an additional megawatt-hour, once all current demand is met. This additional cost is commonly referred to as the marginal cost. The marginal cost of generating electricity rises as more electricity is

[8] We chose these two periods after conducting a statistical analysis of price and demand data from April 1, 1998, through October 31, 2000. This analysis indicated that the August through October 2000 period differed significantly from similar months in 1998 and 1999, when prices were relatively low. Therefore, we focused further on this period and compared it to the same months in 1998.

produced, because different generators use different types and amounts of fuel. For example, hydroelectric and nuclear generating plants have very low fuel costs, while natural-gas-burning plants have higher fuel costs. Generating plants with low marginal costs generally operate during more hours of the day than those with higher marginal costs—the highest-cost plants operate only during the very highest demand hours and may even sit idle most of the year. Therefore, under competition, the rising marginal cost of electricity leads to high prices when demand is high and low prices during low-demand periods.

Figure 2 shows actual average demand and prices for different hours of the day from August through October 1998, the period that we used as our baseline. As the figure shows, prices are generally lower during low-demand hours and higher during high-demand hours.

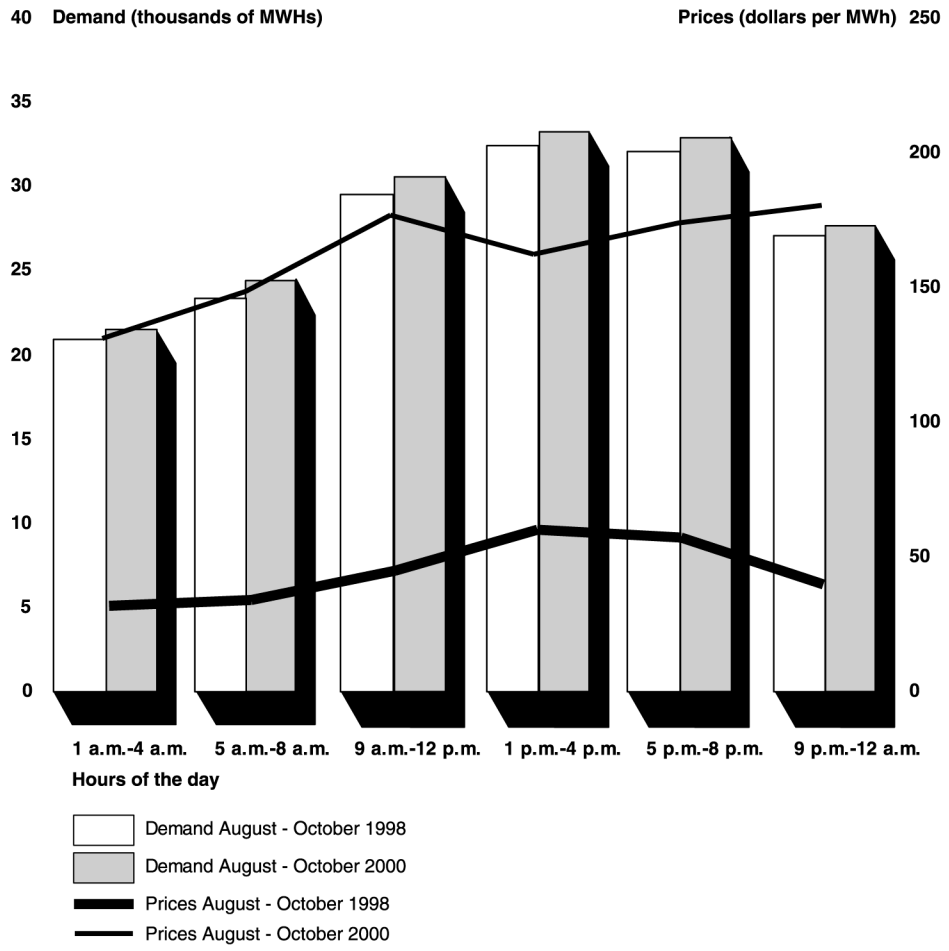
Figure 2: Baseline Relationship between Electricity Demand and Prices (August through October 1998)



Source: GAO's presentation of price data from the California Power Exchange and demand data from CAISO.

Figure 3 illustrates the price and demand patterns we observed during the baseline period compared to those for the period from August through October 2000. In comparing this baseline relationship to the prices and demand observed from August through October 2000, we found that average prices were much higher during the 2000 period than in the baseline. Other studies attributed part of this increase in prices to the exercise of market power. In addition, we found that the relationship between prices and demand observed during the 2000 period was not consistent with what would be expected under competitive conditions. Specifically, during the period analyzed, average prices during the heaviest demand hours were actually lower than in surrounding, lower-demand hours.

Figure 3: Comparison of Prices and Demand (Baseline and August through October 2000)[a]



[a] The actual dates for the 2000 period are August 7 through October 31, 2000 to coincide with the $250 price cap. The 1998 period runs from August 1-October 31. We refer to both periods as August through October.

Sources: GAO's presentation of price data from the California Power Exchange and demand data from CAISO.

Figure 3 shows that the hours of highest demand—1 p.m. through 4 p.m. and 5 p.m. through 8 p.m.—did not correspond to the highest average price, as would be expected under competitive conditions. Instead, the highest average prices came in the lower demand hours of—9 a.m. through 12 p.m. and 9 p.m. through 12 a.m. For example, in the highest demand hours, 1 p.m. through 4 p.m., demand averaged about 33,300 MWh, and the price averaged about $164 per MWh. In contrast, during the hours, 9 p.m.

through 12 a.m., demand averaged about 27,600 MWhs and price averaged about $182 per MWh.

We discussed the patterns of prices with CAISO staff and reviewed studies to try to explain why the prices did not follow the expected pattern in August through October 2000. According to CAISO staff, during this period, some suppliers increased the proportion of their electricity generation that they sold directly to CAISO, as opposed to selling in the power exchange as the market design intended. CAISO staff explained that, during this period, CAISO purchased some electricity at the last minute at prices above the prevailing price cap in order to keep demand and supply in balance and avoid blackouts. As a result, staff said, in-state suppliers withheld some of their electricity from the power exchange market and waited to sell at higher prices at the last minute. One recent study of the California electricity market concluded that suppliers knew that CAISO was unwilling to allow blackouts, even when prices were very high.[9] Therefore, the study concluded, the price cap created a game of "chicken" between suppliers and CAISO. Suppliers would wait until the last minute to sell their electricity, in an attempt to see how much the increasingly desperate CAISO would pay. The supplier behavior described by CAISO staff and in studies we reviewed was consistent with the exercise of market power, because the prices charged did not reflect the marginal costs of generating additional megawatt-hours of electricity. Rather, the behavior reflected an ability to charge higher prices by waiting to commit the generation to a time when buyers were willing to pay more. Other studies we reviewed analyzed the marginal costs of generating electricity during this period and concluded that these costs were well below the market prices we observed.

