Appendix 1

The importance of "market" regulation: lessons from California

A1-1 Introduction

During spring 2000 until spring of 2001, California experienced an energy crisis that led to skyrocketing natural gas and electricity wholesale prices which culminated in a regional electricity shortage. The subsequent electricity shortage caused California's electricity system operator (CAISO), to institute 'rolling blackouts' forcibly to adjust the State's electricity demand to the available amount of electricity in the state. Furthermore, the crisis led to the bankruptcy of PG&E, the largest electricity distribution company in the state, and the California Power Exchange, California's electricity marketplace.

Large supply shocks and a large demand shock that hit the state can largely explain the electricity crisis (Taylor and VanDoren, 2001). Firstly, a lack of investment in power plants represents probably the most important reason of the crisis. While demand grew by about 5,500 MW between 1996 and 1999, generating capacity increased by only 672 MW over the same period[1]. At the same time the California economy grew steadily during that period and this led to an increase in demand. This was exacerbated by the fact that retails prices were fixed and thus Californians had no incentives to decrease their demand.

In conjunction with these two fundamental reasons a combination of several other factors played a role in the crisis. For instance, poor hydro conditions reduced the generating capacity of the hydroelectric dams while abnormally hot weather increased electricity demand for air conditioning. Additionally, due to environmental rules some power plants could not operate because they did not have emissions credits. Similarly, California's dependence on imported electricity (20% of Californian consumption) became problematic because of a growth in electricity demands in neighboring States reduced the amount these States were able to export to California. Moreover this period saw a large increase in natural gas prices which was the fuel of choice for the marginal power plants. Finally

last, but not least, poor market design and abuse of market power also played a role in the crisis.

There are numerous articles detailing the Californian electricity liberalisation process (Blumstein *et al*, 2002) and the collapse of its market (Borenstein, 2001; Jurewitz, 2002). California was among the first states in the U.S. to restructure its electricity industry in accordance with the world-wide trend of liberalisation. California's restructuring process was undertaken within a record-breaking time of five years[2]. The main purpose was to reduce the relatively high electricity prices. The process was based largely upon previous experiences in gas and telecommunications restructuring, rather than on experience with other liberalised electricity markets. California began its electricity market deregulation process in the mid 1990s. Two core pieces of the new industry structure, the California Independent System Operator (CAISO) and the California Power exchange (CalPX) and their procedures and tariffs were conceived and set up within three years. When the restructured electricity market started operating on March 31 1998, it was generally considered to be one of the most liberalised electricity markets in the world.

The main facts of this crisis were a 500% increase in prices between 1999 and 2000 (Joskow, 2001), the bankruptcies of the two largest utilities, dozens of blackouts have taken place, and an increase in the energy bill estimated at about $50 billion. The reasons for this meltdown were multiple and are summarised briefly in figure A1-1. While the issue of market power has been widely studied for this market[3], interestingly, in his statement before the US Senate Committee on Governmental Affairs[4], bad market design was cited first by Paul Joskow as a reason of the Californian crisis. According to Joskow the causes of California's

[1] California Public Utilities Commission, "California's electricity options and Challenges", www.cpuc.ca.gov

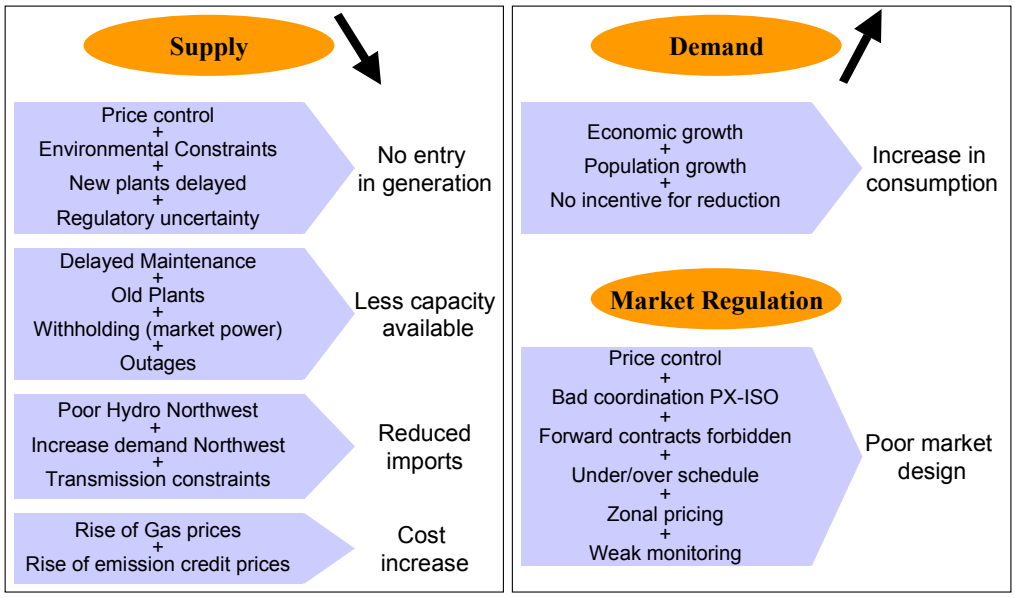
[2] Background documents about the California liberalization process are available at www.ucei.berkeley.edu/restructuring.html

[3] See chapter 6

[4] Statement of Professor Paul L. Joskow Before The Committee on Governmental Affairs

meltdown were *"complex, reflecting a combination of bad market design, bad regulatory decisions, unanticipated changes in basic supply and demand conditions, and supplier behaviors which rationally took advantage of opportunities created by these conditions to further increase market prices".*

Figure A1-1: The causes of California crisis



Beside the supply and demand shocks, three features of the California market design contributed to the crisis. These features were the freeze on retail prices, the restriction placed on long-term contracts, and the design of the PX and CAISO markets (Farmer *et al*, 2001). The first feature certainly represented the most important design flaw of the California market design, i.e. the wholesale market was deregulated while the retails markets were not and were subject to fixed prices defined for four years. Hence, distribution companies were forced to buy in an unregulated wholesale market and to sell to final customers at a regulated fixed price. The freeze on retail prices created important market distortions because suppliers could charge high prices for some periods without worrying that consumers would reduce their consumption (GAO, 2002). This feature had disastrous financials consequences for the distribution companies when, in the summer of 2000, wholesale prices rose above the fixed retail price.

United States Senate. Available at http://econ-www.mit.edu/faculty/pjoskow/papers.htm

This retail price control is always cited as the most important flaw of the California market design (Smith *et al*, 2001). However, two others features which relate directly to wholesale market design also played an important role.

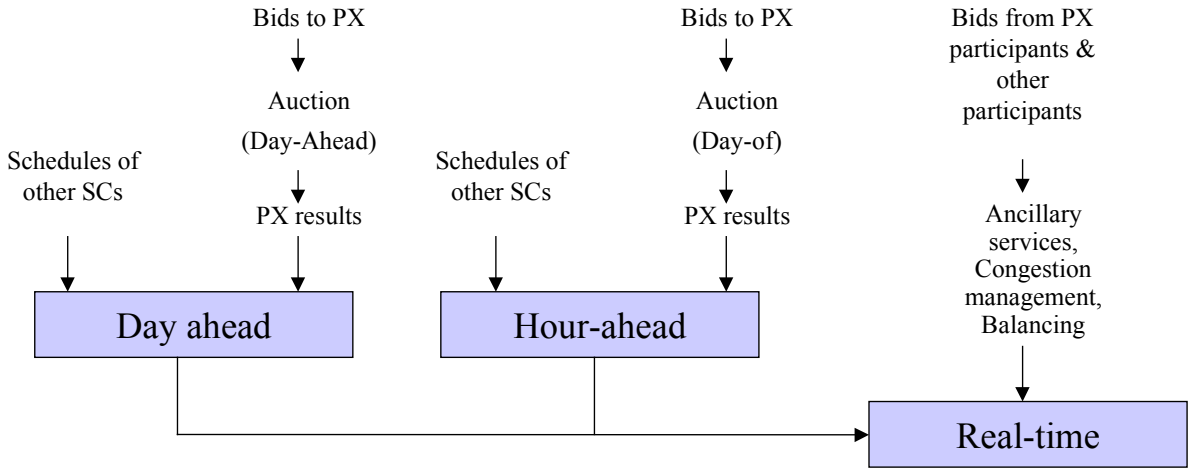
The aim of this appendix is not to provide a new analysis of the crisis but rather to focus on the role of wholesale market design in the meltdown of this market. We first present the main aspects of the design of the Californian market with respect to the respective roles of the power exchange, the system operator and transmission pricing (A1-2). Subsequently we pay attention to the shortcoming of this design (A1-3). Finally we summarise some key lessons that can be learnt from the Californian market for the European market (A1-4).