In addition to discussing our findings with CAISO staff and reviewing other studies, we examined other market data to try to explain the unexpected pattern of demand and prices observed from August through October 2000. We found that the supply of electricity was scarcer during that period than during the baseline period, owing in large part to a reduction in available imports of electricity from other western states. While greater scarcity can explain generally higher prices, it does not explain the pattern of prices we found. Even when electricity becomes

[9] Borenstein, Severin, "The Trouble With Electricity Markets: Understanding California's Restructuring Disaster," *Journal of Economic Perspectives*, Volume 16, Number 1, Winter (2002): pages 191-211.

increasingly scarce, prices should be higher during high-demand periods than when demand is lower, unless suppliers can, through the exercise of market power, affect prices in lower-demand periods. Therefore, based on our analysis and our review of other studies, we believe this pattern of prices demonstrates that suppliers exercised market power by raising prices above their marginal cost. Because we did not have specific cost data and could not accurately measure the role of scarcity in determining prices, we were unable to isolate the relative role of market power in causing the high prices found during 2000.

Other Studies also Found Suppliers Exercised Market Power

The authors of the other studies discussed in table 1 found that suppliers exercised market power by raising prices above marginal costs of generating electricity. Although these authors used different methodologies and studied varying time frames, they all reported that the exercise of market power was a key factor contributing to higher prices in the California market. The reported effect that market power had on prices varied: while the California State Auditor made no specific estimate, the authors of the Berkeley/Stanford study attributed as much as 51 percent of the price increases in the summer of 2000 to market power. The CAISO-B study concluded that $6.2 billion in higher electricity prices resulted from the exercise of market power by electricity suppliers during May 2000 through February 2001. Additional details of these studies are presented in appendix III.

The authors of the studies reported that other factors besides market power, such as increased production costs and a tight supply-demand balance, also contributed to higher electricity prices in California. Some of the authors noted that higher production costs contributed to higher prices in California during 2000 compared with earlier years. These costs included costs to purchase natural gas, which had increased in price, and costs of emissions permits required for some generators to allow them to operate. Some of the authors reported that tight demand and supply balances also affected prices. Demand increased because of unusually hot weather, while supply was scarcer because of the reduced availability of electricity imports from other states and a lack of new electricity generation in California in the preceding years.

Market Design in California Enabled Exercise of Market Power

California's market design enabled wholesale electricity suppliers to exercise market power. According to prominent experts and analysts, two principal market design flaws increased suppliers' ability to raise prices above competitive levels: (1) retail prices were frozen, and (2) with few exceptions, the Public Utilities Commission limited utilities' ability to enter into long-term contracts with suppliers. In addition, we found that California's market design lacked effective price mitigation strategies to be used once exercise of market power was suspected.

A provision of California's restructuring legislation froze retail prices for consumers for 4 years or until the utilities recovered certain costs incurred under the prior regulated market.[10] Numerous authors of studies of the California electricity market, including those studies discussed previously in this report and others, noted that the retail price freeze meant that consumers in California did not reduce their use of electricity when prices began to rise in May 2000.[11] Economists and other market design experts commonly recognized that such insensitivity to price changes is a key factor that enables suppliers to raise prices above competitive levels under tight supply conditions.[12] Therefore, the frozen retail prices in California created a situation in which suppliers could charge high prices during some periods without worrying that consumers would reduce their use of electricity.

With few exceptions, the California Public Utilities Commission severely limited the utilities' use of long-term contracts until after electricity prices increased in the summer of 2000.[13] The Congressional Budget Office notes that in California, as much as 50 percent of electricity purchases occurred

[10]The retail price freeze was in effect for Pacific Gas & Electric Company and Southern California Edison for the entire 4-year period. San Diego Gas and Electric Company recovered its costs in 1999 and started charging consumers their full costs. When prices rose in spring and summer 2000, California enacted legislation in September 2000 to again freeze consumer prices for most customers of San Diego Gas and Electric Company.

[11] See appendix IV for a complete bibliography of studies we reviewed.

[12] For a discussion of the relationship between price sensitivity and the ability of suppliers to exercise market power, see Jean Tirole, *The Theory of Industrial Organization*, The MIT Press, 1988.

[13] Even after the restrictions on long-term contracts were relaxed, the Public Utilities Commission would not guarantee that utilities could recover what they paid for electricity purchased in long-term contracts. Officials of one of the three main utilities told us that, without such a guarantee, they believed the risk of signing long-term contracts was too great.

immediately before electricity was needed to meet demand, compared to 10 to 20 percent in other states that had restructured their electricity markets.[14] Economists and other market design experts recognize that when suppliers have signed long-term contracts to sell much of their capacity at pre-determined prices, they have a much smaller incentive and ability to exercise market power. For example, authors of a study of the June 2000 price increases in California concluded that if the utilities had signed long-term contracts for their expected demand for the months of May and June 2000, average prices in the power exchange would have been significantly lower.[15] FERC also reported in November 2000 that flawed market rules—especially frozen retail prices and limited long-term contracts—contributed to unusually high prices in the summer of 2000 in California.[16] These studies and others concluded that the absence of such contracts between California's utilities and wholesale suppliers created conditions under which these suppliers could and would exercise market power.

In the course of our analysis, we found that the CAISO's use of price caps was ineffective in mitigating high prices and bringing them down to competitive levels in 2000. Other studies and expert opinion also concluded that these price caps did not work, in part because they only applied to the state of California—when prices in surrounding states were higher than the CAISO's price cap, wholesale suppliers naturally tried to sell to the highest location, which led to problems getting needed electricity into California.

Our statistical analysis indicates that the CAISO price caps were ineffective in bringing prices down; in fact, when they lowered the price

[14] Congressional Budget Office, *Causes and Lessons of the California Electricity Crisis*, Washington, D.C., September 2001.