A1-2 Overview of the Californian market design

Similar to European electricity markets, the Californian market was organised around two primary institutions: a power exchange (CalPX) and an independent system operator (CAISO). The power exchange and ISO began operation in April 1998. The power exchange ran a day-ahead market using a one-sided bidding arrangement (as did the UK pool) for each hour with a marginal clearing price system, i.e. all bidders were receiving the same price equal to the highest accepted bid. The power exchange was also mandatory for the demand and supply of the investor-owned-utilities. The exchange handled roughly 85% of the volume of day-ahead transactions. Hence, participation to the power exchange was mandatory for some players and voluntary for some others. Similar to European markets, the power exchange provided a day-ahead market and after matching of supply of demand the PX submitted a balanced schedule to the system operator (figure A1-2). An important aspect of the California markets was the limitations on bilateral transactions. Investor-owned utilities were forced to divest much of their fossil-fuel based power plants and not permitted to sign multiyear contracts to buy part or all of the output from the plants they had just sold. Due to this prohibition, the distribution companies were required to buy

almost all of the power they needed on the power exchange and on the real-time market run by the ISO. In addition to the PX, a peculiarity of the Californian market was that anyone other than investor-owned-utilities was allowed to form their own market. These markets were called scheduling co-ordinators (SCs). Note, Enron was one SCs. In fact SCs were just a way to handle physical bilateral transactions since, similar to the PX, the SCs had to submit a balanced schedule for each hour to the ISO.

Figure A1-2: Californian 's electricity market design



Source: California Power Exchange, Market Year Report to Californians, 1998-1999

Again, similar to European power exchanges, the California power exchanges ran an "energy only" market and did not take into consideration the different aspects of physical delivery. This was the responsibility of the California Independent System Operator (CAISO). The principal responsibility of CAISO was the management of the operation of the network (Alaywan, 2000)[5]. Three majors tasks can be distinguished: real time balancing, congestion management and ancillary services[6]. An important difference between the former Californian design and most European markets is the fact that the ISO was running a real-

[5] See also www.CAISO.com for a detailed description of CAISO design and "redesign"

time market to manage the operation of the network. Hence market participants were able to change their day-ahead position by trading in the ISO's real time market. The purpose of this market commonly called a real–time or balancing market, was to price additional generation in the event of a supply shortfall and generation decreases in the event where supply exceed demand. For instance, a supplier that was scheduled to produce 100 MWh but was able only to produce 90 MWh, was forced to purchase 10 MWh from the ISO real-time market to maintain the balance between supply and demand. The ISO market was thus critical as it fell at the end of the chronological sequence of markets.

The ISO was also operating a "reserve capacity market". Through this market, the ISO purchased reserve capacities for two reasons. One the reserve capacities were used to meet unexpected demand peaks. Two they allowed the ISO to adjust production at different locations within the network to relieve congestion. The ISO also relied on several annual supply contracts with generators to ensure supply availability in constrained area.

One important controversial feature of the California market was the approach used for transmission pricing. When the ISO received schedules from the PX and the SCs it had to determine the physical feasibility of the transactions with respect to transmission constraints. Several zones were determined within the ISO system to take into account transmission constraints and possible congestion within a zone was not priced. When such a type of congestion occurred, the ISO paid above market prices to certain generators to use their output to relieve congestion[7]. Moreover due to important transmission constraints an important problem for the system operator was to make sure that where there was no substitutes for the output of a specific generator this would operate. Reliability Must-Run Contracts (RMR) were created for this purpose. These

[6] Ancillary services cover products such as Regulation reserve, Spinning reserve, Replacement reserve, Black start…

[7] The price paid by the ISO is necessarily above-market, since there would have been no congestion if the necessary generation units had been willing to operate at the zonal market clearing price.

contracts aimed to compensate a generator forced to run for reliability purposes when the market price was below their operating costs.