[15] Frank A. Wolak, Robert Nordhaus, and Carl Shapiro, *An Analysis of the June 2000 Price Spikes in California ISO's Energy and Ancillary Services Markets*, a special report for the Market Surveillance Committee of the California Independent System Operator, September 6, 2000.

[16] Federal Energy Regulatory Commission, *Staff Report to the Federal Energy Regulatory Commission on Western Markets and the Causes of the Summer 2000 Price Abnormalities* (Washington, D.C., Nov. 1, 2000).

cap from $750 to $500 per MWh and again to $250, average prices rose.[17] Specifically, prices during May and June—when the $750 price cap was in place—averaged about $93 per MWh. During the period in which the $500 cap was in place—July1 through August 6—prices rose, averaging about $143 per MWh. When the price cap was lowered again to $250, prices again rose, averaging about $164 per MWh from August 7 through October 31. Our analysis does not allow us to say whether the price caps caused the increase in average prices, or if so, explain why that happened, but it is clear that they were not effective in bringing prices down to competitive levels.

We reviewed studies and interviewed experts to try to determine why the price caps were not effective. There was general agreement that one major flaw in the design of the price caps was that they did not apply to the entire western region. As one expert put it, "California is part of a larger western electricity market, and as a result, the CAISO price cap created an incentive for suppliers to sell electricity outside of California whenever prices were higher in surrounding states." Another study concluded that the implementation of the price cap was also flawed. The author of the study noted that the CAISO did not commit to keeping a firm price cap, because it was unwilling to impose blackouts on customers even when prices increased a great deal. As a result, the author said, the CAISO was put in a very weak position when it came to negotiating prices for electricity at the last minute and suppliers were able to drive up prices above the cap level.

The CAISO told us that as part of the design of California's restructured electricity market, the CAISO had limited authority to mitigate high prices when it found they were caused by the exercise of market power. This authority was largely limited to imposing prices caps on what the CAISO would be willing to pay for electricity from in-state suppliers. These caps did not apply to electricity purchased from out-of-state suppliers. Moreover, if prices outside the state rose above the California price cap, then in-state suppliers would have an incentive to export electricity, thereby making electricity scarcer and placing a greater burden on the CAISO to purchase more electricity at the last minute to balance demand

[17] Our analysis focuses on prices in the power exchange market and therefore does not address the prices CAISO paid for electricity in last minute purchases. Price caps may have affected the prices paid by the CAISO, but we did not have sufficient data to analyze this. Nonetheless, the majority of electricity purchases during the period we analyzed were made in the power exchange.

and supply, sometimes at prices above the price cap. As a result, capping prices in the state was ineffective in bringing down the total expenditures on electricity.

FERC also implemented a mitigation plan in December 2000. FERC's mitigation plan reduced the price cap from $250 to $150, but allowed sellers to receive higher prices for their electricity if they could justify the higher prices by demonstrating that their costs of generating or acquiring the electricity were higher than $150 per MWh. As mentioned previously in this report, prices remained relatively high throughout the winter of 2000 and 2001 despite FERC's mitigation efforts.[18] While it would appear that FERC's December mitigation plan was not effective in bringing prices down to competitive levels, there were other confounding changes in the market environment, including sharp increases in natural gas prices and increasing financial difficulties of the state's three largest utilities, that make it difficult to isolate the impact of FERC's actions on prices. Therefore, we were unable to evaluate the effectiveness of FERC's mitigation strategy.

Conclusion

As discussed in this report, a number of factors caused electricity prices to rise in California in the summer of 2000 and at other times since restructuring. Based on our analysis and studies by prominent economists and other market analysts, the exercise of market power by wholesale suppliers was clearly one of those factors explaining the high prices. Further, the design of the California electricity market created almost textbook conditions under which market power would be expected to exist. As a result, electricity suppliers could withhold electricity from the market until it was critically needed, and at that time, could raise prices above competitive levels. Attempts by the CAISO to mitigate the resulting high prices during 2000 were unsuccessful due to inadequacies in design and implementation of the mitigation strategies. This experience in California highlights the importance of properly designing competitive electricity markets and the need for effective mitigation when restructured markets do not perform as expected.

[18] In June 2001, FERC revised and expanded its mitigation plan, lowering the price cap again and extending its scope to encompass all western states. Subsequently, prices fell dramatically. As discussed previously, FERC's region-wide price cap has been partially credited by some for causing prices to fall. Other factors that may have led to lower prices were cooler weather, increases in supply, conservation efforts, and the state's long-term electricity contracts with wholesale suppliers.

Objectives, Scope, and Methodology

To determine whether wholesale suppliers of electricity exercised market power, we examined and analyzed market data on generation, demand, and prices of electricity in California from April 1998 through October 2000. We did not analyze the period after October 2000 because there were many changes to the market, that beginning in November 2000 made it difficult to determine what competitive prices should be. Among these changes were sharp increases in natural gas prices, increasing financial difficulties for the state's two largest utilities, and the eventual closure of the power exchange. The data we used came from the California Power Exchange, CAISO, and California Energy Commission. We performed statistical analyses to determine whether there were changes in the pattern of prices across different levels of demand during the summer and early fall of 2000. We also assessed other possible explanations for the high electricity prices experienced during 2000, including increased scarcity of supply, higher than normal demand, natural gas fuel costs faced by sellers, and the reduced availability of imports of electricity from other states. Appendix I contains a complete discussion of our methodology and analysis. In addition, we evaluated numerous other studies to determine what other analysts had concluded about the existence and extent of market power in the California electricity market. In particular, we focused on five studies that covered a range of time periods and methodological approaches and that addressed directly at least one of our objectives. A full bibliography of the studies we reviewed is contained in appendix IV. We did not have sufficient data to evaluate whether individual companies exercised market power, or to determine how much of the high prices experienced in California was the result of market power versus other factors that may have led to tighter demand and supply balances or to higher costs of generating electricity during this period.

To determine what role, if any, the design of California's market played in facilitating suppliers' ability to exercise market power, we evaluated the CAISO's price mitigation efforts. Specifically, we performed a statistical analysis of the relationship between prices and levels of demand, controlling for the various price caps imposed by the CAISO. We compared the periods in 2000—during which the CAISO lowered its price caps twice, and prices were generally high—with previous periods in 1998 and 1999, during which prices were generally lower. We also reviewed numerous studies by academics, industry analysts, and government agencies. Further, we interviewed academics, industry experts, industry participants, and officials from state and federal government, including the CAISO, California Energy Commission, Electricity Oversight Board of California, California Public Utility Commission, and FERC. In addition, where applicable, we applied established economic concepts and theories

to predict the likely effects of the CAISO's market power mitigation plan on prices and the supply of electricity.

We evaluated as well, FERC's market power mitigation plan, implemented in December 2000. Data limitations precluded us from evaluating the effectiveness of the FERC plan, but we reviewed academic studies that discussed FERC's mitigation methodology.

We conducted our work from July 2001 through May 2002 in accordance with generally accepted government auditing standards.

As arranged with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days after the date of this letter. At that time, we will send copies to appropriate congressional committees, the Federal Energy Regulatory Agency, the Director of the Office of Management and Budget, and other interested parties. We will make copies available to others on request.

If you or your staff have any questions about this report, please contact me at (202) 512-3841. Key contributors to this report are listed in appendix V.

Jim Wells
Director, Natural Resources
and Environment

Appendix I: Determining the Existence of Market Power and Impact of CAISO Price Caps

This appendix provides a detailed discussion of the analysis we used to determine whether market power existed in California's electricity market in 2000 and also to estimate the impact of the CAISO's changes to price caps in July and August 2000. We conducted econometric analyses using data on market prices in the forward electricity market operated by the California Power Exchange and demand data from the California Independent System Operator (CAISO). We also evaluated data on imports, reserve electricity purchases, and other purchases at the last minute by the CAISO to balance demand and supply.

In summary, the results of our econometric analysis are inconsistent with the absence of market power and are not fully explained by other factors, such as increased scarcity of supply or increases in costs of generating electricity. Therefore, we have concluded that market power played a role in the high prices experienced in California in 2000. Because we do not have sufficient data to allow us to measure costs or scarcity with precision, we could not estimate the extent to which the high prices were attributable to these factors versus market power on the part of wholesale suppliers.

We also found that the price caps imposed by the CAISO in an effort to mitigate market power were ineffective in reducing average prices. In particular, we found that when price caps were reduced in the summer of 2000—from $750 per MWh down to $500 on July 1 and from $500 to $250 on August 7—average prices actually rose. Other studies and experts we interviewed pointed out flaws in the design and implementation of these price caps that likely caused them to be ineffective. In addition to our own analysis, we interviewed economists and other industry experts to get their views on our methodology and results. Our findings are consistent with other studies by academics, industry experts, and staff of the CAISO.

Methodology for Evaluating Electricity Prices

To determine whether the high wholesale electricity prices in summer 2000 were consistent with expected behavior in the absence of market power, we developed an econometric model to estimate the relationship between prices in the power exchange market and variables expected to influence the price, such as the quantity supplied, time of day, and price cap regulation. In this model, we estimated a regression in which the quantity supplied is divided into two parts: the part that is served by in-state generation, and the part served by imports. In general, greater quantity supplied is predicted to lead to higher prices. However, in discussions with experts on the California electricity market, we were told that the availability of imports has a large impact on prices in the state. In

particular, imports have a damping effect on prices, because costs of generating electricity are lower in surrounding states than in California. In addition, they said that the highest cost suppliers during most hours are in-state generators, and it is these suppliers that set the market price for California. Therefore, we expect to find a negative relationship between imports and price and a positive relationship between in-state generation and price.

The model included dummy variables for periods of time during which the CAISO had imposed price caps.[1] We expected price cap variables to have a negative or insignificant impact on prices based on the theory of supply and demand. We also included dummy variables for different years, months, days of the week, and hours of the day, to account for unobserved variations in demand and costs over time. Finally, we included squared and cubed in-state generation terms to account for a possible non-linear relationship between price and quantity supplied of in-state generation.[2] The final form of our regression is shown in the following equation.

$$\Pr ice = \alpha + \beta_1 Gen + \beta_2 (Gen)^2 + \beta_3 (Gen)^3 + \beta_4 Netimports + \vec{\gamma} Pcaps + \vec{\varphi} Timeperiods + \varepsilon$$

In the equation, price is the hourly price set in the power exchange market in an auction held one day ahead of when the electricity will be generated and consumed. "Gen" refers to in-state generation in MWhs, and "netimports" is the amount of electricity imported, minus the amount exported, also in MWhs. "Pcaps" is a vector of dummy variables for various price caps that existed in California between April 1, 1998, and the end of our analysis, October 31, 2000.[3] "Timeperiods" is a vector of dummy variables for year, month, day of the week, and hour of the day.

The results of the ordinary least squares regression are shown in table 2.

[1] A dummy variable takes a value of 1 if a certain characteristic is present and a value of 0 otherwise.

[2] It is important to note that we are not estimating either a demand or supply relationship.

[3] The price data are hourly market clearing prices from the power exchange day-ahead market. Other variables are hourly data from the CAISO.

Table 2: Price Regression Results

Explanatory variables[a]	Coefficient estimate	Standard error
Constant	51.42918	4.800264[b]
In-state generation	0.0019569	0.0006479[b]
(In-state generation)^2	-4.14E-07	3.91E-08[b]
(In-state generation)^3	1.26E-11	6.69E-13[b]
Net imports	-0.0056135	0.0002955[b]
250 Price Cap (1998-1999)	0.2356245	2.067501
750 Price cap	6.352422	3.738449[d]
500 Price cap	56.09492	4.93126[b]
250 Price cap (2000)	72.7612	5.241998[b]
1999	19.03923	1.802957[b]
2000	33.93763	3.739452[b]
February	-5.197752	1.957393[b]
March	-7.083489	1.936569[b]
April	1.394583	1.8194
May	-1.832361	1.864067
June	8.310609	2.029737[b]
July	-14.03577	2.206409[b]
August	3.875315	2.309641[d]
September	22.55745	2.192674[b]
October	25.19806	2.469456[b]
November	22.89343	2.670744[b]
December	18.10554	2.6692[b]
Sunday	-9.019749	1.392289[b]
Monday	-1.399346	1.299002
Tuesday	-1.486778	1.295473
Thursday	-5.967485	1.295307[b]
Friday	-8.301758	1.298334[b]
Saturday	-8.434973	1.356632[b]
2 a.m.	-4.364651	2.41029[d]
3 a.m.	-5.185202	2.440988[c]
4 a.m.	-7.350066	2.473241[b]
5 a.m.	-6.126103	2.496086[b]
6 a.m.	-0.0317145	2.497901
7 a.m.	7.907819	2.480037[b]
8 a.m.	17.78537	2.454051[b]
9 a.m.	18.97172	2.428454[b]
10 a.m.	22.8728	2.417118[b]
11 a.m.	26.67939	2.423078[b]
12 p.m.	27.99686	2.431365[b]
1 p.m.	20.62724	2.438165[b]
2 p.m.	27.76876	2.443315[b]
3 p.m.	28.13216	2.446393[b]