In conclusion the design of the California electricity market consisted of several parallel and overlapping markets. Additionally the wholesale design was based on the idea that most co-ordination problems should be left to the market and that the role of the system operator should be as minimal as possible. Although, the design of this market was not the primary reason of the crisis, obvious mistakes contributed to California's problem by limiting market responsiveness to the extreme conditions.

A1-3 Poor market design?

The existence of retail price control is always cited as the most important flaw of the California market design. However at the wholesale level two others features of the California electricity market exacerbated the problem. One, distribution companies were not allowed to sign long term contracts to hedge their position. Two, the separation between system operation (CAISO) and power exchange (CalPX) created a complicated set of wholesale markets imperfectly coordinated with one another.

The decision to forbid long term contracts has several explanations. First following the divestiture of their generation asset the incentives for the investor-owned utilities were important for them to make contracts with the company buying the generation units. There was a fear that at first such possibility would distort the selling price of the asset and the prices for electricity. Second such contracts could be substituted for a utility ownership of the generator and would represent a threat for the creation of a competitive market. In addition, at the beginning of the market, utilities were reluctant to sign long-term contracts because long-term prices were generally higher than the spot prices of the PX.

This design appears problematic when the prices rose dramatically on the power exchange and on the CAISO market

Beside a lack of demand response and the impossibility for distribution companies to use bilateral contracts for hedging purposes, there was another important controversial issue this was the decision to separate the system operator managing transmission operations and reliability from a separate power exchange to coordinate market operation. The existence of the three markets, day-ahead, real-time and reserve, created uncertainties about which of them would have the best price and thus created even more arbitrage opportunities than would normally exist in a typical market (Taylor and VanDoren, 2001).

In particular, the low co-ordination between the PX and the ISO was an important limitation for the actual role of the ISO in the market. Hence the separation of the PX and the ISO had important consequences with respect to wholesale market design. On a short-term horizon, day-ahead, hour ahead, no distinction can be made between energy dispatch and use of transmission capacity. Thus, it was a fallacy to separate these two aspects (Chandley *et al*, 2000). Moreover the physical feature of contracts on the PX imposed constraints on real-time operation.

In theory, arbitrage between the power exchange and the real-time market would result in similar prices in both markets. However because the ISO market was run after the power exchange results, uncertainties existed about whether a generator would receive a higher price if waited for the ISO results. This is one explanation for the "INC-ing Load into the real-time market" strategy described in the Enron memos[8]. Additionally the pricing rules in the two markets were different in the respective markets of the PX and the ISO. For instance, different price caps created incentives for suppliers during high prices hours to use the ISO real-time market rather than the PX.

[8] See chapter 6

The existence of various markets offered market participants several opportunities to arbitrage price difference across markets but also created perverse incentives for trading strategies. For instance many of market design problems have been identified as early as 1998 by the market surveillance Committee of the California ISO with regard to the market for ancillary services (Wolak *et al*, 1998): *"(1) some firms are subject to cost-based price caps while others are allowed to earn market-base rates; (2) the demand for ancillary services has been higher than anticipated; (3) the amount of each ancillary service demanded by the ISO does not depend on market prices and these demands are not procured in a rational manner; (4) perverse incentives for generator bidding behaviour have been created by reliability must-run contracts; (5) the ISO has often purchased ancillary services separately from small geographic areas, increasing the potential for the exercise of market power; (6) the ISO's dispatch practices have not been transparent to market participants; (7) the allocation of ancillary services costs to scheduling co-ordinators has been flawed".*

With respect to transmission pricing, the use of pre-determined zones for the management of transmission constraints was problematic due to the existence in some periods of intra zone constraints[9]. The day-ahead transmission market relied on incremental/decremental pairs to balance inter-zonal flows, whereas the real-time market was not confined to matched pairs. Furthermore, the SCs paid the cost of inter-zonal balancing whereas the system operator absorbed the cost of intra-zonal balancing (Chao and Wilson, 1999) which provided poor locational signals. Such an approach encouraged overscheduling of constrained transmission.