Explanatory variables[a]	Coefficient estimate	Standard error
4 p.m.	24.37271	2.449033[b]
5 p.m.	20.00959	2.45096[b]
6 p.m.	15.99276	2.458588[b]
7 p.m.	14.57276	2.467717[b]
8 p.m.	10.16211	2.472744[b]
9 p.m.	17.10398	2.481656[b]
10 p.m.	15.11537	2.46666[b]
11 p.m.	6.660357	2.437887[b]
12 a.m.	1.924638	2.409756

Notes: Adjusted R-square: 0.4983

[a]The dependent variable is price.

[b]Significance at the 1-percent level.

[c]Significance at the 5-percent level.

[d]Significance at the 10-percent level.

The regression estimates indicate a positive relationship between price and in-state generation, and a negative relationship between price and net-imports as expected. The relationship appears to be somewhat non-linear, although the non-linear terms are small in magnitude. The initial price cap of $250 per MWh, which was in place from July 18, 1998, through September 30, 1999, had no significant impact on prices. In addition, the $750 price cap appeared to have only a weak if any impact on price. However, lowering the price caps from $750 to $500 per MWh and again from $500 to $250 was associated with increases in average prices. This result is inconsistent with what would be expected under normal conditions, where a price cap can only cause prices to fall and then only during periods where the cap is lower than the market price.

In addition to the least-squares regression results reported, we also performed various checks for robustness. First, we calculated standard errors for the regression coefficient estimates that are robust to heteroscedasticity (White, 1980)[4], and to serial correlation and heteroscedasticity (Newey and West, 1987).[5] The statistical results did not qualitatively change from the reported regression in that lowering the

[4] White, H. "A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity." *Econometrica*, 48, 1980, 817-838.

[5] Newey, W. and K. West. "A simple positive semi-definite, heteroscedasticity and autocorrelation consistent covariance matrix." *Econometrica*, 55, 1987, 703-708.

price caps from $750 to $500 per MWh, and then from $500 to $250, resulted each time in a statistically significant increase in the market clearing price.

Second, because the residuals of the least-squares regression indicated first-order serial correlation, we estimated the regression controlling for the serial correlation and obtained qualitatively similar results using both least-squares standard errors and robust (White, 1980) standard errors.

Third, we analyzed the impact of extreme observations on the regression results because, in least-squares models, the expected value of the market-clearing price and large deviations from the mean can disproportionately affect the coefficient estimates. We estimated a bounded influence regression (Kraskel, Kuh, and Welsch, 1983)[6] in which extreme outlying observations are down weighted; the results of this regression were similar to the least-squares regression although the $250 price cap had a much larger positive effect on the market price. We also estimated a quantile regression in which the median of the market price was modeled because the median is not sensitive to extreme outliers (see Judge et al., 1985, ch. 20);[7] the results of the median regression were similar to the least-squares regression results, although the magnitude of the $250 price cap was again larger.

On balance, the regression results indicate that when price caps were lowered in 2000, average prices rose—a result that is potentially inconsistent with competitive conditions but which does not directly indicate the existence of market power. Average prices could have risen due to changes in some other factors that influenced electricity prices and coincided with the lowering of the price caps, but that are not accounted for in the regression model. For example, the increase in prices could have been caused by increases in costs that coincided with the lowering of the price caps.[8] To determine whether there was evidence of market power,

[6] Krasker, W. S., S. E. Kuh, and R. E. Welsch. "Estimation for dirty data and flawed models." in Z. Griliches and M. D. Intriligator (eds.) *Handbook of Econometrics*, vol 1, Amsterdam, North Holland, 1983, 652-698.

[7] Judge, G.G., and W. E. Griffiths, R. C. Hill, H. Lutkepohl, and T. C. Lee. *The Theory and Practice of Econometrics*. New York, Wiley, 2nd Edition, 1985.

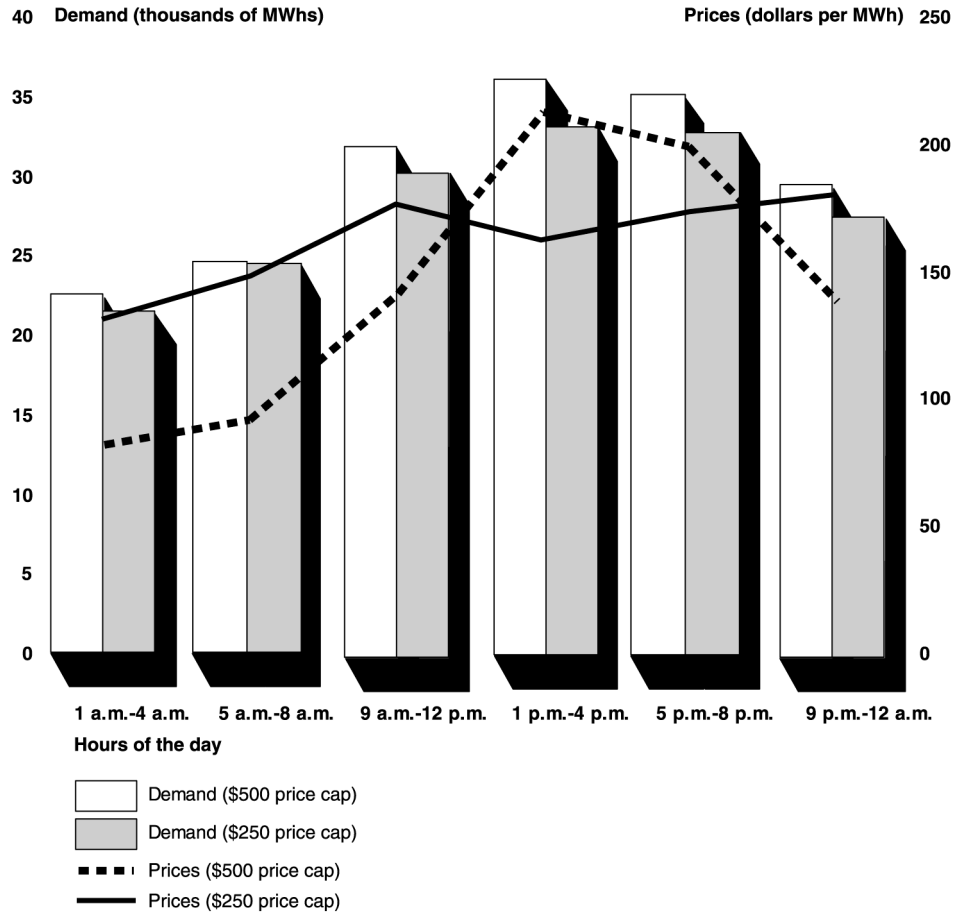
[8] Another possibility is that there were increases in prices of electricity in surrounding states that coincided with the lowering of price caps in California. In this case, in-state suppliers would be able to get higher prices in surrounding states, and this would cause prices in California to rise as well.

we had to explore other possible explanations for the unexpected regression results.

Determining the Existence of Evidence of Market Power

In order to explore the possibility that market power was being exercised, we focused our attention on the period from July 1, 2000—the day the $500 price cap was implemented—through October 31—the last date of our regression analysis. This period encompassed the date the $250 per MWh price cap was implemented—August 7, 2000. As discussed in this report, prices did not follow the pattern expected under competitive conditions during the period of the $250 price cap. In an attempt to explore other possible explanations for the observed pattern of prices, we compared two periods—the first from July 1 through August 6, 2000, during which the price cap was set at $500 per MWh, and the second from August 7 through October 31, 2000, during which the cap was $250. In particular, we evaluated the increase in average prices and the change in the pattern of prices that occurred when the price cap was lowered from $500 to $250 per MWh. Figure 4 shows prices and total electricity demand in the two periods in which the price caps were $500 and $250 per MWh, respectively. While lowering the price cap was associated with falling prices in the two highest demand periods, it was also associated with rising prices in all other periods.

Figure 4: Demand and Prices



Source: GAO analysis of CAISO and California Power Exchange data.

As discussed in this report, the increased prices in the lower-demand periods are not consistent with competitive pricing if all other factors are held constant. However, we cannot conclude directly from this pattern that market power was the cause of the increases in prices or changes in the pattern of prices. Therefore, we evaluated numerous variables, including imports of electricity from surrounding states, last-minute purchases of electricity to balance demand and supply by the CAISO, prices of natural gas (the principle fuel used by many of the in-state generators), total demand, and total in-state generation. We found that these variables were all changing over time, but in ways that should have led to lower rather than higher prices or were of insufficient magnitude to explain the price increase.

For example, imports and net-imports (imports minus exports) of electricity into California were higher during low- and high-demand hours in the $250-price-cap period than in the $500-price-cap period. Our regression results indicate that higher levels of net imports are associated with lower prices. Therefore, changes in net imports are unlikely to explain the increase in prices during low-demand hours after the price cap was lowered to $250 per MWh. In addition, levels of in-state generation are also lower during low- and high-demand hours in the $250-price-cap period than when the cap was $500 per MWh. Our regression results indicate that lower levels of in-state generation are associated with lower prices. Therefore, levels of in-state generation are unlikely to account for the increases and change in pattern of prices after the cap was lowered to $250 per MWh. Similarly, total demand was lower during low- and high-demand hours in the $250-price-cap period. As discussed in this report, lower levels of total demand are predicted to be associated with lower prices. Therefore levels of total demand cannot account for the observed price changes.

Last-minute purchases of electricity to balance the system were relatively unchanged over the two periods. In particular, purchases of regulation electricity, spinning reserves, and non-spinning reserves were close in both low- and high-demand hours in the two periods.[9]

Among the variables affecting electricity prices was the price of natural gas, which rose over this period. While this increase would be expected to cause electricity prices to rise under competitive conditions, prices would likely rise in proportion to the change in natural gas prices. However, electricity prices during low-demand hours rose by much more, proportionally, than did average natural gas prices, which means that gas prices are not likely to fully explain the increase in prices during these hours.

In addition to evaluating these variables, we discussed our findings with two economists with electricity market expertise. They agreed that the pattern of prices we observed was not consistent with competitive conditions. In particular, they said that the fact that prices rose so much at the lowest levels of demand indicates that suppliers changed their

[9] Regulation electricity, spinning reserves and non-spinning reserves are purchased by the CAISO to balance demand and supply and maintain enough reserves of supply to keep the system operating reliably as demand and supply conditions change.

behavior in response to the price cap. Both also agreed that the price cap caused some suppliers to avoid the capped prices, either by withholding some of their electricity from the power exchange and offering it directly to the CAISO at the last minute and at higher prices or by selling it in surrounding states, where prices were at times higher than $250. Further, they said that this withholding of power from the capped market would likely have caused other suppliers to increase their asking price for electricity, knowing that they faced less competition. The economists said that such a change in behavior is only consistent with the existence of market power, because suppliers who do not have market power treat prices as given and do not take actions designed to achieve a higher price.

We also discussed this period of time with staff of the CAISO. In discussions with the CAISO, we were told that sellers were able to partially avoid the price cap by selling some of their power outside the state—perhaps to an affiliated company—and then buying it back to sell to the CAISO at the last minute when the CAISO was desperate to balance demand and supply and therefore willing to pay prices above the capped rate.

We did not have data on specific transactions between suppliers and buyers outside of the capped market, and we had no data on out of state sales or prices. Therefore, we could not verify that supplier behavior changed in the ways suggested by the economists we interviewed and CAISO staff. However, we were able to look at aggregate levels of exports of electricity from California to surrounding states. We found that monthly exports were significantly higher from May through October 2000, than they had been in these same months in 1998 or 1999. Specifically, monthly exports from May through October 2000 were between about 40 and 230 percent higher than the same months in 1998 or 1999. Overall, exports were about 200 percent higher from May through October 2000 than in the same period in either 1998 or 1999.