In conclusion the lack of demand response, the over reliance on the power exchange resulting from the ban on using bilateral contracts, and the inefficient transmission pricing system represent the principal shortcomings of California

[9] See chapter 9

market's design leading to strategic incentives arising from the interaction of the PX and the ISO as illustrated by the Enron's memos[10].

A1-4 Lessons for European markets

In assessing the role of market design in the collapse of the California, one must recognise that the first lesson to be drawn from the California crisis is nothing other than an reminder of the most basic principle of Economic theory, i.e. when supply decreases and demand increases simultaneously, prices go up. Indeed a large part of the price spikes of 2000 and 2001 can be explained by factors directly related to supply and demand. Hence, in the short term for most European Member States, such situation appears to be unlikely due the existence of important reserve margins[11] and the slow increase in demand for electricity in most countries[12]. However, the several similarities between the design and regulatory environment of the former California wholesale market with actual European markets make analysis of the Californian crisis of particular interest.

First, several similarities exist in terms of design between California and most European markets: separation power exchange/system operator[13], non-harmonised transmission pricing methods (national/international)[14], regulated retails prices…etc. These aspects of California market design exacerbated extreme conditions. For this reason it is interesting for European markets to pay attention to the details of the inappropriate Californian market design which were a complementary factor to the Californian crisis. Though, a good market design might not have survived the summer 2000, it would have removed perverse incentives and would have certainly mitigated the extent of the crisis (Hogan,

[10] See chapter 6
[11] Due to over capacity in most European countries, the reserve margin in Europe is above 30% (IEA, 2002)
[12] The projected growth in electricity demand in Europe through 2015 is below the expected rate of GDP growth, 2.6% per year (IEA, 2001)
[13] See chapter 4

2001). For instance, facing a lack of demand response, an increase of retail prices was presented as an essential element for limiting the price spikes[15] but this was not implemented. Moreover the low co-ordination between the power exchange and the system operator and the inefficient transmission pricing mechanisms, illustrated by the Enron strategies, shows that artificially separating these two functions creates artificial constraints on markets functioning.

Second, several authors (Joskow, 2001; Cramton, 2003) have argued that the fact that the Californian market design incorporated bits and pieces of alternatives market models was due to an effort to appease various interest groups. Such process led to the creation of the most complicated electricity market ever created with features beneficial to some participants, but harmful for the over-all design. Hence, it was especially difficult to make changes that would adversely impact a large group of market participants. Again this aspect is interesting for the European situation because most power exchanges to date have been created on private initiatives and most of them are owned by market participants.

Third, California had more than a dozen regulatory bodies with overlapping responsibilities (Robb and Sugalski, 2001). The State's Public Utility Commission (PUC) had not authority over municipal utilities within California, utilities in neighbouring States, or interstates transmission companies. Other agencies such as Air quality Management districts, the California Energy Commission (CEC) also had different types of conflicting regulatory power. For instance, PUC was responsible for approving of the retail prices that private utilities could charge for electricity while FERC was responsible for approving wholesale prices that producers could charge for power and use of their transmission lines. Hence, it was difficult to find which organisation was ultimately responsible because jurisdiction lines were not well defined. For instance when prices started to rise

[14] See chapter 9

dramatically, PUC refused to raise retail prices and insisted that refunds for abuse of market power on the wholesale market (under the responsibility of FERC) would obviate the need for retail price increases (Hirst, 2001). This situation clearly made it difficult for efficient and rapid regulatory decisions to be made when the crisis started. This problem is also present in Europe, where regulatory responsibility is divided up between the European Commission, Member States, national Regulators, competition authorities, and even regional and local authorities.

Finally, the Enron memos illustrate how the complexity of electricity markets result in sophisticated market behaviors, and how players may take advantage of bad rules and poor market design. In a European market where market design has been widely overlooked by the liberalisation process, it is not unreasonable to believe that similar behaviors are taking place. Hence, due to the complexity of different market rules and grid code in the different European Members States it appears sensible to monitor closely electricity markets in order to diagnose and solve market performance and market design problems. Moreover, beyond the problems of market design, the nature of electricity markets and the existence of concentrated markets make this an issue of primary importance because they raises important concerns with respect to market power.

[15] Manifesto on the California Crisis, January 2001, Available at www.haas.berkeley.edu/news/california_electricity_crisis.html