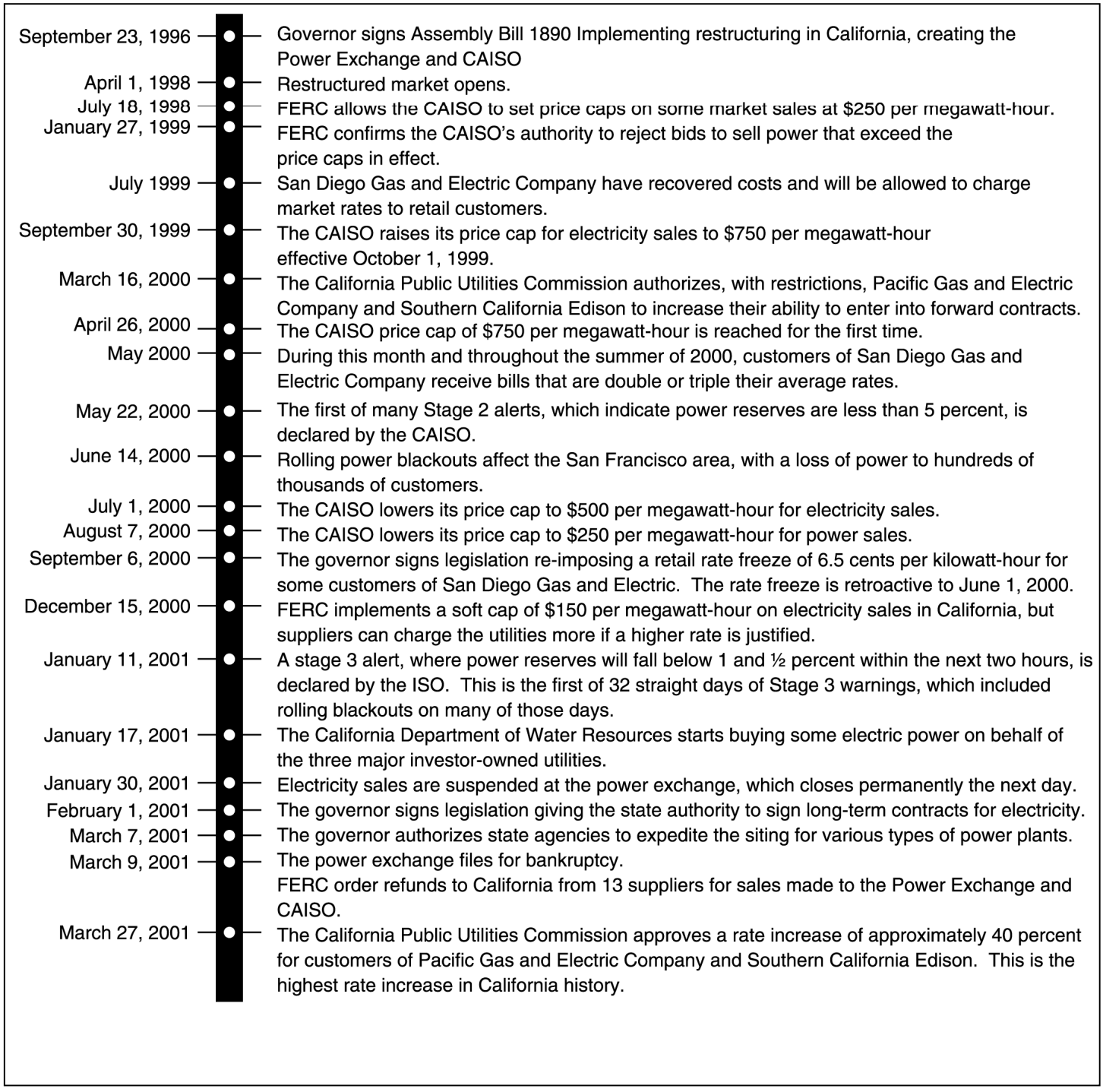
In balance, the combination of the results of our econometric analysis, our analysis of prices and other variables in the period surrounding the change in the price cap from $500 to $250 per MWh, and the interpretation of the economists and CAISO staff we interviewed provide evidence that suppliers were able to exercise market power during the period after the $250 price cap was implemented.

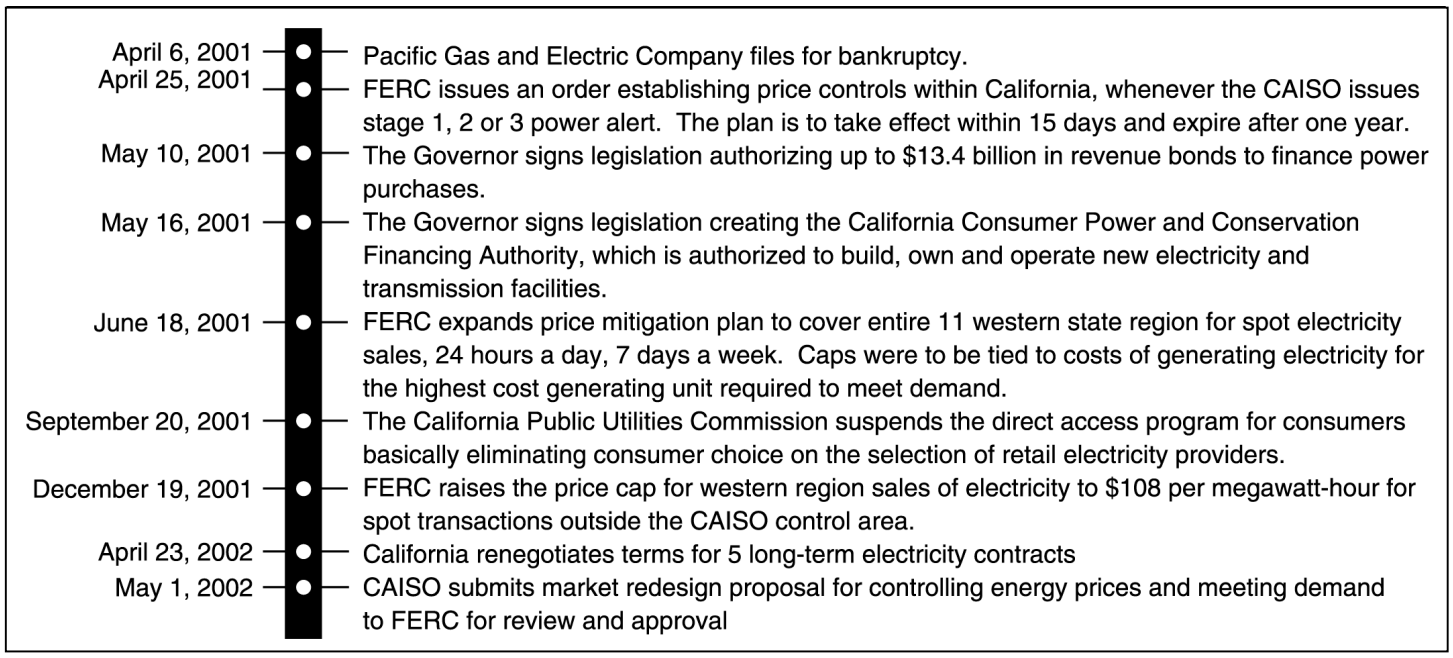
Determining the Effectiveness of Price Caps on Market Power Mitigation

The results of our regression indicated that average prices rose when the caps were lowered during summer 2000. This pattern was inconsistent with our expectations about the impact of price caps. To explain these inconsistent results, we reviewed other studies and interviewed economists and other experts. There was broad agreement that flaws in the design and implementation of the price caps led to their being ineffective as tools for mitigating market power.

The flaws in design identified by studies and experts relate to the ability of suppliers to avoid the price caps and sell at prices above the cap. In particular, the cap was imposed by the CAISO to limit what CAISO would pay for power in the last-minute markets. However, California is a part of a larger western regional market, and the CAISO cap did not apply to other states. Therefore, when prices in other states rose above the CAISO price cap, suppliers in California had an incentive to sell their electricity to other states. As a result, the CAISO found that it was forced to buy a larger share of the total electricity consumed in a given hour during the last minutes before it was needed to meet demand. CAISO was also faced at times with paying prices higher than the cap to avoid electricity shortages and forced blackouts for some consumers. According to one study, the inability of the CAISO to commit to maintaining the cap, even at the risk of blackouts, gave suppliers a bargaining advantage in setting their prices for sales to the CAISO at the last minute.

Appendix II: Key Events during Electricity Restructuring in California





Sources: Multiple news stories, public documents, and studies.

Appendix III: Summary of Studies on Market Power

Borenstein, Severin, James Bushnell, and Frank Wolak. "Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market." (unpublished). February 2002.	The authors examined the degree of competition in the California electricity market from June 1998 to October 2000. They compared market prices, using pricing data from the power exchange, with estimates of marginal costs of producing additional electricity. The authors tested whether the overall market was setting competitive prices considering the production capabilities of all suppliers in the market. The analysis included such cost factors as fuel costs; maintenance costs; and costs for emissions control, a regulatory requirement for some geographic locations. Adjustments were not made for costs related to inefficient transmission of power between geographic areas. Using the cost data, the authors computed the perfectly competitive price for each hour for the months in the sample period. The authors then categorized higher expenditure for wholesale purchases of electricity during the summer of 2000 into increases in production cost, scarcity, and the exercise of market power. The authors found that 51 percent of total electricity expenditures in the summer of 2000 could be attributed to market power. They note that market power was most commonly exercised during peak demand periods.
Joskow, Paul, and Edward Kahn. "A Quantitative Analysis of Pricing Behavior in California's Wholesale's Electricity Market During the Summer 2000: The Final Word." (unpublished). February 4, 2002.	The authors simulated competitive prices under various demand and supply conditions that existed during the summer of 2000. They then used public data on production on an hourly basis from EPA and other public sources and compared the actual prices from this data with their estimated competitive wholesale benchmark prices. The benchmark price was the short-run cost of supplying electricity from the last unit that would clear the market in each hour. Factors such as fuel prices and costs for emissions control to meet environmental requirements were included in the analysis. These authors found that wholesale prices far exceeded competitive levels during the months of June through September 2000. They noted that evidence supports the conclusion that power was withheld from the market by electricity suppliers, which contributed to the high prices during the summer of 2000.

Hildebrant, Eric. *Further Analyses of the Exercise and Cost Impacts of Market Power in California's Wholesale Energy Market.* A special study by the Department of Market Analysis, California Independent System Operator, Folsom, California, March, 2001.	This CAISO economist evaluated electricity prices in California for the period of April 1998 through February 2001. This study compared the difference between actual wholesale prices in the CAISO system with an estimate of baseline costs that would be incurred under competitive market conditions. He included in this analysis the potential impacts of emissions costs and price impacts from hours when supply was scarce. The results of the analysis showed that market power was being exercised for the period evaluated, between May 2000 and February 2001. The author estimated that overall wholesale costs during that period had been driven up by more than $6.2 billion by the exercise of market power and that over 30 percent of wholesale electricity costs during the year prior to his study could be attributed to market power.
Sheffrin, Anjali. *Empirical Evidence of Strategic Bidding in California ISO Real Time Market.* A special study by the Department of Market Analysis, California Independent System Operator, Folsom, California, March 21, 2001.	This CAISO economist reviewed bids from five large in-state non-investor owned utility suppliers, as well as 16 importers selling electricity in the real-time market of the CAISO for each hour between May and November 2000. She compared detailed bidding data in the real-time market to the marginal cost of supplying energy and analyzed the level of mark-up for each supplier. The author used real-time data from the CAISO market for specific companies and generation units. She found bidding behavior that was not consistent with competitive bidding. Further, she found that wholesale suppliers displayed forms of physical and/or economic withholding of electricity for the purposes of inflating prices. The author concluded that large suppliers were actively engaged in bidding behavior that had a direct impact on market prices, and she noted that this behavior indicated systematic exercise of market power to maximize profits.
California State Auditor. *Energy Deregulation: The Benefits of Competition Were Undermined by Structural Flaws in the Market, Unsuccessful Oversight, and Uncontrollable Competitive Forces.* Sacramento, California, March 22, 2001.	The California State Auditor reviewed the operations of the power exchange and CAISO, including prices in the electricity market for the period April 1998 through December 2000. Consultants for the State Auditor reviewed reports and statistical and econometric models used by various monitoring, and/or market analysis groups of the power exchange and CAISO. They also interviewed respective members of these organizations. The State Auditor concluded that market participants adopted tactics to manipulate wholesale electricity prices in California. The authors noted that bidding data from the last year prior to the March 2001 issuance of their report suggested that both buyers and sellers deliberately attempted to manipulate electricity prices. Market participants utilized bidding strategies that held back needed supply, which then forced the CAISO to make purchases at exorbitant prices to guarantee system reliability.

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Appendix V: GAO Contacts and Staff Acknowledgments

GAO Contacts

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